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UPPER TRIASSIC MARINE INVERTEBRATE FAUNAS OF NORTH AMERICA

BY

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UPPER TRIASSIC MARINE INVERTEBRATE FAUNAS OF NORTH AMERICA

By JAMES PERRIN SMITH

INTRODUCTION

Since 1892 the writer has been engaged in the study of the Triassic faunas and stratigraphy of North America. He has collected at nearly all the principal localities in the United States where Triassic marine fossils have been found and has had the use of material from all the others. This work has been done chiefly in cooperation with the United States Geological Survey, and the writer wishes to acknowledge his indebtedness to the officers of that institution, especially to the director George Otis Smith, and to Charles D. Walcott, Joseph S. Diller, T. W. Stanton, and David White for the opportunity to carry on and publish this work.

The following reports, which embody the results of completed investigations, have already been published:

The Carboniferous ammonoids of America: U. S. Geol. Survey Mon. 42, 1903.

The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., Geology, vol. 1, No. 10, 1904.

The stratigraphy of the western American Trias, Von Koenen's Festschrift, 1907.

The Triassic cephalopod genera of America, by Alpheus Hyatt and James Perrin Smith: U. S. Geol. Survey Prof. Paper 40, 1905.

Middle Triassic marine invertebrate faunas of North America: U. S. Geol. Survey Prof. Paper 83, 1914.

Many smaller papers have also been published.

This volume is the third of a series planned many years ago by Alpheus Hyatt and the writer. The first volume of this series is Professional Paper 40 and the second is Professional Paper 83 of the Geological Survey. The fourth volume will present a monographic study of Lower Triassic faunas, which is now nearly completed.

A monographic treatment of all recognized invertebrate marine fossils of the Upper Triassic of North America is set forth in this volume. The geologic horizons of all known localities are determined, so far as possible, and the stratigraphy and correlation are discussed. An attempt is made to place these horizons properly in the standard European time scale, although it is evident that some of these correlations can now be only tentative.

For convenience of reference there is given below a correlation table, showing the position in the stratigraphic column of all known Upper Triassic faunas in North America; also a synopsis of all known Triassic faunas and localities in North America. This synopsis is necessarily incomplete, but it will serve to show the present state of our knowledge and the progress of that knowledge in the last 30 years.

The principal papers in which the Triassic series of North America is described are listed below:

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——— Geographic relations of the Trias of California: Jour. Geology, vol. 6, pp. 776–786, 1898.

——— Ueber Pelecypoden-Zonen in der Trias Nord-Amerikas: Centralbl. Mineralogie, 1902, pp. 689–695.

——— The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., Geology, vol. 1, pp. 323–430, 1904.

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——— The occurrence of coral reefs in the Triassic of North America: Am. Jour. Sci., 4th ser., vol. 33, pp. 92–96, 1912.

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GEOLOGIC RELATIONS OF NORTH AMERICAN UPPER TRIASSIC INVERTEBRATE FAUNAS

The geologic relations of the beds containing the Upper Triassic marine invertebrate faunas of North America are shown in the following table:

Relations of North American Upper Triassic invertebrate faunas

<table>
<tr><th></th><th>European equivalents</th><th colspan="3">California</th><th colspan="2">Nevada</th><th>Oregon</th><th>British Columbia</th><th>Alaska</th></tr>
<tr><td rowspan="6">Upper Triassic.</td><td>Rhaetic.</td><td colspan="3">(?)</td><td colspan="2">(?)</td><td>(?)</td><td>(?)</td><td>(?)</td></tr>
<tr><td rowspan="2">Noric.</td><td>Brock shale.</td><td colspan="2">Pseudomonotis zone with P. subcircularis, Rhabdoceras, and Halorites. Thickness, 1,000 feet.</td><td rowspan="6">Star Peak formation.</td><td>Pseudomonotis zone with P. subcircularis, Rhabdoceras, and Halorites. Thickness, 1,000 feet.</td><td>Pseudomonotis zone.</td><td>Pseudomonotis zone with Arniotites.</td><td>McCarthy formation, with Pseudomonotis subcircularis and Arniotites. Thickness, 2,000 feet.</td></tr>
<tr><td rowspan="3">Hosselkus limestone.</td><td colspan="2">Spiriferina zone.
Coral zone.</td><td>Coral zone.</td><td>Coral zone.</td><td>Sutton formation with Coral zone.</td><td>Coral zone of Gravina Island and Iliamna Lake.</td></tr>
<tr><td rowspan="3">Karnic.</td><td rowspan="2">Tropites subbullatus zone.</td><td>Juvavites subzone, with Tropites, Juvavites, Metasibirites, and Halobia ornatissima.</td><td rowspan="2">Halobia-bearing beds.</td><td rowspan="2">Beds bearing Halobia oregonensis.</td><td rowspan="2"></td><td rowspan="2">Nizina limestone. Chitistone limestone with Juvavites, Tropites, and Halobia superba.</td></tr>
<tr><td>Trachyceras subzone, with Tropites, Paratropites, Clionites, Trachyceras, and Halobia superba.</td></tr>
<tr><td rowspan="2">Pit shale.</td><td colspan="2">Halobia rugosa zone, with Trachyceras storrsi.</td><td></td><td></td><td>Dawsonites zone.</td><td>Dawsonites zone?</td></tr>
<tr><td>Middle Triassic.</td><td></td><td colspan="2"></td><td>Daonella zone, with Ceratites trinodosus fauna.</td><td></td><td>Muschelkalk fauna.</td><td>Muschelkalk fauna.</td></tr>
</table>

OUTLINE OF THE AMERICAN TRIASSIC SEA

During the time represented by the *Meekoceras* zone of the Lower Triassic there was a sea in what is now the Great Basin, which opened to the northwest and connected around the old Pacific shore line with Asia. The Bering portal was open, so this sea was connected with the Arctic Sea as well as with the Oriental Tethys.

During the time represented by the *Tirolites* zone this sea was united through the Central American portal with the Mediterranean, presumably through a mid-Atlantic archipelago; but neither Asiatic nor Boreal immigration took place.

In the *Columbites* zone there was only Boreal influx through the Bering portal, letting in the Arctic fauna, which came down to Idaho on the east, and down to Albania, presumably through the Ural portal, on the west.

The *Parapopanoceras* zone marks the ending of the Boreal connection, and no connection was yet established with the Oriental or the Mediterranean regions.

During the time represented by the *Ceratites trinodosus* zone the Mediterranean and Atlantic furnished the main channel for intermigration, but some intermigration also took place with Asia and the Boreal region.

At the beginning of Upper Triassic time the *Halobia rugosa* zone shows only Mediterranean influence, whereas the *Dawsonites* zone, probably contemporaneous, shows only Boreal influence. There was then probably only a climatic barrier between the faunas of California and those of British Columbia and Alaska.

During the time represented by the *Tropites subbullatus* zone the isotherms had probably shifted to the north, for no barrier is apparent between California and Alaska. This fauna is strictly Mediterranean in its kinship; it is rich in European genera and species up to southern Alaska and still shows some likeness to the Mediterranean up to Nation River in northern Alaska.

During the epoch of the lower Noric coral zone there was no barrier between the Mediterranean region and California, nor any climatic difference between the California sea and southern Alaska, for the same species of corals were building reefs in all three regions.

In the time represented by the *Pseudomonotis* zone the European connection was cut off, and intermigration took place through the Bering portal, which opened into the Arctic Sea. This fauna came down on both sides of the north Pacific, and spread southward even below California, probably under the influence of a Boreal current.

With this epoch the marine Triassic history of North America ends, for everywhere, from Alaska to California, the oldest Jurassic beds lie unconformably upon the upturned edges of the Triassic.

TRIASSIC LOCALITIES AND HORIZONS IN NORTH AMERICA

The following synopsis shows the Triassic localities and horizons in ascending order in North America:

Lower Triassic

Meekoceras zone:
- Southeastern Idaho (Aspen Mountains and Bear Lake).
- South central Utah.
- Eastern Nevada (Phelan ranch).
- Inyo County, Calif.

Tirolites zone: Southeastern Idaho (Bear Lake).
Columbites zone: Southeastern Idaho (Bear Lake).

Middle Triassic

Parapopanoceras zone: Inyo Mountains, Calif.
Ceratites trinodosus zone:
- West Humboldt Range, Nev.
- East Range, Nev.
- Desatoya Mountains, Nev.
- Pit River, Shasta County, Calif.
- British Columbia, Kamloops district.
- Seward Peninsula, Alaska.

Upper Triassic

Halobia rugosa zone: Brock Mountain, Shasta County, Calif.
Dawsonites zone = *Halobia rugosa* zone:
- Liard River, British Columbia.
- (?) Hamilton Bay, Kupreanof Island, Alaska.
- (?) Nation River, Yukon Valley, Alaska.

Tropites subbullatus zone:
- *Trachyceras* subzone:
  - Brock Mountain, Shasta County, Calif.
  - Genesee Valley, Plumas County, Calif.
  - Rush Creek, Feather River, Plumas County, Calif.
  - West Humboldt Range, Nev.
  - Eagle River, Blue Mountains, Oreg.
  - Zacatecas, Mexico.
  - Hamilton Bay, Kupreanof Island, Alaska.
  - Nation River, Yukon Valley, Alaska.

Juvavites subzone (= *Halobia ornatissima* subzone):
- Brock Mountain, Shasta County, Calif.
- Genesee Valley, Plumas County, Calif.
- Hamilton Bay, Kupreanof Island, Alaska.
- Herring Bay, Admiralty Island, Alaska.
- Chitina River, Alaska.
- Copper River region, Alaska.
- Nation River, Yukon Valley, Alaska.

Coral zone:
- Brock Mountain and Cow Creek, Shasta County, Calif.
- West Humboldt Range, Nev.
- Pilot Mountain, Esmeralda County, Nev.
- Eagle Creek, Blue Mountains, Oreg.
- Sutton formation, Cowichan Lake, Vancouver Island.
- Gravina Island, Alaska.
- (?) Admiralty Island, Alaska (*Myophoria suttonensis* zone).
- Chitina River, Alaska.
- Iliamna Lake, near Cook Inlet, Alaska.

Pseudomonotis zone:
- Genesee Valley, Plumas County, Calif.
- Brock Mountain, Shasta County, Calif.
- American Canyon, Placer County, Calif.
- West Humboldt Range, Nev.
- Wallowa Lake, Blue Mountains, Oreg.
- Vancouver Island.
- Queen Charlotte Islands.
- British Columbia (numerous minor localities).
- Copper River region, Alaska.
- Nation River, Alaska.
- Arctic Mountains, Alaska (and many minor localities).

Rhaetic plant-bearing beds: Numerous minor localities in New Mexico, Arizona, and Mexico.

NUMBER OF SPECIES IN THE FAUNA

The invertebrate fauna of the Upper Triassic of western America, described in this volume, totals 314 species. These species include 167 ammonoids, 17 nautiloids, 4 belemnoids, 14 gastropods, 52 pelecypods, 22 brachiopods, 4 echinoderms, 33 corals, and 1 hydroid. The ammonoids are represented by 44 genera and 9 subgenera, the nautiloids by 12 genera, the belemnoids by 3 genera, the gastropods by 10 genera the pelecypods by 19 genera, the brachiopods by 5 genera, the corals by 13 genera, and the hydroids by 1 genus. Of the total number of species the great majority—208 species—occurs in the *Tropites subbullatus* zone of the Hosselkus limestone on Brock Mountain and its continuation in Shasta County, Calif. In the coral zone of Noric age, also in the Hosselkus limestone, 17 additional species have been recognized—16 corals and 1 brachiopod. The *Pseudomonotis* zone of Placer County, Calif., adds 3 to this list, and the same horizon in Plumas County adds 6, making a total of 234 species for the Upper Triassic of California. The rest of America, including Nevada, Oregon, British Columbia, and Alaska, add only 80 species to the total list.

All these species are given in full under the proper localities and in the systematic list on pages 14–20.

LOCALITIES OF UPPER TRIASSIC FOSSILS IN NORTH AMERICA

SHASTA COUNTY, CALIF.

The locality in North America that has yielded the largest number of Upper Triassic fossils is on Brock Mountain, the divide between Squaw Creek and Pit River, in Shasta County, Calif. The Hosselkus limestone crops out almost continuously from the junction of Cedar and Little Cow creeks near the Afterthought mine. It strikes northwestward, crosses Pit River near Brock's ranch, rises into the massive ridge of Brock Mountain, and finally dips under the Tertiary lava near the head of Squaw Creek. Along this entire distance of over 30 miles the dark shale bearing *Pseudomonotis subcircularis* (Brock shale) overlies the limestone and is recognizable by its lithology and by the presence of *Pseudomonotis*.

Fossils occur almost everywhere in the limestone but are most abundant at the south and at the north end of Brock Mountain; at the junction of Cedar and Little Cow creeks, where the coral zone is best exposed; and on the North Fork of Squaw Creek, about 3 miles north of Kelly's ranch, where the best collections come from the *Juvavites* subzone.

A general section of the beds in this region is given below, but the thickness of the limestone is not constant; it increases from about 150 feet on Cedar Creek to about 400 feet on Brock Mountain and then decreases to a thin edge on North Fork of Squaw Creek.

Triassic section in Shasta County, Calif., showing European time equivalents

System or series	European equivalents	Formation		Fossils and character of beds	Thickness (feet)
Upper Triassic.	Noric.	Brock shale.		Black slates that carry *Pseudomonotis subcircularis*, *Rhabdoceras*, and *Halorites*.	800?
		Hosselkus limestone.		*Spiriferina* zone (hard siliceous limestone full of brachiopods).	100
				Coral zone; numerous reefs of Astraeidae, *Isastrea*, *Stephanocoenia*, *Astrocoenia*, *Thamnastraea*, and *Thecosmilia*.	
	Karnic.		*Tropites subbullatus* zone.	*Juvavites* subzone (hard limestone that carries abundant ammonites, *Juvavites*, *Gonionotites*, *Discophyllites*, *Tropites welleri*, and other fossils).	50
				Trachyceras subzone (shaly limestone that carries *Tropites subbullatus*, *Tropites torquillus*, *Tropites dilleri*, *Discotropites sandlingensis*, *Paratropites*, *Trachyceras lecontei*, *Trachyceras shastense*, *Halobia superba*, and other fossils).	50
				Calcareous shales full of *Halobia superba* and a few crushed *Trachyceras*.	100
		Pit shale.		*Halobia rugosa* zone (shales and black argillites that carry *Halobia rugosa* and crushed *Trachyceras*).	150?
				Unconformity?	
Middle Triassic.	Muschelkalk.			Black siliceous shales, altered tuffs, and igneous rocks that carry *Ceratites* cf. *C. humboldtensis*, *Ptychites*, and other fossils.	1,500?
				Unconformity.	
Carboniferous.		Nosoni formation.		Tuffs and shaly limestones that carry *Fusulina elongata* and other fossils.	
		McCloud limestone.		Limestone that carries *Fusulina robusta*, *Fusulina cylindrica*, and other fossils.	

The Karnic fauna of the *Tropites subbullatus* zone of Brock Mountain (the *Trachyceras* subzone and *Juvavites* subzone of the Hosselkus limestone) is listed in full below; the two faunal subzones are distinguished in separate columns.

The fossils of the *Trachyceras* subzone are most abundant and best preserved at the south end of Brock Mountain, 3 miles east of Madison's ranch, near the trail across to Pit River. Those of the *Juvavites* subzone are most abundant at the north end of Brock Mountain, 5 miles north of Madison's ranch, and also on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Of the ammonoids and nautiloids of the *Tropites subbullatus* zone of California 25 per cent are identical with species in the Mediterranean Triassic, and in all 37 per cent are either identical with or very nearly related to species in that region. This kinship applies equally to all the groups of invertebrates and extends through the faunas from the bottom of the *Halobia rugosa* zone to the top of the coral zone. It is therefore not due merely to the kinship of the original immigrants but was maintained by continued intermigration. Many of these same species are also found in the Mediterranean region, which shows a much closer connection between the American and the Mediterranean regions. The Great Basin sea was then the western end of the ancient Tethys, of which the Indian sea was the eastern limit.

The most noteworthy feature of this fauna is the abundance of *Trachyceras* at the lower horizon of the *Tropites subbullatus* zone; in the Mediterranean that genus had disappeared before the advent of the *Tropites subbullatus* fauna.

Another remarkable feature is the abundance of *Clionites* in the middle of the *Tropites subbullatus* zone in California. Elsewhere *Clionites* is almost diagnostic of the Noric. In the Mediterranean and in India *Metasibirites* also is characteristic of the Noric, whereas in California it occurs only in the *Juvavites* subzone of the *Tropites subbullatus* zone.

Another feature is the considerable number of species which in California occur only in the *Juvavites* subzone and are said to occur in the Mediterranean in the zone of *Lobites ellipticus,* below the zone of *Tropites subbullatus.* These species are *Pinacoceras rex, Juvavites subinterruptus, Microtropites tubercularis, Margarites senilis, Metatirolites subpygmaeus, Thisbites uhligi.*

It therefore seems that *Tropites, Metasibirites, Clionites,* and probably *Trachyceras* are of American origin; whereas *Juvavites* and many of its associates in the *Juvavites* subzone must have come from the Mediterranean. On the other hand, the species of *Tropites* in the *Juvavites* subzone of California are not nearly related to Mediterranean forms but are endemic, derived from local ancestors.

The *Juvavites* subzone of California contains a considerable number of species closely related to forms known in the Sicilian Karnic stage, notably of *Juvavites, Margarites, Gonionotites, Discophyllites,* and *Tropites* of the group of *Tropites mojsvarensis.* It is likely that the Sicilian Karnic beds include a higher stage which is not well known in the Hallstatt district of the Alps.

The zone of *Tropites subbullatus* in California is rather sharply separated into two faunal subzones—a lower, the *Trachyceras* subzone, which carries an abundance of *Trachyceras, Tropites* of the group *Tropites subbullatus, Paratropites,* and *Clionites;* and an upper, the *Juvavites* subzone, which carries a few survivors of the *Tropites subbullatus* group and an abundance of *Tropites* of the *Tropites mojsvarensis* group, *Juvavites, Gonionotites, Metasibirites,* and *Arcestes. Discotropites, Sagenites,* and the nautiloids occur in nearly equal numbers in the two faunal subzones.

In its broader sense, the zone of *Tropites subbullatus* is one of the great interregional correlation zones of the earth, for it carries very closely related faunas in (1) the Mediterranean region; (2) the Californian province of the western American region; (3) the Alaskan province; and (4) the Indian region. This wide distribution is rivaled only by that of the *Meekoceras* fauna of the Lower Triassic and of the *Arietites* fauna of the Lower Jurassic, but both these faunas show little identity of species in remote parts of the earth.

There was certainly no restricted Arctic-Pacific province for this epoch of the Triassic; but rather the province was coextensive with the ancient Tethys, which stretched from the old Mediterranean westward across the Atlantic to the Californian province and northward to Alaska and eastward from the Mediterranean to the Indian region, for thus far does the community of species extend.

Karnic fauna of the Tropites subbullatus zone of Brock Mountain, Calif.

Species	Trachyceras subzone	Juvavites subzone
Tropites armatus Smith	×	------
arthaberi Smith	------	×
böhmi Smith	------	×
brockensis Smith	------	×
dieneri Smith	------	×
dilleri Smith	×	------
discobullatus Mojsisovics	×	------
fusobullatus Mojsisovics	×	------
hessi Smith	------	×
johnsoni Smith	------	×
keili Mojsisovics	------	×
kellyi Smith	------	×
kokeni Smit	------	×
mojsvarensis Smith	------	×
Tropites morani Smith	------	×
morloti Mojsisovics	×	------
occidentalis Smith	×	------
philippi Smith	------	×
reticulatus Smith	------	×
rotatorius Smith	------	×
rothpletzi Smith	------	×
schellwienensis Smith	------	×
shastensis Smith	------	×
stearnsi Smith	------	×
subbullatus Hauer	×	×
torquillus Mojsisovics	×	×
traski Smith	------	×
ursensis Smith	------	×

Karnic fauna of the Tropites subbullatus zone of Brock Mountain, Calif.—Continued

Species	Trachyceras subzone	Juvavites subzone
Tropites welleri Smith	------	×
wodani Mojsisovics	------	×
Anatropites hauchecornei Mojsisovics	------	×
Microtropites tubercularis Mojsisovics	------	×
Margarites jokelyi Hauer	------	×
senilis Mojsisovics	------	×
septentrionalis Smith	------	×
Discotropites davisi Smith	------	×
empedoclis Gemmellaro	------	×
formosus Smith	×	------
gemmellaroi Smith	------	×
laurae Mojsisovics	------	×
lineatus Smith	×	×
mojsvarensis Smith	------	×
sandlingensis Hauer	×	×
sengeli Mojsisovics	------	×
theron Mojsisovics	×	×
Paratropites arnoldi Smith	×	------
antiselli Smith	×	------
dittmari Mojsisovics	×	------
gabbi Smith	×	------
gracilis Smith	×	------
sellai Mojsisovics	×	------
(Gymnotropites) americanus Hyatt and Smith	×	×
californicus Smith	×	------
laevis Smith	×	------
rotundus Smith	×	------
yatesi Smith	×	------
(Paulotropites) colei Smith	×	------
shastensis Smith	×	------
Tornquistites evolutus Hyatt and Smith	×	------
obolinus Dittmar	×	------
Homerites semiglobosus Hauer	------	×
Jovites pacificus Smith	------	×
(Bacchites) bacchus Mojsisovics	×	------
pinguis Smith	×	------
sphaericus Smith	×	------
Leconteiceras californicum Hyatt and Smith	×	------
occidentale Smith	×	------
Celtites steindachneri Mojsisovics	------	×
Tropiceltites caducus Dittmar	------	×
Sagenites dickersoni Smith	------	×
erinaceus Dittmar	×	×
herbichi Mojsisovics	×	×
shastensis Smith	×	------
Juvavites adalberti Mojsisovics	------	×
brockensis Smith	------	×
damesi Mojsisovics	------	×
edgari Mojsisovics	------	×
externiplicatus Mojsisovics	------	×
intermittens Mojsisovics	------	×
kellyi Smith	------	×
knowltoni Smith	------	×
konnincki Mojsisovics	------	×
mendenhalli Smith	------	×
obsoletus Smith	------	×
shastensis Smith	------	×
subintermittens Hyatt and Smith	------	×
subinterruptus Mojsisovics	------	×
strongi Smith	------	×
Gonionotites hyatti Smith	------	×
northi Smith	------	×
Metasibirites brockensis Smith	------	×
coei Smith	------	×
frechi Hyatt and Smith	------	×
gracilis Smith	------	×
modestus Smith	------	×
mojsvarensis Smith	------	×
parvus Hyatt and Smith	------	×
pusillus Smith	------	×
pygmaeus Smith	------	×
shastensis Smith	------	×
Arcestes carpenteri Smith	------	×
pacificus Hyatt and Smith	×	×
shastensis Smith	------	×
traski Smith	×	------
whitneyi Smith	------	×
winnemae Smith	×	------
Paraganides californicus Hyatt and Smith	×	------
Dieneria arthaberi Hyatt and Smith	×	------
Fremontites ashleyi Hyatt and Smith	×	×
Hauerites lawsoni Smith	×	------
Klamathites kellyi Smith	------	×
schucherti Smith	------	×
Pinacoceras rex Mojsisovics	------	×
Discophyllites patens Mojsisovics	------	×
Sirenites lawsoni Hyatt and Smith	×	------
Sandlingites andersoni Hyatt and Smith	×	------
oribasus Dittmar	×	------
Trachyceras beckeri Smith	×	------
californicum Smith	×	------
lecontei Hyatt and Smith	×	------
lindgreni Smith	×	------
madisonense Smith	×	------
shastense Smith	×	------
Clionites americus Smith	×	------
californicus Hyatt and Smith	×	------
careyi Smith	×	------
compactus Smith	×	------
compressus Hyatt and Smith	×	------
evolutus Smith	×	------
fairbanksi Hyatt and Smith	×	------
merriami Hyatt and Smith	×	------
minutus Smith	×	------
nanus Smith	×	------
osmonti Smith	×	------
robustus Hyatt and Smith	×	------
rugosus Hyatt and Smith	×	------
stantoni Smith	×	------
tornquisti Smith	×	------
whitneyi Smith	×	------
Metatirolites foliaceus Dittmar	×	------
quadrangulus Hauer	------	×
subpygmaeus Mojsisovics	------	×
Thisbites uhligi Mojsisovics	------	×
Polycyclus henseli Oppel	×	------
major Smith	------	×
nodifer Hyatt and Smith	×	------
Choristoceras kellyi Smith	------	×
klamathense Smith	------	×
Arpadites gabbi Hyatt and Smith	×	------
kingi Smith	×	------
Atractites drakei Smith	------	×
philippii Hyatt and Smith	×	×
Dictyoconites americanus Smith	------	×
Orthoceras shastense Hyatt and Smith	×	------
Proclydonautilus hessi Smith	------	×
sauperi Hauer	------	×
spirolobus Dittmar	------	×
stantoni Smith	------	×
triadicus Mojsisovics	×	×
Oxynautilus acutus Mojsisovics	------	×
Grypoceras cooperi Smith	------	×
Mojsvaroceras turneri Hyatt and Smith	×	------
Cosmonautilus dilleri Hyatt and Smith	×	×
hersheyi Smith	------	×
pacificus Smith	------	×
shastensis Smith	------	×
Halobia cordillerana Smith	------	×
austriaca Mojsisovics	------	×
gigantea Smith	------	×
ornatissima Smith	------	×
cf. H. rugosa Guembel	×	------
superba Mojsisovics	×	×
Posidonia jacksoni Smith	×	------
madisonensis Smith	×	------
Avicula soperi Smith	------	×
Gervilleia shastensis Smith	------	×
Pecten sheddi Smith	×	------
Lima kimballi Smith	×	------
Dimyodon storrsi Smith	------	×
Pachycardia digglesi Smith	×	------
Cardita jenkinsi Smith	------	×
Myophoria brockensis Smith	------	×
Mytilus ursensis Smith	------	×
Myoconcha nana Smith	------	×
Anoplophora shastensis Smith	------	×
Unicardium gleimi Smith	------	×

Karnic fauna of the Tropites subbullatus zone of Brock Mountain, Calif.—Continued

Species	Trachyceras subzone	Juvavites subzone	Species	Trachyceras subzone	Juvavites subzone
Worthenia klamathensis Smith	------	×	Shastasaurus alexandrae Merriam	×	------
Collonia occidentalis Smith	------	×	altispinus Merriam	×	------
obesa Smith	------	×	careyi Merriam	------	×
Patella shechani Smith	×	------	osmonti Merriam	×	×
stuarti Smith	×	------	pacificus Merriam	×	------
Capulus silverthorni Smith	×	------	Delphinosaurus perrini Merriam	×	------
Omphaloptychia shastensis Smith	------	×	Merriamia zitteli Merriam	×	------
Dielasma julicum Bittner	×	×	Toretocnemus californicus Merriam	×	------
Terebratula pyriformis Suess	×	×	Thalattosaurus alexandrae Merriam	×	------
Spiriferina coreyi Smith	------	×	perrini Merriam	×	------
Spirigera milesi Smith	------	×	shastensis Merriam	×	×
Rhynchonella howardi Smith	×	×	Nectosaurus halinus Merriam	×	------
richardsoni Smith	×	×	Hybodus shastensis Wemple	×	------
winnemae Smith	×	×	Acrodus wempleae Jordan	×	------
Isocrinus californicus Clark	×	×			

Lower Noric fauna of the coral zone of the Hosselkus limestone of Brock Mountain, Calif.

Spongiomorpha dendriformis Smith.
cf. S. gibbosa Frech.
tenuis Smith.
Stromatomorpha californica Smith.
Thecosmilia cf. T. fenestrata Reuss.
Stylophyllopsis mojsvari Frech.
Confusastrea decussata Reuss.
Isastrea vancouverensis Clapp and Shimer.
Isastrea profunda Reuss.
Latimaeandra eucystis Frech.
Stephanocoenia cf. S. juvavica Frech.
Astrocoenia shastensis Smith.
Thamnastraea rectilamellosa var. minor Frech.
rectilamellosa Winkler.
Spiriferina pittensis Smith.

The Brock shale, about 1,000 feet thick, lies above the Hosselkus limestone. In it only *Pseudomonotis subcircularis* has been identified.

At the junction of Cedar Creek and Little Cow Creek, 3 miles east of the Afterthought mine, Shasta County, Calif., the Upper Triassic is well exposed, both the Hosselkus limestone and the Brock shale being present.

In the Hosselkus limestone, in the lower Noric coral zone, the writer has recognized the following forms:

Species from the coral zone of Cedar Creek, Shasta County, Calif.

Isastrea profunda.
vancouverensis.
Confusastrea grandissima.
Stephanocoenia cf. S. juvavica.
Latimaeandra eucystis.
Thamnastraea rectilamellosa.
Spongiomorpha dendriformis.
cf. S. gibbosa.
Spiriferina pittensis.
Undetermined brachiopods, pelecypods, and ammonites.

In the *Pseudomonotis* zone only *Pseudomonotis subcircularis* was identified. The writer has also found an isolated outcrop of the Hosselkus limestone on Bear Mountain, 2 miles northwest of Sherman's ranch and 18 miles northeast of Redding. The fauna of the beds here, which is the same as at the other localities, is characterized by *Tropites subbullatus, Paratropites sellai, Discotropites sandlingensis, Sagenites herbichi, Trachyceras, Atractites, Halobia superba*, and many other forms.

The lower Noric coral zone has added another great interregional correlation zone to those already known in the Triassic. It extends westward from the Mediterranean region to California, northward from there to Alaska, and eastward to the Himalayas in India. In all these regions it is characterized by the abundance of reef-forming Astraeidae, nearly related to modern reef-building forms that do not flourish in water that has a temperature below 74° F. It is highly probable that this equable temperature extended at least to 61° north latitude in the north Pacific. How far north it may have extended in the Mediterranean-Atlantic region there is no way of telling, for there is no strictly marine Triassic in Europe north of the Alps, in 45° north latitude.

The coral fauna of the Upper Triassic, composed almost entirely of Hexacoralla, is unexpectedly rich for that early period. In the Noric coral zone of western America there are 6 genera and 18 species of Astraeidae, 2 genera and 3 species of Stylophoridae, 2 genera and 4 species of Fungidae, 3 genera and 8 species of Poritidae; in all, 18 genera and 33 species.

The principal localities for this fauna are Brock Mountain and Cow Creek, Shasta County, Calif.; Eagle Creek, in the Blue Mountains, Oreg.; Cowichan Lake, Vancouver Island; Gravina Island, Alaska; and Iliamna Lake, near Cook Inlet, Alaska.

Of this fauna, *Astrocoenia* and *Stephanocoenia* are still building reefs in the West Indies, and *Halomitra* still lives on the reefs in the South Sea. *Spongiomorpha* is ancestral to *Porites* and *Goniopora; Thecosmilia* to *Mussa; Latimaeandra* is probably ancestral to the recent brain corals *Maeandra* and *Leptoria; Isastrea* is very similar to *Goniastrea*, and probably ancestral to it; *Confusastrea* is probably ancestral to *Orbicella;* and *Thamnastraea* to *Siderastrea* and the other more modern Fungidae. Of these corals the chief reef builders are *Isastrea, Confusastrea, Spongio-*

morpha, and *Stromatomorpha.* The Triassic reefs were masses of *Isastrea* and *Confusastrea,* with fringes of the branching and solid stocks of the massive *Spongiomorpha,* as on the modern reefs the Astraeidae have fringes of *Porites, Madrepora,* and *Pocillopora.* The thin incrusting Fungidae, *Agaricia* and similar forms, had their counterpart in *Thamnastraea.* The rare *Halomitra* of the South Sea lived on the reefs then as now. The slender and delicate *Thecosmilia* flourished on sheltered parts of the reef, as *Mussa* does in this day.

The species that are useful for interregional correlation are *Spongiomorpha (Heptastylopsis) gibbosa, Spongiomorpha (Heptastylopsis) ramosa, Stephanocoenia juvavica, Isastrea profunda, Confusastrea decussata, Confusastrea grandissima, Thecosmilia fenestrata, Thamnastraea rectilamellosa,* all common and characteristic species in the Tyrolian Alps and all found at the same lower Noric horizon in the western American coral zone. Along with these species there are others of the same genera and other genera with species different from their European relatives, as *Latimaeandra* and *Astrocoenia.* The *Spongiomorpha* group is much more common in the American than in the Mediterranean region, though that may be an accident of collecting. The only genus thus far found in the American fauna and not known to occur in the Mediterranean fauna is the rare *Halomitra.* The coral zone fauna of America is an exact counterpart of that of the Zlambach beds of the Alps and gives us one of the most clearly defined interregional correlation zones in the Triassic.

The general aspect of the Triassic reefs of America must have been strangely modern, but not like that of the region where they are found as fossils. Instead of the massive mountains of California, Nevada, and Oregon there was a marginal archipelago, the outer barrier of the Triassic basin sea, probably very like that which now exists in the East Indies. Around the islands of this archipelago extended fringing reefs, as they do now in the coral seas. On the reefs flourished corals, a few of them generically identical with those now building reefs and others wonderfully like their modern descendants, probably like them in life even in the bright colors.

Around the reefs of the East Indies live the brilliant *Nautilus* and the exotic-looking pearl oysters. These forms also abounded on the American Triassic reefs and in addition those remarkable cousins of the *Nautilus,* the multiform *Ammonites,* which have no counterpart in modern life.

The islands with their fringing reefs are swallowed up in the massive Cordilleran mountain system. The marginal sea that extended along the west coast of North America is dry land. The climate has changed from that of the balmy hothouse Tropics, where the sea water had a temperature of more than 70° F., to the kindly air of California, the arid continental waste of Nevada, and the biting cold temperate air of Alaska. Only the fossils remain as mute but certain evidence of ancient conditions.

PLUMAS COUNTY, CALIF.

The Triassic of California was first discovered in Plumas County, in Genesee Valley, on Indian Creek, near Robinson's ranch. The section there is very much the same as that in Shasta County, except that nothing older than the *Halobia*-bearing slates is known, and the Hosselkus limestone is not nearly so thick nor so rich in fossils as it is in the Brock Mountain section. The massive limestone, corresponding to the beds of the *Trachyceras* subzone of Shasta County, is comparatively barren of fossils, whereas the beds of the *Pseudomonotis* zone are better exposed and richer in fossils.

Section of Triassic rocks in Genesee Valley, Plumas County, Calif.

Upper Triassic:
- Noric:
  - *Pseudomonotis*-bearing shales and limestones (Swearinger slate) with *Pseudomonotis subcircularis, Halorites americanus, Rhabdoceras russelli, Arcestes* cf. *A. andersoni, Atractites* sp. undet., and a few other forms.
- Karnic:
  - Massive Hosselkus limestone with a few fossils (corresponding to the *Tropites subbullatus* zone of Shasta County).
  - Slates with *Halobia superba, Tropites* cf. *T. subbullatus.*

This section agrees with that observed in Shasta County, Calif., and in the Muttleberry Mountains, West Humboldt Range, Nev.

Fossils from the Pseudomonotis zone of Genesee Valley, Plumas County, Calif.

Arcestes andersoni?
Halorites americanus.
Rhabdoceras russelli.
Pseudomonotis subcircularis.
Avicula mucronata.
Pecten deformis.

Species not recognized (names only)

Daonella tenuistriata Hyatt.
Pecten (Hemientolium) daytonensis Hyatt.
Pecten inexpectans Hyatt.
Pecten lasseni Hyatt.
Lima acuta Hyatt.
Inoceramus? gervillioides Hyatt.
Inoceramus? simplex Hyatt.
Nucula tenuis Hyatt.
Modiola triquetraeformis.
Arcestes californiensis Hyatt.
Rhynchonella solitaria Hyatt.

All these unrecognized species are from beds of the lower Noric age (Swearinger slate) in Genesee Valley, Plumas County, listed by Hyatt,[1] but not described nor figured, so it is impossible to identify them.

The writer has also observed a section similar to that in Genesee Valley on Rush Creek, half a mile

[1] Hyatt, Alpheus, Jura and Trias at Taylorville, Calif.: Geol. Soc. America Bull. vol. 3. pp. 395–412, 1892.

above its junction with Feather River. In the Hosselkus limestone he found *Halobia superba*, *Tropites torquillus*, and *Isocrinus californicus*, characteristic of the Karnic zone of *Tropites subbullatus*.

Diller [2] has described from the Taylorsville region, under the name of Foreman formation, a series of slates and conglomerates with plant remains, first assigned to the Upper Triassic Rhaetic horizon. These beds, however, have since been assigned by Ward [3] to the Jurassic.

MINERAL KING, TULARE COUNTY, CALIF.

Triassic slates that contain *Pseudomonotis subcircularis?*, *Palaeoneilo?*, and other indeterminable pelecypods and ammonites have been seen by the writer at Mineral King, in Tulare County. This fauna looks like that described by Burckhardt from Zacatecas and listed below. It is probably of Upper Triassic age, but the fossils are not sufficiently well preserved for specific identification.

AMERICAN CANYON, PLACER COUNTY, CALIF.

Only the *Pseudomonotis* zone is known at this locality. It has been described by Alpheus Hyatt,[4] and the following fossils listed: *Monotis semiplicata*, *Monotis symmetrica*, *Daonella? subjecta*, *Daonella boechiformis*, and *Daonella cardinoides*. Of these species the first two are nothing more than synonyms of *Pseudomonotis subcircularis*, and the last three were never figured. It is, however, fairly certain that the slates of Sailor Canyon, a small tributary of American Canyon, belong to the *Pseudomonotis subcircularis* zone, and thus to the Noric stage of the Upper Triassic.

WEST HUMBOLDT RANGE, NEV.

W. M. Gabb [5] has described a few species from the Upper Triassic beds of the West Humboldt Range, Nev. These species are listed below, along with others recognized by the writer.

Upper Triassic fossils from the West Humboldt Range, Nev.

Arcestes andersoni Hyatt and Smith.
Placites humboldtensis Hyatt and Smith.
Halorites americanus Hyatt.
Rhabdoceras russelli Hyatt.
Syringoceras spurri Smith.
Pseudomonotis subcircularis Gabb.
    circularis Gabb.
Myophoria humboldtensis Smith.
Posidonia blatchleyi Gabb.
    daytonensis Gabb.

All these forms came from the Noric shales that carry *Pseudomonotis subcircularis* in the upper part of the Star Peak formation. The best place to collect at this horizon is in Muttleberry Canyon, about 8 miles east of Lovelocks.

In the limestone underlying these shales in Star Canyon the writer found *Halobia* (cf. *H. superba*) and some indeterminable gastropods and pelecypods, probably of Karnic age. Most of the species described by Gabb [6] and by Meek [7] as belonging to the Upper Triassic really came out of the Middle Triassic, or Muschelkalk. These have already been treated by the writer elsewhere.[8]

PILOT MOUNTAIN, NEV.

Some years ago H. W. Turner discovered some corals in limestone in Dunlap Canyon, Pilot Mountain, near Mina, Mineral County, Nev. These corals were sent to the writer, who pronounced them Jurassic, as reported by J. E. Spurr upon this identification. A later examination of these corals has shown them to be more probably of Upper Triassic age, which is in perfect accord with the stratigraphy. The species determined are *Montlivaultia* cf. *M. marmorea*, *Stephanocoenia* cf. *S. juvavica*, and *Isocrinus* sp. undetermined. The two species of coral are well-known forms in the Noric beds of the Alps, and *Stephanocoenia juvavica* occurs also in the Noric coral zone of Shasta County, Calif. The Lower and Middle Jurassic of the Great Basin area are not known in the coral reef facies anywhere.

Besides the localities for Upper Triassic fossils mentioned above Gabb has listed *Pseudomonotis subcircularis* from the East Range and from the vicinity of New Pass, Desatoya Mountains.

BLUE MOUNTAINS, OREG.

In the Blue Mountains of northeastern Oregon, at Martin Bridge, near the junction of Paddy Creek with Eagle River, in Baker County, the writer discovered in 1908 a small coral reef in the Upper Triassic limestones, of which a section is given below.

It will be noted that this section is entirely different in lithologic sequence from that in Shasta County, Calif. Nothing lower than the *Halobia*-bearing shales was found, and the writer could not determine just what part corresponded to the Hosselkus limestone, for the *Tropites* zone was not exposed if it is present in that region. Nor could the *Pseudomonotis* zone be found above the coral zone, though it is probably represented by the barren limestone. The lower shales, which carry *Halobia oregonensis*, were also found at the junction of the two forks of Eagle River, at Anthony's hydraulic mine, but there the limestones that should contain the coral reef are crystalline and the fossils are destroyed. Massive limestones are abundant on North Fork of Eagle River, but they are everywhere changed to marble.

[2] Diller, J. S., Geology of the Taylorsville region of California: Geol. Soc. America Bull., vol. 3, pp. 369–394, 1892.

[3] Ward, L. F., in Diller, J. S., Geology of the Taylorsville region: U. S. Geol. Survey Bull. 353, p. 56, 1908.

[4] Hyatt, Alpheus, Trias and Jura in the Western States: Geol. Soc. America Bull., vol. 5, pp. 395–434, 1894.

[5] Gabb, W. M., California Geol. Survey, Paleontology, vol. 1, 1864; Descriptions of some Secondary fossils from the Pacific States: Am. Jour. Conchology, vol. 5, pp. 5–18, 1869.

[6] Gabb, W. M., Description of the Triassic fossils of California and the adjacent territories: California Geol. Survey, Paleontology, vol. 1, pp. 17–35, 1864.

[7] Meek, F. B., Paleontology: U. S. Geol. Expl. 40th Par. Rept., vol. 4, pp. 1–197, 1877.

[8] Smith, J. P., The Middle Triassic marine invertebrate faunas of North America: U. S. Geol. Survey Prof. Paper 83, 254 pp., 99 pls., 1914.

Section on Eagle River, Baker County, Oreg.

Upper Triassic:	Feet
Massive limestone without visible fossils	60
Dark-brown argillaceous shales; contain *Halobia halorica* and other species of *Halobia*	100
Thin-bedded limestone in which there are banks of corals—*Thecosmilia norica* Frech, *Spongiomorpha, Heptastylis,* and *Montlivaultia norica* Frech	40
Barren shales	300
Massive limestone without fossils	100
Calcareous shales; contain *Halobia oregonensis, Halobia salinarum, Dittmarites* sp. ?, and other fossils	30

In the lower shales the writer recognized *Halobia oregonensis, Halobia salinarum* Bronn, *Pecten* (*Entolium*) *ceruleus,* and *Dittmarites*? sp.

The coral zone contains *Heptastylis oregonensis, Heptastylis aquilae, Montlivaultia norica,* and *Thecosmilia norica.*

This horizon is clearly lower Noric and represents the Fischerwiese fauna of the Alps.

In the shales above the coral zone were found *Halobia halorica* and *Halobia dilatata,* both Noric species.

Pseudomonotis subcircularis has been found at the Noric horizon in the region of Wallowa Lake.

BRITISH COLUMBIA

Whiteaves [9] has described Upper Triassic fossils from Vancouver Island, Queen Charlotte Islands, and the mainland of British Columbia. Those from Vancouver and Queen Charlotte Islands, which include *Pseudomonotis subcircularis, Acrochordiceras? carlottense, Arniotites vancouverensis, Badiotites? carlottensis,* and *Aulacoceras carlottense,* are all apparently from the *Pseudomonotis* zone.

From the mainland of British Columbia, on Liard River, about 25 miles below Devils Portage, Whiteaves described the following forms out of the *Dawsonites* zone, presumably of lower Karnic age: *Spiriferina borealis, Terebratula liardensis, Monotis ovalis, Halobia occidentalis, Trigonodus? productus, Margarita triassica, Nautilus liardensis, Popanoceras mcconnelli, Popanoceras lenticulare,* and *Trachyceras* (*Dawsonites*) *canadense.*

The *Dawsonites* fauna is recognizable in British Columbia, Bear Island in the Arctic Ocean, and doubtfully in Alaska, and therefore furnishes another interregional correlation zone. It is supposed to belong below the zone of *Halobia superba,* but the two have not been observed in sequence. It is also not known that all these species came from the same horizon.

Clapp and Shimer [10] described a fauna from Cowichan Lake, on Vancouver Island, which they assigned to the Jurassic. It would seem, however, that these beds belong rather to the lower Noric horizon of the Upper Triassic. The arguments in favor of this view are given by Martin [11] in his paper on the Triassic rocks of Alaska, and the writer agrees with his conclusions. Clapp and Shimer described the forms listed below.

Fauna of the Lower Noric coral zone of Vancouver Island

Isastrea whiteavesi.
 vancouverensis.
 cowichanensis.
Thecosmilia suttonensis.
 dawsoni.
Terebratula suttonensis.
Myophoria suttonensis.
Choristoceras suttonensis.

Of these species *Isastrea whiteavesi* (=*I. profunda* Reuss), *Isastrea vancouverensis, Isastrea cowichanensis* (=*Confusastrea*), *Thecosmilia suttonensis* (=*T. fenestrata*), *Thecosmilia dawsoni* (=*T. delicatula*), and *Choristoceras suttonense* all occur in the lower Noric coral zone of Alaska; and *Myophoria suttonensis* occurs in the Upper Triassic, probably at the lower Noric horizon, of Alaska.

ALASKA

Upper Triassic faunas have in recent years been found at many places in Alaska. Martin [12] in his paper gives all the known localities, the local stratigraphy, and the lists of fossils so far as they had been determined. All the data presented below on Alaskan localities are taken from Martin's paper, except where special references or statements are given.

Chitina Valley.—The standard section of the Upper Triassic of Alaska is found in the Chitina Valley. The uppermost part of the section is made up of the McCarthy formation, which consists of shales, cherts, and limestones that aggregate 1,500 to 2,500 feet in thickness and that contain *Pseudomonotis subcircularis, Halobia* sp., and *Arniotites* sp.

Below the McCarthy formation lie the Nizina and Chitistone limestones, the probable equivalents of the Hosselkus limestone of California. The fossils listed by Martin from here include the following fossils of undetermined species: *Pentacrinus, Terebratula, Spiriferina, Orbiculoidea?, Halobia* cf. *H. occidentalis, Halobia* cf. *H. superba, Pecten, Avicula, Hinnites?, Gryphaea, Myophoria, Pleuromya, Turbo?, Natica, Pseudomelania, Tropites, Arniotites, Juvavites?, Arcestes, Orthoceras, Atractites.*

In addition to these forms the writer recognized, in material sent to him by the United States Geological Survey, the following:

Locality 9927, east fork of Strelna Creek: *Halobia dilatata, Halobia* cf. *H. fallax, Halobia* cf. *H. lineata,* probably of lower Noric age.

Locality 8946, Copper River region, south fork of Strelna Creek, on trail to west fork of Strelna Creek: *Myophoria sut-*

[9] Whiteaves, J. F., On some fossils from the Triassic rocks of British Columbia: Canada Geol. Survey, Contr. Canadian Paleontology, vol. 1, pt. 2, pp. 127–149, 1889.

[10] Clapp, C. H., and Shimer, H. W., The Sutton Jurassic of the Vancouver group, Vancouver Island: Boston Soc. Nat. Hist. Proc., vol. 34, pp. 426–438, pls. 40–42, 1911.

[11] Martin, G. C., Triassic rocks of Alaska: Geol. Soc. America Bull., vol. 27, pp. 709, 710, 1916.

[12] Martin, G. C., op. cit., pp. 685–718.

tonensis, Avicula soperi. The former species occurs in the coral zone of Vancouver Island, and the latter in the Upper Triassic of California, and the beds here probably are of Noric age.

Locality 8153, Kuskulana River: *Halobia brooksi.*

Locality 9935, Rock Creek: *Halobia austriaca.*

Locality 6319, Copper River region: *Tropites stantoni.*

Locality 4810, Chitistone limestone, south side of Chitina River, Copper River region: *Margarites moffiti.*

Locality 9921, United States Geological Survey, north side of Strelna Creek, half a mile north of bench mark 3664: *Halobia ornatissima.*

Locality 6312, Nikolai Creek, Nizina district: *Juvavites septentrionalis.*

These last six localities represent the *Juvavites* subzone of upper Karnic age, of California and Admiralty Island.

At locality 9941, United States Geological Survey, in a gulch on the north side of Kotsina River, 1½ miles below Kluvesa Bridge, in the Copper River region, was found *Halobia superba;* the beds at this place probably belong to the zone of *Tropites subbullatus*, but the wide stratigraphic range of *Halobia superba* prevents more exact assignment.

Nutzotin and Alaska ranges.—In the Nutzotin and Alaska ranges was found the equivalent of the McCarthy formation, bearing *Pseudomonotis subcircularis* and *Clionites* (*Shastites*) sp., underlain by limestones with bearing *Halobia* cf. *H. superba, Tropites* sp., *Discotropites* sp., and *Arcestes* sp. These limestones are the probable equivalents of the Nizina and Chitistone limestones of the Chitina Valley and of the Hosselkus limestone of California.

Cook Inlet.—At several places around the shores of Cook Inlet Upper Triassic beds crop out in an upper series of shales and limestones that bears *Pseudomonotis subcircularis* and in places a lower series that bears *Halobia* cf. *H. superba.*

Iliamna Lake.—On the shores of Iliamna Lake, near Cook Inlet, Martin has discovered a coral zone not previously recognized elsewhere in Alaska. Its position is in the lower Noric, above the zone of *Halobia superba*, and below that of *Pseudomonotis subcircularis*. The writer [13] has already given a preliminary list of species found there. The following are described in this paper:

Upper Triassic corals from Iliamna Lake

Spongiomorpha cf. S. ramosa.
  cf. S. gibbosa.
Thecosmilia cf. T. fenestrata.
  caespitosa.
Stylophyllopsis mojsvari.
Confusastrea cf. C. decussata.
  cf. C. incrassata.
  cowichanensis.
Isastrea vancouverensis.
Montlivaultia martini.

This locality on Iliamna Lake is most interesting, because it is the one farthest north at which a Triassic fauna of tropical character has been found. Of the corals, *Astrocoenia* is still a reef builder, and *Confusastrea, Isastrea*, and *Spongiomorpha* are represented in modern tropical seas by little modified descendants. Unless these corals have changed their habits very greatly we must assume that they lived then under approximately the same conditions as now. That is, the waters of the Gulf of Alaska must have had a minimum temperature of not less than 70° F.

This was not a local phenomenon, for coral reefs with some of the same species have been found in beds of the same age on Gravina Island in southern Alaska, also in California, also in the Tyrolian Alps. And very similar forms occur in the Indian region in the same geologic horizon. Conditions must have been the same where all these closely related fossil faunas have been found. There is no possible question as to the tropical habitat of the Indian fauna, and there is equally little doubt as to the tropical conditions of the others.

Herring Bay, Admiralty Island.—The equivalent of the McCarthy formation occurs on Herring Bay, Admiralty Island, and contains *Pseudomonotis subcircularis.* The lower Noric reef zone here contains no known corals, but at locality 10172, United States Geological Survey, south of False Point Pybus, it contains *Myophoria suttonensis*, which is found elsewhere in Alaska and on Vancouver Island in the Upper Triassic.

A slightly lower horizon is represented at locality 10197, where *Halobia cordillerana* occurs, and also at locality 10196, which is the type locality for *Halobia dalliana, Halobia septentrionalis*, and *Halobia symmetrica.*

The *Juvavites* subzone, the upper division of the *Tropites subbullatus* zone, of Karnic age, is represented at locality 10180, a point between Chapin and Herring bays. Here occur *Halobia ornatissima, Juvavites brockensis, Juvavites knowltoni, Tropites* cf. *T. johnsoni, Discotropites sandlingensis, Discotropites davisi, Discotropites mojsvarensis*, and *Arcestes shastensis*, all of which are species characteristic of this subzone in the Hosselkus limestone of Brock Mountain, Shasta County, Calif. The same horizon is represented at locality 8848, United States Geological Survey, a point at the north entrance of Herring Bay, where are found *Halobia ornatissima, Halobia austriaca, Halobia lineata, Margarites* cf. *M. jokelyi, Juvavites externiplicatus, Juvavites knowltoni, Juvavites* cf. *J. subinterruptus, Arcestes shastensis, Pinacoceras* cf. *P. rex, Aulacoceras* cf. *A. carlottense*, and *Nautilus* sp. In the same zone, at locality 8847, near the last-mentioned place *Halobia austriaca* was also found. At locality 8849 *Halobia distincta* is common, along with *Halobia cordillerana.*

Hamilton Bay, Kupreanof Island.—On Hamilton Bay, Kupreanof Island, the *Pseudomonotis* zone bears *Pseudomonotis subcircularis.* The coral zone appears

[13] Smith, J. P., The occurrence of coral reefs in the Triassic of North America: Am. Jour. Sci., 4th ser., vol. 33, pp. 92-96, 1912.

to be lacking and to be represented by an unconformity. The *Juvavites* subzone is present at locality 4823 and bears *Tropites* cf. *T. johnsoni* and *Halobia ornatissima*. The *Trachyceras* subzone of California, the lower subzone of the *Tropites subbullatus* zone, is represented at locality 4822 by *Trachyceras* cf. *T. lecontei* and *Dielasma hamiltonense*. This horizon was assigned by Martin [14] to the *Dawsonites* zone of Canada. This assignment may be correct, but there is no proof in the fauna.

Gravina Island.—Our knowledge of the Triassic geology of Gravina Island has recently been greatly amplified by Chapin.[15] The writer has studied the collections made by Chapin and Martin and by T. E. Bassett and C. O. Blackburn, of the Stanford University geologic expedition. The fossils all came from the narrow peninsula between Threemile Cove and Thompson Cove, from 3 to 5 miles north of Dall Head, and all represent the same horizon, the lower Noric. Here were found *Halobia alaskana*, *Halobia dilatata*, *Cassianella gravinaensis*, *Myophoria beringiana*, *Protorcula bassetti*, *Purpurina? gravinaensis*, *Arcestes* sp., *Choristoceras* cf. *C. suttonense*, *Confusastrea borealis*, *Confusastrea cowichanensis*, *Confusastrea decussata*, *Confusastrea grandissima*, *Isastrea parva*, *Isastrea profunda*, *Isastrea vancouverensis*, *Thecosmilia fenestrata*, *Thecosmilia* cf. *T. delicatula*, *Montlivaultia norica*, *Stylophyllopsis zitteli*, *Latimaeandra alaskana*, *Astrocoenia martini*, *Stephanocoenia* cf. *S. juvavica*, *Thamnastraea borealis*, *Thamnastraea rectilamellosa* var. *minor*, *Halomitra triadica*, *Spongiomorpha gibbosa*, *Spongiomorpha ramosa*, *Stromatomorpha californica*.

A comparison with the lists from the lower Noric coral zone of Shasta County, Calif., shows that the two faunas are almost completely identical, and the common species at one locality are also the common species at the other. Both faunas are of the same age as the coral zone fauna of Iliamna Lake in Alaska and of Cowichan Lake on Vancouver Island.

Skolai Pass, Nabesna-White River district.—From Skolai Pass, in the Nabesna-White River district Martin [16] has listed *Pseudomonotis subcircularis* from shales, and *Clionites* (*Shastites*) sp. from the overlying volcanic rocks. The specimen assigned to *Clionites* is *Sirenites hayesi* Smith, and the forms assigned to *Pseudomonotis subcircularis* are *Halobia*. This horizon is therefore probably that of the Karnic, and equivalent to that of the *Tropites subbullatus* zone.

Nation River, Yukon Valley.—There are at least three horizons of Upper Triassic age near the mouth of Nation River. The beds at the upper horizon contain *Pseudomonotis subcircularis*, and these beds are underlain by calcareous shales and shaly limestone in which two and possibly three faunal horizons may be distinguished. At locality 9389, United States Geological Survey, 2 miles above the mouth of Nation River, there are shaly limestones that contain *Halobia fallax*, *Halobia halorica*, and *Halobia lineata*, species which in the Alps and in America characterize the horizon at the junction of the beds of Karnic and Noric age and below the *Pseudomonotis* zone.

At locality 4054, United States Geological Survey, a quarter of a mile above the mouth of Nation River, was found *Halobia superba*, which elsewhere is characteristic of the zone of *Tropites subbullatus*.

At locality 8897, United States Geological Survey, south of Yukon River, 1 mile above the mouth of Nation River, there are calcareous shales that bear *Halobia cordillerana*, which is characteristic of the upper horizon of the zone of *Tropites subbullatus*, and *Halobia superba*, which is characteristic of the zone of *Tropites subbullatus* in general. At locality 8849, at the same place, in limestone less than 100 feet below locality 8897, were found *Pecten yukonensis*, *Eumorphotis nationalis*, *Lima martini*, *Pleurophorus? overbecki*, *Orthoceras* sp., *Germanonautilus brooksi*, *Cladiscites martini*, *Nathorstites alaskanus*, *Trachyceras* cf. *T. lecontei*, *Rhynchonella blackwelderi*, *Spiriferina yukonensis*, and *Dielasma chapini*. This fauna suggests the *Dawsonites* fauna of British Columbia and of Bear Island in the Arctic Ocean.

The known fauna from Nation River contains no members of the group of *Tropites*, and the coral zone appears to be lacking in the section represented by calcareous shales. This conjunction may be only fortuitous, but it is suggestive. The corals of the coral zone are certainly tropical, as are probably the Tropitidae. Their absence, if real, may indicate a lower temperature of the sea here than that which prevailed in southern Alaska.

Northeastern Alaska (*Firth and Canning valleys*).—The Triassic beds on Firth River show the two horizons. The beds at the upper horizon contain *Pseudomonotis subcircularis*, and those at the lower contain *Halobia* cf. *H. superba*. The beds on Canning River have yielded *Halobia* cf. *H. superba*, *Aviculopecten*, *Megalodon?*, *Gervilleia*, *Gryphaea*, *Cardium*, *Natica*, *Cladiscites mendenhalli*, *Clionites*, and *Atractites* and are the probable equivalent of the Chitistone limestone. Above these beds lies the *Pseudomonotis subcircularis* zone.

Northwestern Alaska.—Near Cape Lisburne and near Cape Thompson occur cherts and thin-bedded limestones that carry *Pseudomonotis subcircularis*, which has also been found at several other places in that general region.

Chulitna River.—At locality 10241, on the south bank of East Fork of Chulitna River, 1½ miles below Camp 9, R. M. Overbeck found *Heterastridium conglobatum*, which in the Tyrol is characteristic of the upper Karnic; no other fossils were associated with this species, but the rocks here may be tentatively assigned to the same horizon.

[14] Geol. Soc. America Bull., vol. 27, p. 706, 1916.
[15] Chapin, Theodore, The structure and stratigraphy of Gravina and Revillagigedo islands, Alaska: U. S. Geol. Survey Prof. Paper 120, pp. 83-100, 1918.
[16] Op. cit., p. 696.

ZACATECAS, MEXICO

Burckhardt [17] has described Upper Triassic strata from Zacatecas, Mexico, comprising siliceous and sandy shales which lie at the Karnic horizon. The fossils listed embrace *Juvavites, Sirenites, Trachyceras, Clionites,* and *Palaeoneilo,* the ammonites certainly indicating the Karnic age of the Alpine section and corresponding to the age of the Hosselkus limestone of the California section.

The material is too poor for specific identification, hence Burckhardt's descriptions and figures are not reproduced here, but for convenience his list and references to his text and plates are given.

Upper Triassic fossils from Zacatecas, Mexico

Sirenites smithi Burckhardt, p. 7, pl. 1, figs. 1a, 1b.
Trachyceras (Protrachyceras) sp. indet., p. 8, pl. 1, figs. 4a, 4b.
Trachyceras (Protrachyceras) sp. indet., p. 8, pl. 1, figs. 5a, 5b.
Clionites sp. indet., p. 8, pl. 1, figs. 3a, 3b.
Juvavites (Anatomites) mojsvari, p. 9, pl. 1, figs. 2a, 2b; pl. 6, fig. 1.
Palaeoneilo longa Burckhardt, p. 14, pl. 2, figs. 1a, 1b.
 zacatecana Burckhardt, p. 15, pl. 2, figs. 2a–2f; pl. 7, figs. 1, 2.
 broilii Burckhardt, p. 2, figs. 3a–3m; pl. 6, fig. 2; pl. 7, fig. 3.
 burkarti Burckhardt, p. 18, pl. 3, figs. 2a–2d; pl. 6, fig. 6; pl. 7, fig. 4.
 frechi Burckhardt, p. 19, pl. 2, figs. 4a, 4b.
 villadae Burckhardt, p. 19, pl. 2, figs. 5a, 5b.
 mexicana Burckhardt, p. 20, pl. 3, figs. 1a–1d; pl. 7, figs. 16, 17.
 cordobae Burckhardt, p. 21, pl. 2, figs. 6a, 6b.
 triangularis Burckhardt, p. 22, pl. 3, figs. 3a–3h; pl. 7, figs. 6, 7.
 boesei Burckhardt, p. 23, pl. 4, figs. 3a–3e; pl. 5, figs. 1a, 1b.
 aguilerae Burckhardt, p. 24, pl. 4, figs. 2a–2f; pl. 6, fig. 5; pl. 7, fig. 10.
 inflata Burckhardt, p. 25, pl. 4, figs. 1a–1f; pl. 6, fig. 4; pl. 7, fig. 11.
 humboldti Burckhardt, p. 26, pl. 4, figs. 5a–5d; pl. 7, fig. 9.
 circularis Burckhardt, p. 27, pl. 4, figs. 6a, 6b; pl. 7, fig. 5.
 cordiformis Burckhardt, p. 28, pl. 5, figs. 1a, 1b.
 waitzi Burckhardt, p. 29, pl. 5, figs. 2a–2d.
 rectangularis Burckhardt, p. 30, pl. 5, figs. 3a–3d; pl. 6, fig. 3; pl. 7, fig. 12.
 quadrata Burckhardt, p. 30, pl. 5, figs. 4a, 4b.
 ledaeformis Burckhardt, p. 31, pl. 5, figs. 6a–6e; pl. 7, fig. 14.
 costata Burckhardt, p. 32, pl. 5, figs. 7a–7d; pl. 7, fig. 15.
 ordonezi Burckhardt, p. 33, pl. 5, figs. 5a–5d; pl. 7, fig. 13.

SPECIES OF THE UPPER TRIASSIC FAUNAS OF WESTERN NORTH AMERICA RELATED TO MEDITERRANEAN AND INDIAN SPECIES

The following lists show the species of the Upper Triassic faunas of western North America that occur in the Mediterranean and Indian areas or that are related to forms that occur in those areas.

[17] Burckhardt, Carlos, La faune marine du Trias supérieur de Zacatecas: Inst. geol. México Bol. 21, pp. 1–44, pls. 1–8, 1905.

Karnic species of California nearly related to Mediterranean forms

Tropites subbullatus zone, California	Tropites zone, Mediterranean
Tropites armatus.	Tropites telleri.
discobullatus.	discobullatus.
fusobullatus.	fusobullatus.
keili.	keili.
kellyi.	laestrigonus.
morloti.	morloti.
mojsvarensis.	quenstedti.
subbullatus.	subbullatus.
torquillus.	torquillus.
wodani.	wodani.
Anatropites hauchecornei.	Anatropites hauchecornei.
Microtropites tuberculatus.	Microtropites tuberculatus.
Margarites jokelyi.	Margarites jokelyi.
senilis.	senilis.
Discotropites empedoclis.	Discotropites empedoclis.
gemmellaroi.	gemmellaroi?
laurae.	laurae.
sandlingensis.	sandlingensis.
sengeli.	sengeli.
theron.	theron.
Tornquistites obolinus.	Tornquistites obolinus.
Sagenites erinaceus.	Sagenites erinaceus.
herbichi.	herbichi.
Homerites semiglobosus.	Homerites semiglobosus.
Bacchites bacchus.	Bacchites bacchus.
Gonionotites hyatti.	Gonionotites italicus.
Juvavites adalberti.	Juvavites adalberti.
damesi.	damesi.
edgari.	edgari.
externiplicatus.	externiplicatus.
intermittens.	intermittens.
konnincki.	konnincki.
subinterruptus.	subinterruptus.
Tropiceltites caducus.	Tropiceltites caducus.
Celtites steindachneri.	Celtites steindachneri.
Metasibirites brockensis.	Metasibirites spinescens.
mojsvarensis.	uhligi.
Arcestes shastensis.	Arcestes gaytani.
Hauerites lawsoni.	Hauerites aesculapii.
Pinacoceras rex.	Pinacoceras rex.
Discophyllites patens.	Discophyllites patens.
Metatirolites foliaceus.	Metatirolites foliaceus.
subpygmaeus.	subpygmaeus.
quadrangulus.	quadrangulus.
Thisbites uhligi.	Thisbites uhligi.
Polycyclus henseli.	Polycyclus henseli.
Trachyceras californicum.	Trachyceras gredleri.
Sandlingites oribasus.	Sandlingites oribasus.
Dictyoconites californicus.	Dictyoconites haugi.
Proclydonautilus triadicus.	Proclydonautilus triadicus.
sauperi.	sauperi.
spirolobus.	spirolobus.
Grypoceras cooperi.	Grypoceras suessi.
Halobia austriaca.	Halobia austriaca.
cordillerana.	fallax.
rugosa.	rugosa.
superba.	superba.
Terebratula pyriformis.	Terebratula pyriformis.
Dielasma julicum.	Dielasma julicum.

Karnic species of California nearly related to Indian forms

Tropites subbullatus zone of California	Tropites zone of India
Tropites fusobullatus.	Tropites fusobullatus.
discobullatus.	discobullatus.
mojsvarensis.	jalandhara.
subbullatus.	subbullatus.
torquillus.	torquillus.
wodani.	wodani.
Discotropites sandlingensis.	Discotropites sandlingensis.
theroni.	kraffti.
Polycyclus henseli.	Polycyclus henseli.
Gonionotites hyatti.	Gonionotites gemmellaroi.
Discophyllites insignis.	Discophyllites ebneri.
Sagenites herbichi.	Sagenites herbichi.
erinaceus.	galeatus.
Juvavites edgari.	Juvavites edgari.
brockensis.	fischeri.
Jovites pacificus.	Jovites spectabilis.
Margarites senilis.	Margarites senilis.
Arcestes shastensis.	Arcestes gaytani.
Halobia superba.	Halobia superba.
Terebratula pyriformis.	Terebratula pyriformis.
Dielasma julicum.	Dielasma julicum.

The species identical in the two regions occur also in the Mediterranean region, with which the American has a much closer affinity in the Karnic stage.

Noric species of western America nearly related to Mediterranean forms

Western America	Mediterranean
Halobia dilatata.	Halobia dilatata.
fallax.	fallax.
halorica.	halorica.
Pseudomonotis subcircularis.	ochotica (Crimea).
Arcestes andersoni.	Arcestes coloni group.
Halorites americanus.	Halorites ramsaueri.
Rhabdoceras russelli.	Rhabdoceras suessi.
Heptastylis oregonensis.	Heptastylis stromatoporoides.
gibbosa.	gibbosa.
ramosa.	ramosa.
Stromatomorpha californica.	Stromatomorpha stylifora.
Thecosmilia delicatula.	Thecosmilia delicatula.
fenestrata.	fenestrata.
norica.	norica.
caespitosa.	caespitosa.
Thamnastraea rectilamellosa.	Thamnastraea rectilamellosa.
Montlivaultia marmorea.	Montlivaultia marmorea.
norica.	norica.
Stylophyllopsis mojsvari.	Stylophyllopsis mojsvari.
Confusastrea decussata.	Confusastrea decussata.
grandissima.	grandissima.
incrassata.	incrassata.
Stephanocoenia juvavica.	Stephanocoenia juvavica.
Astrocoenia martini.	Astrocoenia waltheri.
Isastrea profunda.	Isastrea profunda.
Latimaeandra eucystis.	Latimaeandra eucystis.

The Noric species of western America nearly related to Mediterranean forms are chiefly confined to the pelecypods and the corals, and these are almost universal forms.

MARINE INVERTEBRATE FAUNA OF THE UPPER TRIASSIC OF NORTH AMERICA

The marine invertebrate fauna obtained from the Upper Triassic beds of western North America, which is described and illustrated in this paper, includes the following species:

Marine invertebrate fauna of the Upper Triassic of North America

Karnic fauna of Shasta County, Calif.

Name	Illustration	Stratigraphic position	Occurrence elsewhere
I. Tropites armatus Smith	Pl. XXXIII, Figs. 1–7; Pl. LXIX, Figs. 1–12.	*Tropites subbullatus* zone.	
dilleri Smith	Pl. LXVIII, Figs. 1–13	do	
discobullatus Mojsisovics	Pl. LXVIII, Figs. 32–34	do	Tyrolian Alps.
morloti Mojsisovics	Pl. LXIX, Figs. 13–24	do	Do.
occidentalis Smith	Pl. LXX, Figs. 1–20	do	
subbullatus Hauer	Pl. XXXIV, Figs. 1–14; Pl. LXXIX, Figs. 1–10.	do	Tyrolian Alps and India.
torquillus Mojsisovics	Pl. LXVIII, Figs. 1–31	do	Do.
II. Tropites brockensis Smith	Pl. LXXIV, Figs. 1–6	do	
fusobullatus Mojsisovics	Pl. LXX, Figs. 21–28	do	Do.
mojsvarensis Smith	Pl. LXXIV, Figs. 7–9	do	
rotatorius Smith	Pl. LXXI, Figs. 1–3	do	
rothpletzi Smith	Pl. LXXI, Figs. 4–8	do	
III. Tropites keili Mojsisovics	Pl. LXII, Figs. 24–28	do	Tyrolian Alps.
kellyi Smith	Pl. LXXVII, Figs. 12–15	do	
shastensis Smith	Pl. LXVIII, Figs. 1–4	do	
schellwieni Smith	Pl. LXXVII, Figs. 1–11	do	
ursensis Smith	Pl. LXXVIII, Figs. 18–26	do	
wodani Mojsisovics	Pl. LXXII, Figs. 29–31	do	Tyrolian Alps and India.
welleri Smith	Pl. LXXVIII, Figs. 5–17	do	
IV. Tropites boehmi Smith	Pl. LXXV, Figs. 3–11	do	
dieneri Smith	Pl. LXXVI, Figs. 19–28	do	
johnsoni Smith	Pl. LXXIV, Figs. 10–15	do	Alaska.
kokeni Smith	Pl. LXXVI, Figs. 1–7	do	
philippii Smith	Pl. LXXV, Figs. 12–16	do	
reticulatus Smith	Pl. LXXVI, Figs. 8–18		
traski Smith	Pl. LXXV, Figs. 1, 2		
arthaberi Smith	Pl. LXXII, Figs. 13–23	*Tropites subbullatus* zone.	
hessi Smith	Pl. LXXIII, Figs. 1–6		
morani Smith	Pl. LXXIII, Figs. 7–18	do	
stearnsi Smith	Pl. LXXII, Figs. 1–12	do	
Anatropites hauchecornei Mojsisovics	Pl. LVIII, Figs. 10–11	do	Tyrolian Alps.
Microtropites tubercularis Mojsisovics	Pl. LIX, Figs. 6–8	do	Do.

Marine invertebrate fauna of the Upper Triassic of North America—Continued

Karnic fauna of Shasta County, Calif.—Continued

Name	Illustration	Stratigraphic position	Occurrence elsewhere
Margarites jokelyi Hauer	Pl. LVIII, Figs. 24–29	*Tropites subbullatus* zone.	Tyrolian Alps and Alaska.
senilis Mojsisovics	Pl. LVIII, Figs. 33–36	do	Tyrolian Alps.
septentrionalis Smith	Pl. LIX, Figs. 27–33	do	
Discotropites davisi Smith	Pl. IX, Figs. 4–6	do	Alaska.
empedoclis Gemmellaro	Pl. XI, Figs. 1–7	do	Sicily.
gemmellaroi Smith	Pl. X, Figs. 1–13	do	Do. (?)
formosus Smith	Pl. XI, Figs. 23–28	do	
lineatus Smith	Pl. X, Figs. 20–29	do	
laurae Mojsisovics	Pl. XI, Figs. 8–22	do	Tyrolian Alps.
mojsvarensis Smith	Pl. VIII, Figs. 1–18	do	
sandlingensis Hauer	Pl. XXXV, Figs. 1–12; Pl. XXXVI, Figs. 1–26.	do	Tyrolian Alps and Alaska.
sengeli Mojsisovics	Pl. X, Figs. 15–19	do	Do.
theron Mojsisovics	Pl. IX, Figs. 1–3	do	Do.
Paratropites arnoldi Smith	Pl. XXV, Figs. 3–9	do	
antiselli Smith	Pl. XXIV, Figs. 1–8	do	
dittmari Mojsisovics	Pl. XXV, Figs. 1–2	do	Tyrolian Alps.
gabbi Smith	Pl. XXIV, Figs. 9–13	do	
gracilis Smith	Pl. XXV, Figs. 10–13	do	
sellai Mojsisovics	Pl. XXIV, Figs. 14–16; Pl. XXX, Figs. 6–10; Pl. XXXI, Figs. 1–26.	do	Do.
(Paulotropites) colei Smith	Pl. LVII, Figs. 22–23	do	
(Paulotropites) shastensis Smith	Pl. LVII, Figs. 12–21	do	
(Gymnotropites) americanus Hyatt and Smith.	Pl. XXXII, Figs. 1–10	do	
(Gymnotropites) californicus Smith	Pl. LVII, Figs 1–11	do	
Paratropites (Gymnotropites) laevis Smith	Pl. XXV, Figs. 16–20	do	
(Gymnotropites) rotundus Smith	Pl. XXV, Figs. 14–15	do	
(Gymnotropites) yatesi Smith	Pl. XXV, Figs. 21–24	do	
Tornquistites evolutus Hyatt and Smith	Pl. XXXII, Figs. 11–21	do	
obolinus Dittmar	Pl. LVIII, Figs. 12–15	do	Do.
Homerites semiglobosus Hauer	Pl. XXVIII, Figs. 19–24; Pl. LIX, Figs. 21–26.	do	Do.
Jovites pacificus Smith	Pl. XIII, Figs. 11–13	do	Do.
(Bacchites) bacchus Mojsisovics	Pl. XIV, Figs. 1–5	do	Do.
(Bacchites) pinguis Smith	Pl. XIV, Figs. 10–12	do	
(Bacchites) sphaericus Smith	Pl. XIV, Figs. 6–9	do	
Leconteiceras californicum Hyatt and Smith.	Pl. XXIX, Figs. 3–21	do	
occidentale Smith	Pl. LVIII, Figs. 16–20	do	
Tropiceltites caducus Dittmar	Pl. LVIII, Figs. 1–5	do	Do.
Celtites steindachneri Mojsisovics	Pl. LVIII, Figs. 8–11	do	Do.
Sagenites dickersoni Smith	Pl. XIV, Figs. 19–20	do	
erinaceus Dittmar	Pl. XII, Figs. 1–8	do	Do.
herbichi Mojsisovics	Pl. XXVI, Figs. 1, 2; Pl. XXVII, Figs. 1–4; Pl. XXVIII, Figs. 1–18.	do	Do.
shastensis Smith	Pl. XII, Figs. 9–11	do	
Juvavites adalberti Mojsisovics	Pl. XVIII, Figs. 26–32	do	Do.
brockensis Smith	Pl. XVI, Figs. 15–24	do	Alaska.
damesi Mojsisovics	Pl. XIX, Figs. 23–29	do	Tyrolian Alps.
edgari Mojsisovics	Pl. XVI, Figs. 11–14	do	Do.
externiplicatus Mojsisovics	Pl. XIX, Figs. 1–5	do	Alaska and Tyrolian Alps.
intermittens Mojsisovics	Pl. XIX, Figs 6–13	do	Do.
kellyi Smith	Pl. XVIII, Figs, 8–25	do	Alaska.
knowltoni Smith	Pl. XV, Figs. 16–19	do	Do.
konnincki Mojsisovics	Pl. XIX, Figs. 14–22	do	Tyrolian Alps.
mendenhalli Smith	Pl. XV, Figs. 9–15	do	
obsoletus Smith	Pl. XV, Figs. 1–8	do	
subintermittens Hyatt and Smith	Pl. XVI, Figs. 25–39; Pl. XXX, Figs. 3–5.	do	
subinterruptus Mojsisovics	Pl. XVIII, Figs. 1–7; Pl. XXX, Figs. 1, 2.	do	Tyrolian Alps and Alaska.
strongi Smith	Pl. XVI, Figs. 1–10	do	
shastensis Smith	Pl. XIX, Figs. 30–32	do	
Gonionotites hyatti Smith	Pl. XIII, Figs. 1–10	do	Tyrolian Alps (?).
northi Smith	Pl. XIV, Figs. 13–18	do	
Metasibirites brockensis Smith	Pl. LX, Figs. 47–53	do	
coei Smith	Pl. LX, Figs. 1–16	do	
frechi Hyatt and Smith	Pl. LX, Figs. 17–30, Pl. LXXX, Figs. 1–11.	do	
gracilis Smith	Pl. LXI, Figs. 34–37	do	
modestus Smith	Pl. LXI, Figs. 38–47	do	
mojsvarensis Smith	Pl. LXI, Figs. 8–21	do	
parvus Hyatt and Smith	Pl. LX, Figs. 31–46; Pl. LXXIX, Figs. 11–20.	do	
pusillus Smith	Pl. LXI, Figs. 1–7	do	
pygmaeus Smith	Pl. LIX, Figs. 34–47	do	
shastensis Smith	Pl. LXI, Figs. 22–33	do	

Marine invertebrate fauna of the Upper Triassic of North America—Continued

Karnic fauna of Shasta County, Calif.—Continued

Name	Illustration	Stratigraphic position	Occurrence elsewhere
Arcestes carpenteri Smith	Pl. XXIII, Figs. 1–11	*Tropites subbullatus* zone.	
pacificus Hyatt and Smith	Pl. XXIII, Figs. 12–23; Pl. XXXVII, Figs. 1–9; Pl. LXXXI, Figs. 1–9.	do	
shastensis Smith	Pl. XXII, Figs. 7–26	do	Alaska.
traski Smith	Pl. XXII, Figs. 27–41	do	
whitneyi Smith	Pl. XXII, Figs. 1–6	do	
winnemae Smith	Pl. XXIII, Figs. 24–33	do	
Paraganides californicus Hyatt and Smith	Pl. LXXX, Figs. 12–21	do	
Dieneria arthaberi Hyatt and Smith	Pl. XXXVII, Figs. 13–16; Pl. LXXXI, Figs. 10–25.	do	
Fremontites ashleyi Hyatt and Smith	Pl. XXXVII, Figs. 10–12; Pl. LXIII, Figs. 6–10.	do	
Hauerites lawsoni Smith	Pl. LXIII, Figs. 22–29	do	Do.
Klamathites kellyi Smith	Pl. LXIII, Figs. 1–5	do	Do.
schucherti Smith	Pl. LXII, Figs. 14–17	do	Do.
Pinacoceras rex Mojsisovics	Pl. LXII, Figs. 18–20; Pl. CIII, Figs. 13, 14.	do	Tyrolian Alps.
Discophyllites patens Mojsisovics	Pl. LXII, Figs. 1–13; Pl. CIII, Figs. 4–6.	do	Sicily.
Trachyceras beckeri Smith	Pl. IV, Figs. 1–8	do	
californicum Smith	Pl. I, Figs. 1, 2; Pl. II, Figs. 1–7	do	
lecontei Hyatt and Smith	Pl. VI, Fig. 1; Pl. XLIV, Figs. 1, 2; Pl. XLV, Figs. 1–9; Pl. XLIV, Figs. 1–15.	do	
lindgreni Smith	Pl. III, Figs. 1–6	do	
madisonense Smith	Pl. VI, Figs. 2–14	do	
shastense Smith	Pl. V, Figs. 1–19	do	
storrsi Smith	Pl. VII, Figs. 1–4	*Halobia rugosa* zone	
Sirenites lawsoni Hyatt and Smith	Pl. XLVI, Figs. 16, 17; Pl. XLVII, Figs. 1–9.	*Tropites subbullatus* zone.	
Sandlingites andersoni Hyatt and Smith	Pl. XLVII, Figs. 10–12	do	
oribasus Dittmar	Pl. LVII, Figs. 24–27	do	Tyrolian Alps.
Clionites americanus Smith	Pl. LXIV, Figs. 1–15	do	
californicus Hyatt and Smith	Pl. LXXIII, Figs. 14–27	do	
careyi Smith	Pl. LXVI, Figs. 1–12	do	
compactus Smith	Pl. LXVII, Figs. 12–23	do	
compressus Hyatt and Smith	Pl. XLIII, Figs. 1–15	do	
evolutus Smith	Pl. LXVI, Figs. 13–20	do	
fairbanksi Hyatt and Smith	Pl. XL, Figs. 1–11; Pl. XLI, Figs. 1–14.	do	
merriami Hyatt and Smith	Pl. LXXXII, Figs. 11–23	do	
minutus Smith	Pl. LXIV, Figs. 28–38	do	
nanus Smith	Pl. LXV, Figs. 1–7	do	
osmonti Smith	Pl. LXVII, Figs. 1–11	do	
robustus Hyatt and Smith	Pl. XLII, Figs. 1–19; Pl. LXVI, Figs. 30–32.	do	
rugosus Hyatt and Smith	Pl. XLI, Figs. 15–26	do	
stantoni Smith	Pl. LXIV, Figs. 16–27	do	
tornquisti Smith	Pl. LXV, Figs. 8–25	do	
whitneyi Smith	Pl. LXVI, Figs. 21–29	do	
Metatirolites foliaceus Dittmar	Pl. LXXXII, Figs. 1–10	do	Do.
quadrangulus Hauer	Pl. LIX, Figs. 9–11	do	Do.
subpygmaeus Mojsisovics	Pl. LIX, Figs. 4–8	do	Do.
Thisbites uhligi Mojsisovics	Pl. LVIII, Figs. 6, 7	do	Do.
Polycyclus henseli Oppel	Pl. LVII, Figs. 28–30	do	Do.
major Smith	Pl. LVIII, Figs. 30–32	do	
nodifer Hyatt and Smith	Pl. XXXVIII, Figs. 1–18	do	
Choristoceras kellyi Smith	Pl. LIX, Figs. 1–3	do	
klamathense Smith	Pl. LIX, Figs. 12–13	do	
Arpadites gabbi Hyatt and Smith	Pl. XXXIX, Figs. 1–17; Pl. LXXXIII, Figs. 1–13.	do	
kingi Smith	Pl. LVII, Figs. 31–34	do	
Atractites drakei Smith	Pl. LXXXIX, Figs. 14, 15	do	
philippii Hyatt and Smith	Pl. XLVIII, Figs. 1–3	do	
Dictyoconites americanus Smith	Pl. LXXXIX, Figs. 10–14	do	
Orthoceras shastense Hyatt and Smith	Pl. XLVIII, Figs. 4–5	do	
Proclydonautilus triadicus Mojsisovics	Pl. L, Figs. 1–17; Pl. XLIX, Figs. 1–3.	do	Tyrolian Alps and India.
spirolobus Dittmar	Pl. LXXXVIII, Figs. 6–14	do	Tyrolian Alps.
stantoni Smith	Pl. LXXXV, Figs. 6–11	do	
ursensis Smith	Pl. LXXXIV, Figs. 1–3; Pl. LXXXV, Figs. 1–5.	do	
Cosmonautilus dilleri Hyatt and Smith	Pl. LI, Fig. 1; Pl. LII, Fig. 1; Pl. LIII, Figs. 1, 2; Pl. LIV, Figs. 1–4; Pl. LV, figs. 1–11; Pl. XC, Fig. 1; Pl. XCI, Figs. 1, 2; Pl. XCII, Figs. 1, 2.	do	
hersheyi Smith	Pl. LXXXIX, Figs. 1–9	do	
pacificus Smith	Pl. LXXXVI, Figs. 1–15	do	
shastensis Smith	Pl. LXXXVII, Figs. 1–11	do	

Marine invertebrate fauna of the Upper Triassic of North America—Continued

Karnic fauna of Shasta County, Calif.—Continued

Name	Illustration	Stratigraphic position	Occurrence elsewhere
Mojsvaroceras turneri Hyatt and Smith	Pl. XLVIII, Figs. 6–11	*Tropites subbullatus* zone.	
Juvavionautilus acutus Hauer	Not figured	do	
Grypoceras cooperi Smith	Pl. LXXXVIII, Figs. 1–5	do	
Styrionautilus sauperi Hauer	Pl. LXXXV, Figs. 12–18	do	
Clydonautilus hessi Smith	Pl. LXXXVIII, Figs. 15–19	do	
Patella sheehani Smith	Pl. XCVI, Figs. 28–29	do	
stuarti Smith	Pl. XCIV, Fig. 18	do	
Capulus silverthorni Smith	Pl. XCIV, Fig. 15	do	
Collonia occidentalis Smith	Pl. XCIV, Figs. 16, 17	do	
Omphaloptychia obesa Smith	Pl. XCVI, Fig. 4	do	
shastensis Smith	Pl. XCVI, Fig. 5	do	
Worthenia klamathensis Smith	Pl. XCVI, Fig. 3	do	
Halobia austriaca Mojsisovics	Pl. XCIX, Figs. 10–13	do	Tyrolian Alps and Alaska.
cordillerana Smith	Pl. XCIII, Fig. 8; Pl. XCVIII, Fig. 9; Pl. XCIX, Figs. 1–6.	do	Alaska.
gigantea Smith	Pl. XCIII, Figs. 6, 7; Pl. XCIV, Figs. 1–3.	do	Do.
ornatissima Smith	Pl. XCIV, Figs. 4–6; Pl. XCVII, Figs. 4–8.	do	Do.
Halobia rugosa Guembel	Pl. VII, Figs. 7–10	*Halobia rugosa* zone	Tyrolian Alps.
superba Mojsisovics	Pl. XCIII, Figs. 1–5; Pl. XCIV, Fig. 7; Pl. XCVII, Figs. 1–3.	*Tropites subbullatus* zone.	Do.
Avicula soperi Smith	Pl. XCVI, Fig. 9	do	
Cassianella shastensis Smith	Pl. XCVI, Fig. 6	do	
Pecten pittensis Smith	Pl. VII, Fig. 5	*Halobia rugosa* zone	
Lima kimballi Smith	Pl. VII, Fig. 6	do	
Mytilus ursensis Smith	Pl. XCIV, Fig. 9	*Tropites subbullatus* zone.	
Dimyodon storrsi Smith	Pl. XCVI, Fig. 1	do	
Myophoria brockensis Smith	Pl. XCVI, Figs. 25, 26	do	
Cardita jenkinsi Smith	Pl. XCVI, Fig. 2	do	
Myoconcha nana Smith	Pl. XCIV, Figs. 10, 11	do	
Cardiomorpha digglesi Smith	Pl. XCIV, Fig. 8	do	
Anoplophora shastensis Smith	Pl. XCIV, Fig. 14	do	
Cardinia gleimi Smith	Pl. XCVI, Figs. 7, 8	do	
Posidonia jacksoni Smith	Pl. XCIV, Fig. 13	do	
madisonensis Smith	Pl. XCIV, Fig. 12	do	
Terebratula pyriformia Suess	Pl. XCVI, Figs. 14, 15	do	Tyrolian Alps and India.
Dielasma julicum Bittner	Pl. XCVI, Figs. 12, 13	do	Do.
Spirigera milesi Smith	Pl. XCVI, Figs. 10, 11	do	
Spiriferina coreyi Smith	Pl. XCV, Fig. 12	*Spiriferina* zone	
Rhynchonella howardii Smith	Pl. XCVI, Figs. 16–18	*Tropites subbullatus* zone.	
richardsoni Smith	Pl. XCVI, Figs. 19–21	do	
winnemae Smith	Pl. XCVI, Figs. 22–24	do	
Isocrinus californicus Clark	Pl. XCV, Fig. 6; Pl. CIV, Fig. 13	do	
Encrinus hyatti Clark	Pl. CIV, Figs. 14, 15	do	
Cidaris dilleri Clark	Pl. CIV, Fig. 12	do	
shastensis Clark	Pl. CIV, Fig. 11	do	
Shastasaurus alexandrae Merriam	Not figured	do	
altispinus Merriam	do	do	
careyi Merriam	do	do	
osmonti Merriam	do	do	
pacificus Merriam	do	do	
Delphinosaurus perrini Merriam	do	do	
Merriamia zitteli Merriam	do	do	
Toretocnemus californicus Merriam	do	do	
Thalattosaurus alexandrae Merriam	do	do	
perrini Merriam	do	do	
shastensis Merriam	do	do	
Nectosaurus halius Merriam	do	do	
Hybodus shastensis Wemple	do	do	
Acrodus wempleae Jordan	do	do	

Karnic species of Oregon.

Halobia oregonensis Smith	Pl. XCV, Figs. 1, 2	*Halobia oregonensis* zone.	
salinarum Bronn	Pl. XCV, Fig. 7	do	Tyrolian Alps.
Pecten ceruleus Smith	Pl. XCV, Fig. 13	do	

Marine invertebrate fauna of the Upper Triassic of North America—Continued

Lower Karnic fauna of the Dawsonites zone of British Columbia

Name	Illustration	Occurrence elsewhere
Paranautilus liardensis Whiteaves	Pl. CVII, Figs. 1, 2	
Dawsonites canadensis Whiteaves	Pl. CVII, Figs. 8–10	Bear Island and Alaska.
Nathorstites lenticularis Whiteaves	Pl. CVII, Figs. 6, 7	Bear Island.
mcconnelli Whiteaves	Pl. CVII, Figs. 3–5	Bear Island and Alaska(?).
Margarita triassica Whiteaves	Pl. CVI, Figs. 14, 15	
Trigonodus productus Whiteaves	Pl. CVI, Figs. 11–13	
Pseudomonotis ovalis Whiteaves	Pl. CVI, Fig. 8	
Halobia occidentalis Whiteaves	Pl. CVI, Figs. 9, 10	
Dielasma liardense Whiteaves	Pl. CVI, Figs. 2–5	Alaska.
Spiriferina borealis Whiteaves	Pl. CVI, Fig. 1	Do.

Karnic fauna of Alaska

Name	Illustration	Stratigraphic position and locality	Occurrence elsewhere
Dielasma chapini Smith	Pl. CII, Figs. 4–6	Nation River	
hamiltonense Smith	Pl. CII, Figs. 14–16	Hamilton Bay	
Rhynchonella blackwelderi Smith	Pl. CII, Figs. 1–3	Nation River	
Spiriferina yukonensis Smith	Pl. CI, Figs. 13, 14	do	
Lima martini Smith	Pl. CI, Fig. 11	do	
blackburni Smith	Pl. CIII, Fig. 11	Karnic horizon	
Pecten yukonensis Smith	Pl. CI, Figs. 9, 10	do	
Halobia austriaca Mojsisovics	Pl. XCIX, Figs. 10–13	do	Karnic beds of Alps.
distincta Mojsisovics	Pl. XCVII, Figs. 9, 10	do	Karnic and Noric beds of Alps.
brooksi Smith	Pl. XCIX, Figs. 7–9		
lineata Muenster	Pl. XCVIII, Figs. 13, 14	Karnic or Noric horizon.	Do.
cordillerana Smith	Pl. XCIII, Fig. 8; Pl. XCVIII, Fig. 9; Pl. XCIX, Figs. 1–6.	Upper Karnic horizon.	California and Alps(?).
superba Mojsisovics	Pl. XCIII, Figs. 1–5; Pl. XCIV, Fig. 7; Pl. XCVII, Figs. 1–3.	do	Karnic beds of Alps.
ornatissima Smith	Pl. XCIV, Figs. 4–6; Pl. XCVII, Figs. 4–8.	do	Do. (?)
Eumorphotis nationalis Smith	Pl. CI, Fig. 12	Nation River	
Pleurophorus overbecki Smith	Pl. CI, Fig. 15	do	
Protorcula alaskana Smith	Pl. CIII, Figs. 9, 10	Karnic horizon (?)	
Orthoceras sp		Nation River	
Germanonautilus brooksi Smith	Pl. CII, Figs. 7–10	do	
Aulacoceras cf. A. carlottense Whiteaves	Pl. CVIII, Fig. 6	Herring Bay	Queen Charlotte Islands.
Margarites moffiti Smith	Pl. CIII, Figs. 1–3		
cf. M. jokelyi Hauer	Pl. LVIII, Figs. 24–29	Herring Bay	California and Alps.
Juvavites brockensis Smith	Pl. XVI, Figs. 15–24	do	Do.
externiplicatus Mojsisovics	Pl. XIX, Figs. 1–5	do	Do.
knowltoni Smith	Pl. XV, Figs. 16–19	do	California.
septentrionalis Smith	Pl. XIX, Figs. 33, 34	Nizina district	
cf. J. subinterruptus Mojsisovics	Pl. XXX, Figs. 1, 2	Herring Bay	California and Alps.
Metasibirites shastensis Smith	Pl. LXI, Figs. 22–33	do	California.
Nathorstites alaskanus Smith	Pl. CII, Figs. 11–13	Nation River	
Discophyllites patens Mojsisovics	Pl. LXII, Figs. 1–13; Pl. CIII, Figs. 4–6.	do	California and Sicily.
Pinacoceras cf. P. rex Mojsisovics	Pl. LXII, Figs. 18–20; Pl. CIII, Figs. 13, 14.	do	California and Alps.
Cladiscites martini Smith	Pl. CII, Figs. 17–20	do	
mendenhalli Smith	Pl. CII, Figs. 21–24	Canning River	
Trachyceras cf. T. lecontei Hyatt and Smith	Pl. VI, Fig. 1; Pl. XLIV, Figs. 1, 2; Pl. XLV, Figs. 1–9; Pl. XLVI, Figs. 1–15.		California.
Sirenites hayesi Smith	Pl. CIII, Figs. 7, 8	Skolai Pass	
Discotropites davisi Smith	Pl. IX, Figs. 4–6	Herring Bay	Do.
mojsvarensis Smith	Pl. VIII, Figs. 1–18	do	Do.
sandlingensis Hauer	Pl. XXXV, Figs. 1–12; Pl. XXXVI, Figs. 1–26.	do	California and Alps.
Tropites stantoni Smith	Pl. CII, Figs. 25–27	Nizina district	
cf. T. johnsoni Smith	Pl. LXXIV, Figs. 10–15	Herring Bay	California.

Marine invertebrate fauna of the Upper Triassic of North America—Continued

Fauna of Sutton formation of Vancouver Island

Name	Illustration	Occurrence elsewhere
Terebratula suttonensis Clapp and Shimer	Pl. CV, Fig. 7	
Myophoria suttonensis Clapp and Shimer	Pl. CV, Fig. 2	Alaska.
Choristoceras suttonense Clapp and Shimer	Pl. CV, Figs. 5, 6	Do.
Isastrea profunda Reuss	Pl. CV, Fig. 8; Pl. CXII, Figs. 5–6; Pl. CXIV, Figs. 1–3.	Zlambach beds of Alps; Alaska and California.
vancouverensis Clapp and Shimer	Pl. CV, Fig. 10; Pl. CXII, Figs. 1–4; Pl. CXIV, Figs. 4–6; Pl. CXXI, Figs. 4, 5.	Do.
Confusastrea cowichanensis Clapp and Shimer	Pl. CV, Fig. 3; Pl. CXIV, Figs. 10–13; Pl. CXXI, Fig. 1.	Alaska.
decussata Reuss	Pl. CXIII, Fig. 7; Pl. CXV, Figs. 1–3; Pl. CXXI, Fig. 2.	Zlambach beds of Alps; also Alaska and California.
Thecosmilia delicatula Frech	Pl. CV, Fig. 4	Zlambach beds of Alps; also Alaska.
fenestrata Reuss	Pl. CV, Fig. 1	Alaska, California, and Zlambach beds of Alps.

Lower Noric coral zone fauna

Name	Illustration	Occurrence in North America	Occurrence elsewhere
Avicula soperi Smith	Pl. XCVI, Fig. 9; Pl. CIII, Fig. 12.	Alaska and California	
Halobia dalliana Smith	Pl. XCVIII, Figs. 5, 6	Alaska	
dilatata Mojsisovics	Pl. XCV, Fig. 5; Pl. C, Figs. 1, 4	Oregon and Alaska	Tyrolian Alps.
fallax Mojsisovics	Pl. XCVIII, Figs. 10, 11	Alaska	Do.
halorica Mojsisovics	Pl. XCV, Figs. 3, 4; Pl. XCVIII, Fig. 12.	Oregon and Alaska	Do.
lineata Muenster	Pl. XCVIII, Figs. 13, 14	Alaska	Do.
alaskana Smith	Pl. C, Figs. 5–7	do	
septentrionalis Smith	Pl. XCVIII, Figs. 1–4	do	
symmetrica Smith	Pl. XCVIII, Figs. 7, 8	do	
Cassianella gravinaensis Smith	Pl. CI, Figs. 4, 5	do	
Myophoria suttonensis Clapp and Shimer	Pl. CV, Fig. 2	Alaska and British Columbia.	
beringiana Smith	Pl. CI, Fig. 3	Alaska	
Purpurina gravinaensis Smith	Pl. CI, Fig. 6	do	
Protorcula bassetti Smith	Pl. CI, Fig. 7	do	
Dielasma suttonense Clapp and Shimer	Pl. CV, Fig. 7	Vancouver Island	
Spiriferina pittensis Smith	Pl. XCV, Figs. 10, 11	California	
Choristoceras suttonense Clapp and Shimer	Pl. CV, Figs. 5, 6	Vancouver Island and Alaska.	
Thecosmilia caespitosa Frech	Pl. CXXI, Fig. 7	Alaska	Do.
delicatula Frech	Pl. CV, Fig. 4	Vancouver Island and Alaska.	Do.
fenestrata Reuss	Pl. CV, Figs. 1, 9	Vancouver Island, Alaska, and California.	Do.
norica Frech	Pl. CXI, Figs. 1–4	Oregon	Do.
Stylophyllopsis mojsvari Frech	Pl. CXVIII, Fig. 10	California and Alaska	Do.
zitteli Frech	Pl. CXI, Figs. 7–9	Oregon and Alaska	Do.
Montlivaultia marmorea Frech	Not figured	Nevada	Do.
martini Smith	Pl. CXXI, Fig. 6	Iliamna Lake, Alaska	
norica Frech	Pl. CXI, Fig. 6	Oregon and Alaska	Do.
Isastrea parva Smith	Pl. CXIV, Figs. 7–9	Alaska	
profunda Reuss	Pl. CV, Fig. 8; Pl. CXII, Figs. 5, 6; Pl. CXIV, Figs. 1–3.	California, Alaska, and Vancouver Island.	
vancouverensis Clapp and Shimer	Pl. CV, Fig. 10; Pl. CXII, Figs. 1–4; Pl. CXIV, Figs. 4–6; Pl. CXXI, Figs. 4, 5.	do	
Latimaeandra alaskana Smith	Pl. CXV, Figs. 11, 12	Alaska	
eucystis Frech	Pl. CXIII, Figs. 8, 9	California	Do.
Confusastrea decussata Reuss	Pl. CXIII, Fig. 7; Pl. CXV, Figs. 1–3; Pl. CXXI, Fig. 2.	California and Alaska	Zlambach beds of Alps.
borealis Smith	Pl. CXVI, Figs. 1, 2	Alaska	
grandissima Frech	Pl. CXV, Fig. 4	California and Alaska	Do.
incrassata Frech	Pl. CXXI, Fig. 3	Alaska	Do.
cowichanensis Clapp and Shimer	Pl. CV, Fig. 3; Pl. CXIV, Figs. 10–13; Pl. CXXI, Fig. 1.	Vancouver Island and Alaska.	
Astrocoenia shastensis Smith	Pl. CXII, Figs. 11–13	California	
martini Smith	Pl. CXV, Fig. 5	Alaska	
Stephanocoenia juvavica Frech	Pl. CXII, Figs. 7–10	California and Alaska	Do.
Thamnastraea borealis Smith	Pl. CXV, Figs. 6–10	Alaska	
rectilamellosa Winkler	Pl. CXIII, Figs. 1–6	California	Do.
rectilamellosa var. minor Frech	Pl. CXVI, Fig. 3; Pl. CXVIII, Figs. 5, 6.	Alaska and California	Do.
Halomitra triadica Smith	Pl. CXX, Figs. 7, 8	Alaska	

Marine invertebrate fauna of the Upper Triassic of North America—Continued

Lower Noric coral zone fauna—Continued

Name	Illustration	Stratigraphic position	Occurrence elsewhere
Spongiomorpha dendriformis Smith	Pl. CXVII, Fig. 1; Pl. CXVIII, Figs. 1, 2.	California	
gibbosa Frech	Pl. CXX, Figs. 1–3; Pl. CXXI, Figs. 14, 15.	California and Alaska	Zlambach beds of Alps.
ramosa Frech	Pl. CXX, Figs. 4, 5; Pl. CXXI, Figs. 10–13.	Alaska	Do.
tenuis Smith	Pl. CXVIII, Fig. 3	California	
Heptastylis aquilae Smith	Pl. CIX, Figs. 1–6; Pl. CXI, Fig. 5.	Oregon	
oregonensis Smith	Pl. CX, Figs. 1–5	do	
Stromatomorpha californica Smith	Pl. CXVIII, Fig. 4; Pl. CXIX, Fig. 1; Pl. CXX, Fig. 6.	California and Alaska	
Heterastridium conglobatum Reuss	Pl. CXVIII, Figs. 7–9	Alaska	Do.

Noric fauna of the Pseudomonotis zone of western North America

Name	Illustration	Occurrence in North America
Aulacoceras carlottense Whiteaves	Pl. CVIII, Fig. 6	Queen Charlotte Islands.
Syringoceras spurri Smith	Pl. CIV, Figs. 8, 9	Nevada.
Badiotites? carlottensis Whiteaves	Pl. CVIII, Fig. 5	Queen Charlotte Islands.
Rhabdoceras russelli Hyatt	Pl. XLVII, Figs. 13–15; Pl. LVI, Fig. 26.	California and Nevada.
Placites humboldtensis Hyatt and Smith	Pl. LVI, Figs. 10–25	Nevada.
Arcestes andersoni Hyatt and Smith	Pl. LVI, Figs. 1–9	Do.
Arniotites vancouverensis Whiteaves	Pl. CVIII, Fig. 2	Vancouver Island and Queen Charlotte Islands.
Juvavites? carlottensis Whiteaves	Pl. CVIII, Fig. 1	
Halorites americanus Hyatt	Pl. XXIX, Figs. 1, 2	California and Nevada.
Monotis alaskana Smith	Pl. CI, Figs. 1, 2	Alaska.
Pseudomonotis subcircularis Gabb	Pl. XCV, Figs. 8–9; Pl. CI, Fig. 8; Pl. CIV, Figs. 6, 7.	Nevada, California, North Pacific, and Alaska.
circularis Gabb	Pl. CIV, Fig. 5	Nevada.
Avicula mucronata Gabb	Pl. CIV, Fig. 1	California.
Posidonia blatchleyi Gabb	Pl. CIV, Fig. 4	Nevada.
daytonensis Gabb	Pl. CIV, Fig. 3	Do.
stella Gabb	Pl. CIV, Fig. 10	Do.
Pecten deformis Gabb	Pl. CIV, Fig. 2	California.
Daonella? bochiformis Hyatt	Not figured	Do.
cardinoides Hyatt	do	Do.
subjecta Hyatt	do	Do.
Cardinia? ponderosa Gabb	do	Nevada.
Myophoria humboldtensis Smith	Pl. XCVI, Fig. 27	Do.
alta Gabb	Pl. CIV, Fig. 16	Do.
Names only		
Arcestes californiensis Hyatt		Plumas County, Calif.
Daonella tenuistriata Hyatt		Do.
Inoceramus gervillioides Hyatt		Do.
simplex Hyatt		Do.
Pecten daytonensis Hyatt		Do.
inexpectans Hyatt		Do.
lasseni Hyatt		Do.
Lima acuta Hyatt		Do.
Nucula tenuis		Do.
Modiola triquetraeformis Hyatt		Do.
Rhynchonella solitaria Hyatt		Do.

CLASSIFICATION OF TRIASSIC AMMONOIDS

The systematic relationships of Triassic ammonoids are comparatively simple. There are in reality only two major stocks, one coming from the Gephyrocera-tidae and one from the *Gastrioceras* branch of the Glyphioceratidae. From the *Gephyroceras* stock came the Ceratitoidea and Pinacoceratoidea; from the *Gastrioceras* stock came the Ptychitoidea, the Tropitoidea, and the Arcestoidea.

The genetic relationships are expressed in the diagram below.

Most of the larger groups of the Upper Triassic fauna are progressive, developing rapidly, giving rise to numerous normal genera, and multiplying in species with abundant individuals.

Now, as the Upper Triassic faunas of the world are well known, it is not likely that there are many unknown groups of ammonoids in that time, and as these groups were in existence at the end of the Triassic period, it is more than probable that the Jurassic ammonites must have developed out of the known groups. The genetic series of *Lytoceras-Phylloceras* is

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                                          ⎧Lytoceratidae  ⎫
                           ⎧Xenodiscidae ⎨Ceratitidae    ⎬Ceratitoidea
                           ⎪              ⎪Hungaritidae   ⎪
               ⎧Gephyroceras⎨              ⎩Gymnitidae     ⎭
               ⎪           ⎩Pronoritidae ──→ Noritidae                  ⎫
               ⎪              └→Gonioloboceras⎧Thalassoceratidae        ⎪
Anarcestidae ⎨                              ⎩Haueritidae              ⎬Pinacoceratoidea
               ⎪     └→ Beloceras ──→ Prodromitidae ──→ Pinacoceratidae ⎭
               ⎪           ⎧Juvenites⎧        Ptychitidae              Ptychitoidea
               ⎪           ⎪          ⎩Acrochordiceratidae       Haloritidae⎫
               ⎩Gastrioceras⎨Schistoceras ──→ Celtitidae ──→ Tropitidae     ⎭Tropitoidea
                           ⎩Agathiceras→⎧Popanoceratidae ──→ Arcestidae    ⎫Arcestoidea
                                        ⎩        Cladiscitidae             ⎭
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Arthaber [18] has given a most elaborate classification of Triassic ammonites, which differs considerably from that shown above. He recognizes five principal stocks (stamm), of which (I) Beloceratea, (II) Tornoceratea, and (III) Gephyroceratea correspond to the *Gephyroceras* stock in the table above. His (IV) Agathiceratea and (V) Gastrioceratea correspond to the *Gastrioceras* stock.

The stock of Beloceratea can not stand, for only a small part of the genera included by Arthaber in that group can possibly have been derived from *Beloceras*. His Tornoceratea also can not be accepted, for the supposed components of that group are of very diverse origin, the Ptychitidae from the *Gastrioceras* stock and the Gymnitinae from the *Gephyroceras* branch of Xenodiscidae. As to the other groups, the writer agrees substantially with Arthaber.

All five suborders are represented in the Upper Triassic of North America, the Ceratitoidea by Lytoceratidae and Ceratitidae; the Pinacoceratoidea by Haueritidae and Pinacoceratidae; the Ptychitoidea by Ptychitidae; the Tropitoidea by Celtitidae, Haloritidae and Tropitidae; the Arcestoidea by Arcestidae and Cladiscitidae. These are described fully under the proper heads.

The Noritidae and Hungaritidae, which are fairly common in the Upper Triassic beds of Europe, are lacking in North America in beds laid down at that time, although Hungaritidae were abundant there in Middle Triassic time.

The name Lytoceratoidea, formerly used by the writer to designate the group of *Monophyllites*, *Lytoceras*, *Phylloceras*, and their kindred, is given up, since Arthaber has shown that this line was derived from the Xenodiscidae. The group is therefore placed under the Ceratitoidea.

[18] Arthaber, G. von, Die Trias von Albanien: Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, Band 24, pp. 177-179, 1911.

the only one that goes through from Triassic to Jurassic unchanged, but in Jurassic and even Cretaceous genera there are many reminiscences of Triassic genera, as seen in recapitulation in ontogeny and in arrested development, as well as in reversionary types. A discussion of this subject has been given elsewhere by the writer,[19] so there is no need of repetition here.

DEGENERATE OR RETARDED FORMS IN THE UPPER TRIASSIC OF CALIFORNIA

Although retarded forms, such as *Nannites* and *Lecanites*, are common in the Lower Triassic, these are simply nearly stationary, and in *Paranannites* and *Thermalites* are still, to some extent, progressive. Even in the Middle Triassic *Lecanites* and *Nannites* still persist with little change but show by their dwarfed forms that they are no longer progressive.

In the Upper Triassic none of the left-over types persist, but there are many dwarfs that resemble the ancient forms. These dwarfs are, without exception, reversionary groups, arrested in development, and retrograding to the stage of evolution of their Paleozoic and early Mesozoic ancestors. Those known in California are listed below.

Ptychitidae:	
Paraganidea californicus	Fully retarded and reversionary to the stage of Devonian and early Carboniferous Aganides.
Haloritidae:	
Metasibirites brockensis	All retarded in stage showing characters of Pericyclus of Carboniferous, Gastrioceras of Carboniferous, and Acrochordiceras of Middle Triassic.
coei	
frechi	
gracilis	
modestus	
mojsvarensis	
parvus	
pusillus	
pygmaeus	
shastensis	

[19] Smith, J. P., Acceleration of development in fossil Cephalopoda: Leland Stanford Junior Univ. Pub., univ. ser., 1914.

Haloritidae—Continued.	
Homerites semiglobosus	Some characters of primitive Acrochordiceras.
Leconteiceras californicum occidentale	Arrested in development in stage corresponding to some characters of Gastrioceras and Acrochordiceras.
Jovites pacificus	Partly arrested.
Bacchites bacchus	Reversionary by loss of sculpture.
Halorites americanus	Abnormal in body whorl.
Gonionotites hyatti northi pinguis	Arrested and retarded in sculpture and to some extent in septa.
Tropitidae:	
Tornquistites evolutus obolinus	Retarded in characters resembling Tropigastrites.
Microtropites tubercularis	Arrested in stage resembling Protropites.
Tropiceltites caducus	Retarded in stage resembling both Gastrioceras and Tropigastrites.
Celtites steindachneri	Arrested in stage corresponding to transition from Gastrioceras to Celtites.
Anatropites hauchecornei	Partly arrested in stage showing characters of Tropigastrites.
Margarites senilis jokelyi septentrionalis	Partly arrested and retarded in Tropigastrites stage.
Pinacoceratidae:	
Dieneria arthaberi	Arrested in stage like Beatites of the Lower Triassic.
Ceratitidae:	
Metatirolites foliaceus quadrangulus subpygmaeus	Arrested in stage like Tirolites of the Lower Triassic.
Choristoceras kellyi klamathense	Arrested and uncoiling, reverting to form between Bactrites and Anarcestes.
Polycyclus henseli nodifer major	Retarded in many characters of primitive Xenodiscus.
Rhabdoceras russelli	Reversionary to Bactrites in form, still ceratitic in septa.
Thisbites uhligi	Retarded in some characters of primitive Ceratites, in others reversionary to goniatite ancestor.
Sandlingites andersoni oribasus	Retarded in septa to early ceratitic ancestor, in sculpture to transitional Anolcites.
Clionites careyi merriami minutus	Almost completely arrested in Tirolites stage but retains the trachyceran furrow.
americanus fairbanksi	Retains some of the trachyceran sculpture.
evolutus occidentalis rugosus	Partly reversionary in form, completely in septa.
californicus osmonti	Arrested in Tirolites stage almost at maturity.
compactus compressus whitneyi	Retains some trachyceran characters but arrested in septa.
nanus robustus stantoni tornquisti	Retains most of the trachyceran sculpture but thoroughly retarded in septa.

In all the species and genera cited above the reversion by arrest of development occurs, but it is never complete. In some characters the form may be completely arrested, and in others it may still be up to the stage of its immediate ancestors. But even partial arrest of development is a sign of degeneration and is nearly always accompanied by dwarfing of the form and followed by early extinction. This phenomenon brings out the strange palingenesis of long extinct types, the reappearance in the old age of the race of characters that belonged to its long-forgotten youth. It is true senescence, not of individuals but of the race. Alpheus Hyatt was not able to use these examples in his studies of ontogeny and phylogeny, for nearly all these dwarfed and arrested types have been made known since his classic studies were published. The prophetic mind of E. D. Cope foresaw the principles, but he had no examples. The writer has recently given a full discussion of arrest of development and retardation in fossil Cephalopoda, with illustrations.[20]

The Upper Triassic cephalopod fauna, if one judges by the large number of dwarfed and arrested forms, was largely in a state of old age. Very few of these stocks passed over into the Jurassic period but were largely replaced by genera that came as vigorous immigrants from breeding grounds as yet unknown.

In all the degenerate forms listed above degeneration seems to be very sudden, for they are little removed in time from the genera from which they must have retrograded, and the reversion toward their remote Paleozoic and early Mesozoic ancestors is exceedingly rapid. They show their degeneration partly in loss of the distinctive characters of their immediate ancestors, in reduction in size, in simplification of the septa, and in their partial return to the characters of their remote ancestors, thus accentuating the characters of the radicle stock.

The cause of this degeneration is not known, but it is essentially a dropping back in the race—retardation. These forms behave like those in unfavorable surroundings in showing unusual individual variation, which again is a return to the behavior of the stock in its distant youth.

Species living under unfavorable conditions show unusual individual variation and various degrees of reversion, as, for example, *Gastrioceras diadema* of the European "Coal Measures." This species, while the main stock was still young and progressive, lived under abnormal conditions in an oscillating basin, and it shows, by its extreme variability and the various degrees of reversion to *Pericyclus*, that something was wrong with it. The reversion is all along the line, and even the young stages vary as much as the mature forms. No constant tendency to the fixation of subspecies or varieties can be observed in this variation. This species is simply a group of individuals affected by abnormal conditions of salinity, or possibly temperature, and striving to adapt itself. The fundamen-

[20] Op. cit., pp. 12-19.

tal pathologic condition calls forth deep-seated hereditary characters, and the species reverts to some of these. It plainly shows premature senility at a time when the race was not yet old. This species behaves exactly as does the group of *Clionites*, but in that group, which was worn out in varying, the senility is real.

A series of degenerate *Clionites* behaves entirely differently from one of progressive *Tropites*. In *Clionites* there is greater variation and difficulty of discriminating species, and the variation is extremely irregular and lawless. In *Tropites* there is also great variation, but it is linear and regular, between extremes of the series. There is no difficulty in placing a good specimen in that part of the linear series where it belongs, even though there may be difficulty in drawing the line between contiguous species.

In addition to the more completely retarded or reversionary genera and species listed above, *Juvavites* and *Trachyceras* show a tendency to prolong their ontogeny.

Several species of *Juvavites* linger in the stages corresponding to *Gastrioceras* and its immediate descendants, which is a beginning of arrest of development. *Trachyceras lecontei* remains until fully mature in the compressed, nearly smooth form characteristic of the ancestral *Meekoceras*. *Trachyceras beckeri* persists in that same stage until half grown, then suddenly reverts to the rough-shelled sculpture of the Ladinic species of *Trachyceras*.

Arpadites might be called a persistent larval form, for in most characters it is not beyond *Meekoceras*.

These degenerate and arrested or reversionary forms are of great value in classification, for through them we obtain confirmation of conclusions based upon the study of progressive genera in the same families.

SYSTEMATIC DESCRIPTIONS

Phylum MOLLUSCA

Class CEPHALOPODA

Order AMMONOIDEA

Suborder TROPITOIDEA

Forms that have long body chamber, umbilical ribs or knots, periodic constrictions, usually strong surface sculpture, and comparatively simple septa. The septa are digitate in the highly developed genera; simple or goniatitic in the primitive ancestral types; ceratitic in the transitional types; and either goniatitic or ceratitic in the arrested or retarded reversionary forms.

The principal stocks of Tropitoidea are as follows:

I. Celtitidae:

Celtites Mojsisovics	Primitive.
Columbites Hyatt and Smith	
Prenkites Arthaber	
Juvenites Smith	

II. Haloritidae:

Thermalites Smith	Transitional.
Isculites Mojsisovics	
Acrochordiceras Hyatt	
Sagenites Mojsisovics	Fully developed.
Halorites Mojsisovics	
Jovites Mojsisovics	
Bacchites Smith	
Juvavites Mojsisovics	
Gonionotites Gemmellaro	
Leconteiceras Smith	Reversionary arrested.
Miltites Mojsisovics	
Homerites Mojsisovics	
Metasibirites Mojsisovics	

III. Tropitidae:

Tropites Mojsisovics	Progressive.
Protropites Arthaber	
Tropigastrites Smith	
Paratropites Mojsisovics	
Discotropites Hyatt and Smith	
Arniotites Hyatt	
Microtropites Mojsisovics	Reversionary arrested.
Margarites Mojsisovics	
Anatropites Mojsisovics	
Tropiceltites Mojsisovics	
Styrites Mojsisovics	
Tornquistites Hyatt and Smith	

The young stages of all Tropitoidea are like *Gastrioceras*, and all arrested reversionary forms tend to revert to gastrioceran characters, thus pointing to *Gastrioceras* as the family radicle. This genus is confined to the Carboniferous, where it is abundant and characteristic. It has been fully described and illustrated by the writer.[21] The type species of the genus, *Gastrioceras listeri* Martin, from the Middle Coal Measures of Manchester, England, is figured in Plate XX, Figures 8–12, for comparison with the young stages of Tropitoidea described and figured below.

The group of *Gastrioceras globulosum* seems to have been the starting point of the Haloritidae; hence a typical member of that group, *Gastrioceras welleri* Smith, from the "Upper Coal Measures" (Pennsylvanian) of Howard, Kans., is figured in Plate XX, Figures 14–17.

A group transitional from *Gastrioceras* toward the Haloritidae is described below for comparison with the youthful stages of fully developed Haloritidae.

JUVENITES Smith, n. gen.

Type.—Juvenites kraffti Smith.

Form robust, moderately involute, widely umbilicate, cross sections trapezoidal. Surface with numerous close-set periodic constrictions. Body chamber long. Septa simple, goniatitic with divided ventral lobe, and two simple laterals.

Juvenites includes the primitive Lower Triassic forms that have hitherto been classed under the arrested and reversionary *Nannites: Nannites dieneri* Hyatt and Smith, *Nannites medius* Krafft, *Nannites herberti* Diener, *?Nannites hindostanus* Diener.

Juvenites kraffti Smith, n. sp.

Plate XXI, Figures 1-10

Form broad, widely umbilicate, with low crescentic cross section. Surface with very numerous close-pressed folds, giving an imbricated appearance. Body chamber long. Septa simple, goniatitic, with divided ventral and two laterals.

[21] Smith, J. P., The Carboniferous ammonoids of America: U. S. Geol. Survey Mon. 42, pp. 82-98, 1903.

Closely related to *Juvenites dieneri* Hyatt and Smith [22] of the Lower Triassic but broader, less involute, more strongly sculptured, and more decidedly gastrioceran in appearance.

Occurrence: Lower Triassic, *Meekoceras* zone, Warm Springs, northeast end of Bear Lake, Idaho. Named in memory of Dr. A. von Krafft.

The genus *Columbites* Hyatt and Smith, of the Lower Triassic, is transitional from *Gastrioceras* toward the Tropitidae. It has already been fully described and illustrated by the writer,[23] and its relation to the phylogeny of the Tropitoidea discussed. A farther link in the chain, transitional from *Columbites* toward *Tropites*, has been described by the writer [24] in *Tropigastrites* of the Middle Triassic. *Columbites* is nearest to *Gastrioceras* in time and relationship, and its forms agree perfectly with those of that genus until they attain a diameter of 15 millimeters. *Tropigastrites*, which is farther removed, passes through the *Gastrioceras* stage when its forms are less than 10 millimeters in diameter. Both *Columbites* and *Tropigastrites* appear to come from the group of *Gastrioceras listeri*, whereas the primitive Haloritidae appear to come from the group of *Gastrioceras welleri*. These primitive Haloritidae are *Juvenites* Smith, described above, and *Thermalites* Smith, n. gen., of which a species, *Thermalites thermarum* Smith, n. sp., is described here for comparison with the young stages of the more specialized Haloritidae.

Genus THERMALITES Smith, n. gen.

1911. *Isculites*. Arthaber, Die Trias von Albanien: Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, Band 24, p. 259.

(Not 1893. *Isculites* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 64.)

Type.—Thermalites thermarum Smith, n. sp.

Form robust, subspherical, with broad subtrapezoidal whorls, wide umbilicus. Surface with numerous constrictions and folds. Body chamber long. Septa with entire saddles and slightly serrated lobes of simple pattern.

This genus is transitional from *Juvenites* to the Haloritidae, differing from the former only in the serration of the lobes and from the latter only in the rudimentary development of the sculpture and the very primitive septa.

Thermalites should probably include "*Isculites*" *originis* Arthaber, [25] which certainly is not a member of *Isculites* and which is closely related to *Thermalites thermarum*.

Thermalites thermarum Smith, n. sp.

Plate XXI, Figures 11–20

Form robust, with highly arched, helmet-shaped, deeply embracing whorls, subtrapezoidal, moderately wide umbilicus. Surface with numerous strong constrictions, which become nearly obsolete with age and are replaced by rather weak folds. Septa with rounded entire saddles and serrated lobes. The external septa consist of a divided ventral lobe and two laterals; the internal septa consist of a divided antisiphonal and two laterals, all slightly serrated. The body chamber is more than one revolution in length. The height of the last whorl is nearly half the total diameter of the shell, and the width is 1½ times the height. The whorl is rather deeply embracing and is indented to half its height by the inner whorl. The width of the umbilicus is one-third of the diameter of the shell.

Thermalites thermarum differs from "*Isculites*" *originis* Arthaber in being more trapezoidal and in having stronger sculpture. It is almost certainly congeneric with that species, and neither can belong to *Isculites*. It has also a very close resemblance to *Juvenites kraffti* Smith, differing only in the serration of the lobes, the form, sculpture, and ground plan of the septa being the same in both species. In both species the shell is ornamented with very fine cross striae of growth, and both lack suggestion of spiral lines, so common on most descendants of the gastrioceran stock.

Occurrence: Rather common in the Lower Triassic *Meekoceras* zone of Aspen Ridge, Bannock County, and at Warm Springs, at the northeast end of Bear Lake, Idaho.

Sibirites Mojsisovics of the Lower Triassic has been thought to be transitional from the gastrioceran stock to *Acrochordiceras* but is more likely a member of the Meekoceratidae. *Acrochordiceras* already shows the typical development of the Haloritidae.

The young of *Sagenites*, *Juvavites*, and *Metasibirites* are more like the group of *Gastrioceras welleri*, agreeing in this with *Juvenites and Isculites*.

Mojsisovics regarded *Celtites* Mojsisovics as the radicle of the Tropitidae, but the typical forms of this genus are dwarfed, arrested, reversionary forms, largely confined to the Middle Triassic and already antedated by genuine tropitoid forms and probably not congeneric with the primitive so-called *Celtites* of the Lower Triassic.

Proteusites Hauer, of the Middle Triassic, has been assigned to the Ceratitidae, but in the opinion of the writer it belongs in the same genetic series with *Columbites*.

The following diagram gives the writer's ideas of the phylogeny of the Tropitoidea.

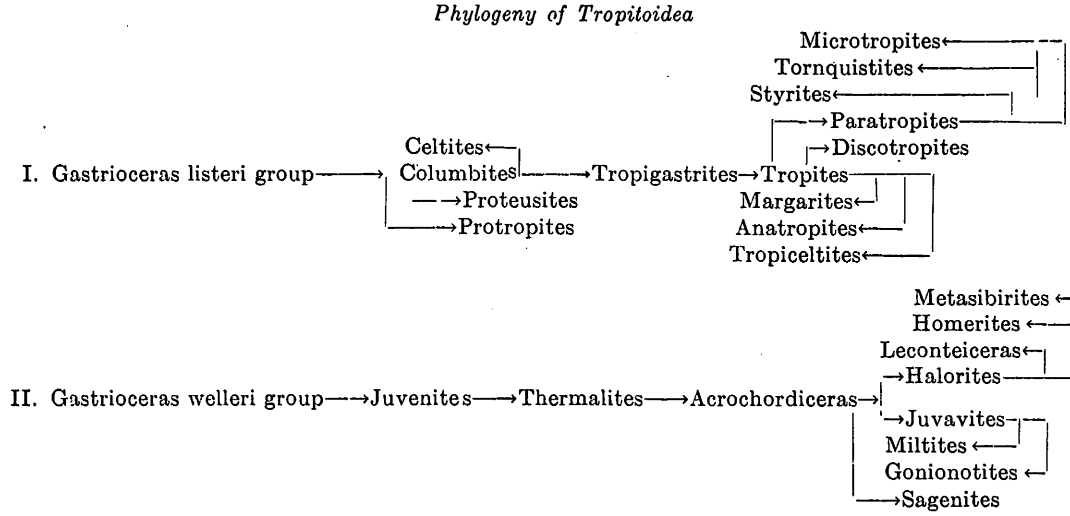
[22] Hyatt, Alpheus, and Smith, J. P., The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 79, pl. 7, figs. 5–25, 1905.

[23] Idem, pp. 50–52, 1905. Smith, J. P., Middle Triassic marine invertebrate faunas of America: U. S. Geol. Survey Prof. Paper 83, pp. 36, 37, 1914; Acceleration of development in fossil Cephalopoda: Leland Stanford Junior Univ. Pubs., univ. ser., p. 28, 1914.

[24] Smith, J. P., Middle Triassic marine invertebrate faunas of America: U. S. Geol. Survey Prof. Paper 83, pp. 25–33, 1914.

[25] Arthaber, G. von, Die Trias von Albanien: Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, Band 24, p. 259, pl. 23, figs. 1–10, 1911.

Phylogeny of Tropitoidea



In series I *Protropites* is a remarkable forerunner of *Tropites*, but it is too highly specialized for an ancestor; the other Tropitoidea in the Middle Triassic are not so far along as this Lower Triassic genus. *Tropigastrites*, on the other hand, is just ahead of *Columbites* in the series, and intermediate between it and *Tropites* in all characters and in the development of the lobes and beginning of the keel. Arthaber [26] has described, from the Lower Triassic of Albania, *Columbites mirditensis*, which looks very like a transition to *Tropites* and may belong to *Tropigastrites*. It can hardly belong to *Columbites*.

Just where *Paratropites* should be placed in the series is somewhat doubtful, but probably it is somewhere near *Discotropites*. *Gymnotropites* is the first step in degeneration from *Paratropites*, by loss of sculpture; next comes *Paulotropites*, in dwarfing and change of form; then *Microtropites*, in further dwarfing and simplification of septa; then *Styrites* and *Tornquistites*, in almost complete arrest of development and reversion to ancestral types.

Margarites is only slightly reversionary, or rather arrested, from *Tropites*. *Anatropites* is dwarfed and the septa simplified. *Tropiceltites* is arrested and decidedly reversionary toward *Columbites* but retains the tropitoid keel.

In series II, the Haloritidae, *Juvenites* and *Thermalites* are simple progressive forms, as is also *Acrochordiceras*, out of which came *Juvavites*. *Halorites*, and *Sagenites* as parallel developments. *Homerites* is arrested and reversionary from *Halorites* but retains the rudimentary keel. *Jovites* and *Bacchites* are only slightly reversionary from *Halorites*. *Gonionotites* is slightly arrested and reversionary from *Juvavites* by loss of sculpture and slight simplification of the septa. *Miltites* is dwarfed but otherwise normal. *Leconteiceras* is arrested, dwarfed, and reversionary to some primitive ancestor of *Acrochordiceras*, possibly *Thermalites*, but in some characters to *Pericyclus* itself, the primitive ancestor of *Gastrioceras*.

The Tropitoidea, which are more highly specialized and reached their full development earlier, show at the Karnic horizon of the Upper Triassic many more degenerate and reversionary groups than do the Ceratitoidea, which were of slower development. The Ceratitoidea reached their height of development in the Noric stage and then produced a wealth of arrested reversionary genera.

The distribution of Tropitoidea in the American Triassic is as follows:

Lower Triassic: *Juvenites, Thermalites, Columbites, Celtites;* parent stocks of both Haloritidae and Tropitidae.

Middle Triassic: *Acrochordiceras, Celtites, Columbites, Tropigastrites;* groups transitional to Haloritidae and Tropitidae.

Upper Triassic: Haloritidae: *Halorites, Jovites, Bacchites, Homerites, Leconteiceras, Metasibirites, Juvavites, Anatomites, Gonionotites,* and *Sagenites*. Tropitidae: *Tropites, Discotropites, Paratropites, Paulotropites, Gymnotropites, Margarites, Anatropites, Microtropites, Tropiceltites, Tornquistites,* and *Arniotites?*. Celtitidae: *Celtites*.

[26] Arthaber, G. von, op. cit., p. 263, pl. 24, figs. 2-4.

Family TROPITIDAE Mojsisovics

Forms ranging from involute subspherical to evolute discoidal; body chamber long; keels and bordering furrows invariably present at maturity. Septa somewhat digitate in all highly specialized progressive genera; ceratitic in primitive progressive genera; and ceratitic or even goniatitic in arrested and reversionary genera. All the forms show at some stage of growth the umbilical knots and the periodic constrictions of *Gastrioceras*.

The young stages of all Tropitidae are like *Gastrioceras*, which is the family radicle, and the genetic series is *Gastrioceras*→*Columbites*→*Tropigastrites*→*Tropites*. In each of the later members the *Gastrioceras* stage of growth becomes smaller and shorter by acceleration of development. Each of the members of the main line gives off many side branches, some of which are reversionary, and in the arrested or reversionary members the *Gastrioceras* stage is still as persistent as in the progressive members, but the later characters are successively obscured or obliterated. This phase of their development has been fully discussed by the writer elsewhere.[27]

Genus TROPITES Mojsisovics

1875. *Tropites* (part). Mojsisovics, in Neumayr, M., Die Ammoniten der Kreide und die Systematik der Ammonitiden: Deutsche geol. Gesell. Zeitschr., Band 27, p. 889.
1879. *Tropites* (part). Mojsisovics, Vorläufige kurze Uebersicht der Ammoniten-Gattungen der Mediterranen und Juvavischen Trias: K.-k. geol. Reichsanstalt Wien Verh., p. 136.
1893. *Tropites* (part). Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 184.
1896. *Tropites* (part). Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 39.
1904. *Tropites*. Smith, The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., vol. 1, p. 392.
1904. *Tropites*. Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 94.
1905. *Tropites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 65.
1906. *Tropites*. Diener, Fauna of the *Tropites* limestone of Byans: Geol. Survey India Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 145.
1906. *Tropites*. Arthaber, Die alpine Trias des Mediterran-Gebietes: Lethaea Geognostica, Teil 2, Das Mesozoicum, Band 1, p. 372.
1908. *Tropites*. Diener, Upper Triassic and Liassic faunae of the exotic blocks of Malla Johar in the Bhot Mahals of Kumaon: Geol. Survey India Mem., Palaeontologia Indica, ser. 15, vol. 1, pt. 1, p. 28.
1908. *Tropites*. Diener, Ladinic, Carnic, and Noric faunae of Spiti: Geol. Survey India Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 3, p. 78.
1914. *Tropites*. Smith, Acceleration of development in fossil Cephalopoda: Leland Stanford Junior Univ. Pub., univ. ser., p. 9.
1914. *Tropites*. Smith, The Middle Triassic marine invertebrate faunas of North America: U. S. Geol. Survey Prof. Paper 83, p. 24.
1914. *Tropites*. Welter, Obertriadische Ammoniten und Nautiloiden von Timor: Paläontologie von Timor, Lief. 1, p. 110.
1920. *Tropites*. Diener, Neue Tropitoidea aus den Hallstätterkalken des Salzkammergutes: K. Akad. Wiss. Wien Denkschr., Band 97, p. 38.

The following description of *Tropites* is quoted from Hyatt and Smith:[28]

Type.—Ammonites subbullatus Hauer.[29]

Moderately evolute whorls, not deeply embracing, and not deeply indented by the inner whorls. Umbilicus open and deep, with steep walls. Whorls usually broader than high, with angular prominent umbilical shoulders and arched venter, which may be broad and flattened or helmet-shaped. At maturity the whorls are often contracted, showing egression, so that the body whorl is lower and narrower than the inner volution. The cross section is usually trapezoidal, and in the typical forms there are no flanks, for the venter is flattened so that it begins at the umbilical shoulders. Surface ornamented with strong umbilical knots, from which dichotomous ribs start out, curving gently across the sides to near the center, upon which a strong keel is developed, usually with marginal furrows at which the lateral ribs end. The surface of the shell also has spiral lines, which are not visible on the cast. No constrictions appear on the shell and [in most specimens] no knots except on the umbilical shoulders. The septa are ammonitic but not deeply digitate. The external lobe is divided by a siphonal saddle into two broad, shallow branches. The lateral lobe is still broader, and there are usually several auxiliaries, which in the type species are on the steep umbilical walls. Since the height of the whorl varies greatly there is a corresponding variation in the number of the lateral lobes. The body chamber is long, at least a revolution in length.

Mojsisovics[30] divides *Tropites* into five groups: (1) *Tropites bullati* (*Tropites* s. s.); (2) *Tropites spinosi* (subgenus *Anatropites*); (3) *Tropites labiati* (subgenus *Paulotropites*); (4) *Tropites aequabiles* (subgenus *Paratropites*); (5) *Tropites galeoli* (subgenus *Microtropites*). Only the first group is now retained under *Tropites*, the others having all been separated as independent genera or as subgenera under other groups belonging to the Tropitidae.

The genus *Tropites* appears rather suddenly in the Upper Triassic Karnic stage in the Mediterranean region, in the Himalayas, in California, and in Alaska. A few remnants live on into the Noric stage, but here the entire genus disappears. Whether it really became extinct or merely changed into other forms is not yet known.

[27] Smith, J. P., Acceleration of development in fossil Cephalopoda: Leland Stanford Junior Univ. Pubs., Univ. ser., 1914.

[28] Hyatt, Alpheus, and Smith, J. P., The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 66, 1905.

[29] Hauer, F. von, Ueber neue Cephalopoden aus den marmorschichten von Hallstatt und Aussee: Haidinger's Naturwiss. Abh., Band 3, p. 19, pl. 4, figs. 1–4 (not 5–7), 1849; Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh. Band 6, Hälfte 2, p. 187, pl. 106 figs. 1, 2, 3, 5, 7; pl. 108; pl. 110, fig. 6, 1893.

[30] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 184, 1893.

The writer [31] has already in several papers traced the development of *Tropites* from *Gastrioceras* of the Carboniferous through *Columbites* of the Lower Triassic and *Tropigastrites* of the Middle Triassic. The sequence of mature forms in the genetic series and the ontogeny of typical species in each genus in the series all agree.

Tropites is represented in the Mediterranean region by a large number of species, in the Indian region by a considerable number, and in the western American region by a much greater wealth of forms than in any of the others.

GROUPS OF TROPITES IN THE AMERICAN TRIASSIC

I. Group of *Tropites subbullatus* Hauer: Robust whorls, moderately weak sculpture, fine ribs curving gently forward to the ventral keel. This is a Mediterranean group, and nearly all *Tropites* of that region belong here. In America it is almost exclusively confined to the lower horizon (*Trachyceras* subzone) of the zone of *Tropites subbullatus*.

Tropites discobullatus Mojsisovics.
torquillus Mojsisovics.
dilleri Smith.
subbullatus Hauer.
subbullatus var. pacifica Smith.
armatus Smith.
morloti Mojsisovics.
occidentalis Smith.
fusobullatus Mojsisovics.

II. Group of *Tropites mojsvarensis* Smith: Ribs and umbilical knots strong; spiral lines moderately strong. Sculpture much sharper than in *Tropites subbullatus* group. Chiefly American and almost exclusively confined to the *Juvavites* subzone of the *Tropites subbullatus* zone.

Tropites brockensis Smith.
mojsvarensis Smith.
rotatorius Smith.

III. Group of *Tropites welleri* Smith: Strong, sharply forward-curving ribs, and strong spiral lines; umbilical knots well developed. Chiefly American and entirely confined to the *Juvavites* subzone.

Tropites keili Mojsisovics.
wodani Mojsisovics.
ursensis Smith.
welleri Smith.
schellwieni Smith.
kellyi Smith.
shastensis Smith.

IV. Group of *Tropites reticulatus* Smith: Ribs and spirals strong: surface reticulate; ranging from laterally depressed to strongly depressed forms; the latter forms develop spines on the ribs. Exclusively American and confined to the *Juvavites* subzone.

Subgroup 1:
Tropites reticulatus Smith.
dieneri Smith.
kokeni Smith.
Subgroup 2:
Tropites traski Smith.
philippii Smith.
johnsoni Smith.
boehmi Smith.

V. Group of *Tropites morani* Smith: Fine radial and nearly straight ribs, weak spirals, and little or no umbilical knots. Ranges from laterally compressed to spherical forms. Exclusively American, so far as known, and confined entirely to the *Juvavites* subzone.

Tropites morani Smith.
hessi Smith.
arthaberi Smith.
stantoni Smith.
stearnsi Smith.
rothpletzi Smith.

Each group of *Tropites* given above forms a series of species in the making. In each series the species range from laterally compressed involute to depressed broad trapezoidal involute forms. In the more complete series there is nearly complete intergradation, but there is total dissimilarity between the extremes. For example, there is hardly any break in the series from *Tropites discobullatus* to *Tropites fusobullatus*, and yet these two extremes are so dissimilar that one would almost be inclined to place the species in different genera.

Each series or group is a "gross Art," or superspecies, an assemblage of forms diverging from a common ancestor not far below them. As the common ancestor of all *Tropites* did not antedate them by a very long time, the different series have developed somewhat in the same direction, each series having species that are parallel with those in the other series. Although the compressed or the depressed members resemble each other, they are more closely related to the unlike members of their own group than they are to the like members of the other groups. Thus, for example, *Tropites fusobullatus*, *Tropites rotatorius*, *Tropites schellwieni*, *Tropites stearnsi*, *and Tropites boehmi* are all broad depressed keg-shaped forms and resemble each other in many respects. But each one intergrades with a series of species unlike itself and wholly unlike the analogous species. The young of all the species are robust forms, though not like the extremes, and point to a species of medium depressed form as the common ancestor.

The group of *Tropites subbullatus* is as well represented in Europe as in America; the other groups are almost entirely American. The abundance and completeness of these series is good proof that they are endemic in Pacific waters. It is not likely that if they were immigrants all the diverging members would have been able to make the journey from one region to another unchanged. The similarity of

[31] Smith, J. P., The Middle Triassic marine invertebrate faunas of North America: U. S. Geol. Survey Prof. Paper 83, pp. 27 et seq., 1914; Acceleration of development in fossil Cephalopoda: Leland Stanford Junior Univ. Pub., univ. ser., pp. 9 et seq., 1914.

corresponding members of the series is an example of parallelism or orthogenesis; that is, forms from a common ancestor (which could not possibly resemble all these species) developing along similar lines and producing convergence of species not very nearly related.

This parallelism or convergence or orthogenesis is most definitely illustrated in the genus *Tropites*, because this group was probably endemic in the Pacific region, and the species are seen in the making. In other regions *Tropites* is represented by fragments of series that reached those regions by immigration. Nearly all the species of *Tropites* in India occur also in the Mediterranean region, and all the species common to America and India occur also in the Mediterranean. Also in the Mediterranean region nearly all the species of *Tropites* belong to group I, that of *Tropites subbullatus*, though there are a few stragglers from other groups.

The genus *Tropigastrites* Smith, the probable immediate ancestor of *Tropites*, is very common in the Middle Triassic of Nevada, very rare and not typically developed in the Mediterranean, and wholly unknown in India. *Tropites* appears as an immigrant in India and is represented by only a few of the hardier forms that are already specifically fixed. In the Mediterranean, which was much more closely connected with the Cordilleran sea in Upper Triassic time, *Tropites* also appears as an immigrant, in much greater variety than it shows in India and much less than in America. In spite of Mojsisovics's exceedingly narrow interpretation of species, *Tropites* is represented in America by much more numerous forms than it shows in Europe. Also it seems to have appeared earlier, while the genus was still abundant, and to have lived longer.

It is almost certainly an axiom that any group is endemic in that region where it is more abundantly represented by the greatest variety of forms and the greatest number of individuals and where intergradation between the component species of the genus is most nearly complete. There evolution and variation are just beginning, and elimination by natural selection has not yet shown its work.

Series I, the *Tropites subbullatus* group, and series III, the *Tropites welleri* group, are good illustrations of species in the process of formation, in which the intergradations are almost perfect from *Tropites discobullatus* to *Tropites fusobullatus* and from *Tropites wodani* to *Tropites schellwieni*, from thin discoidal to subspherical robust forms, all at least nearly contemporary. They have diverged so recently that natural selection has not yet had time to weed out the unfit and set the stamp of approval on the fit. And yet no systematist would place *Tropites discobullatus* and *Tropites fusobullatus* in the same species, nor could he do so with *Tropites wodani* and *Tropites schellwieni*, the extremes of the two series.

One must admit variation without isolation, at the same place and at the same time, to the extent of developing species. These forms are all abundant in the beds in which they were found, and for the time at least all equally successful, whatever may have happened to them later. Unfortunately their later history is not now accessible, for just above the *Tropites* zone the facies changes to coral limestone, and *Tropites* disappears, never to be seen again in American waters. A similar change occurs in India and in the Mediterranean, the only other regions where the genus is known.

GROUP OF TROPITES SUBBULLATUS

Tropites discobullatus Mojsisovics

Plate LXVIII, Figures 32–34

1893. *Tropites discobullatus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 212, pl. 102, figs. 7, 8; pl. 104, figs. 1–6; pl. 105, figs. 2, 3, 4, 7.

1896. *Tropites* cf. *T. discobullatus.* Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 613, pl. 11, fig. 7.

1906. *Tropites discobullatus.* Diener, Fauna of the *Tropites* limestone of Byans: Geol. Survey India Mem.. Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 147, pl. 4, fig. 1.

1908. *Tropites discobullatus.* Diener, Ladinic, Carnic, and Noric faunae of Spiti: Geol. Survey India Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 3, p. 79, pl. 14, fig. 1.

Laterally compressed, involute, high-whorled, with open, narrow umbilicus, gently rounded sides, and arched venter. Surface with very fine growth lines, forming almost invisible folds, and almost microscopic spiral lines. Keel distinct, keel furrows almost obsolete. The height of the last whorl is less than half the total diameter of the shell, and the width is slightly greater than the height. The width of the umbilicus is about one-fourth of the diameter of the shell.

Tropites discobullatus is most nearly related to *Tropites torquillus* Mojsisovics but differs in its greater compression and much finer sculpture.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, lower horizon (*Trachyceras* subzone), 4 miles northeast of Madison's ranch, on Brock Mountain, 1 mile north of the trail from Squaw Creek to Pit River, Shasta County, Calif. It was first described from the same horizon at Hallstatt, in the Tyrolian Alps, Austria.

Tropites torquillus Mojsisovics

Plate LXVIII, Figures 1–31

1893. *Tropites torquillus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 210, pl. 103, figs. 1–8; pl. 106, fig. 4.

1904. *Tropites torquillus.* Smith, The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., vol. 1, No. 10, p. 394, pl. 46, figs. 5, 6; pl. 47, fig. 4.

1904. *Tropites torquillus.* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 105.
1908. *Tropites torquillus.* Diener, Ladinic, Carnic, and Noric faunae of Spiti: Geol. Survey India Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 3, p. 80, pl. 14, fig. 4.

Form involute, robust; whorl high, helmet-shaped, deeply embracing, and deeply indented by the inner whorl. Umbilical shoulders angular, with nearly vertical walls. Sides curving gently from the shoulder to the venter, without abdominal shoulders, so that there is no separation into flanks and venter. The umbilicus is narrow and deep, exposing only the edge of the umbilical shoulders of the inner whorls. The height of the whorl is a little more than half the total diameter; the width is about 1½ times the height; and the whorl is indented to one-third of its height by the inner volution. The width of the umbilicus is a little more than one-fifth of the total diameter of the shell. The surface is ornamented with fine but distinct umbilical knots, from which fine dichotomous ribs curve forward up the sides; there are also fine spiral lines, visible only on the outer shell. The keel is low and the keel furrows nearly obsolete. The septa are of the type common in *Tropites,* almost exactly like those of *Tropites subbullatus,* with a divided ventral lobe, a principal lateral, and a single auxiliary above the ventral shoulders. The septa are only moderately brachyphylloid.

Tropites torquillus is nearly related to *Tropites dilleri* Smith but differs in its more compressed whorl and narrower umbilicus. It differs from *Tropites discobullatus* Mojsisovics in its more robust whorl and coarser sculpture.

In the young stages the keel begins to show at 1.5 millimeters, and at 3 millimeters, the shell in shape, ornamentation, and septation shows a remarkable similarity to *Columbites europaeus* Arthaber.[32] The writer is of the opinion that *Columbites europaeus* does not belong to *Columbites* but to *Protropites* or *Tropigastrites.*

Occurrence: Very common in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the zone of *Tropites subbullatus,* 3 miles east of Madison's ranch, south end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was first described from the same horizon at Hallstatt in the Tyrolian Alps, Austria, and since then has also been found in the Karnic beds of the Himalayas in India.

Tropites dilleri Smith

Plate LXVIII, Figure 13

1904. *Tropites dilleri.* Smith, The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., vol. 1, No. 10, p. 393, pl. 46, figs. 3, 4; pl. 47, fig. 3.

Involute, robust, whorls broad and helmet-shaped, curving gently from the subangular umbilical shoulder to the venter, without abdominal shoulders. The umbilicus is rather narrow, with steep inner walls, exposing the umbilical shoulders of the inner whorls. There are weak umbilical knots, from which faint ribs run forward with a gentle curve over the flanks. There are also distinct fine spiral lines covering the entire shell. The ribs show on the cast as well as the outer shell, whereas the spiral lines are visible only on the outer shell. There is a low ventral keel bordered by deep keel furrows, showing more distinctly on the cast. The height of the whorl is less than half the diameter of the shell, the width is 1⅗ times the height, and the whorl is indented to more than one-third the height by the inner volution. The umbilicus is about one-sixth of the total diameter of the shell, becoming wider and showing egression with age. Also the whorl becomes higher and narrower in proportion as maturity advances. The septa are only slightly digitate, as in *Tropites subbullatus.*

Tropites dilleri differs from the *Tropites subbullatus* in the narrower, higher whorl, and this difference is constant even in the early adolescent stages. It is intermediate between *Tropites torquillus* and *Tropites subbullatus;* it is more robust and coarser than *torquillus* and is more compressed and has finer sculpture than *subbullatus.* It may be identical with the form described by Mojsisovics[33] as a variety of *Tropites torquillus,* which differs from the species to which it is ascribed in the broader whorl and wider umbilicus. *Tropites dilleri* differs from *Tropites discobullatus* in these same characters, only to a greater degree, for *Tropites discobullatus* is even more compressed. All these species of the narrow group may be more or less artificial; they are certainly not sharply separated, and probably form a series or "gross Art"—that is, a species in the making.

Occurrence: Common in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the zone of *Tropites subbullatus,* 3 miles east of Madison's ranch, south end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Tropites subbullatus (Hauer)

Plate XXXIV, Figures 1–14; Plate LXXIX, Figures 1–10

1849. *Ammonites subbullatus* (part). Hauer, Ueber neue Cephalopoden aus den Marmorschichten von Hallstatt und Aussee: Haidinger's Abh., Band 3, p. 19, pl. 4, figs. 1–4 (not 5–7).
1893. *Tropites subbullatus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 187, pl. 106, figs. 1, 2, 3, 5, 7; pl. 107; pl. 108; pl. 110, fig. 6.
1905 *Tropites subbullatus.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 67, pl. 34, figs. 1–14; pl. 79, figs. 1–10. (Not pl. 33, figs. 1–7 = *Tropites armatus* Smith.)

[32] Arthaber, G. von, Die Trias von Albanien: Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, Band 24, p. 261, pl. 23, figs. 15a–c, 1911.

[33] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, pl. 106, fig. 4, 1893.

1906. *Tropites subbullatus.* Arthaber, Die Alpine Trias des Mediterran-Gebietes: Lethaea Geognostica, Part 2, Das Mesozoicum, Band 1, pl. 45, fig. 6.

1906. *Tropites subbullatus.* Diener, Fauna of the *Tropites* limestone of Byans: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 145, pl. 4, figs. 6, 7.

1908. *Tropites subbullatus.* Diener, Upper Triassic and Liassic faunae of the exotic blocks of Molla Johar in the Bhot Mahals of Kumaon: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 1, pt. 1, p. 28.

1908. *Tropites subbullatus.* Diener, Ladinic, Carnic, and Noric faunae of Spiti: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 8, p. 78, pl. 14, figs. 2, 3.

1914. *Tropites subbullatus.* Welter, Die obertriadischen Ammoniten und Nautiloiden von Timor: Paläontologie von Timor, Lief. 1, p. 110, pl. 19, figs. 11–13.

1920. *Tropites subbullatus.* Diener, Neue Tropitoidea aus den Hallstätterkalken des Salzkammergutes: K. Akad. Wiss Wien Denkschr., Band 97, p. 502.

Form subglobose, broad, evolute; cross section trapezoidal. Whorl broad, arched but depressed, rising with gentle curve from the umbilicus to the venter without any marked abdominal shoulders. Umbilical shoulders abrupt and angular, with the inner walls steep. Umbilicus wide and deep, exposing the umbilical margins of the inner whorls, forming a funnel-shaped cavity with a spiral row of knots, marking the edges of the inner volutions. The breadth of the whorl is nearly equal to the diameter of the shell and is about twice the height. The whorl is indented to about one-fourth its height by the inner volution. The width of the umbilicus is about three-eighths of the total diameter.

The venter is surmounted by a strong, low, median keel, bordered by shallow furrows. The umbilical margin is ornamented with a row of blunt nodes, and from these branch out the radial ribs, which run with a forward curve across the whorl to the keel furrows. These ribs are faint but invariably present and usually dichotomous, the division taking place about halfway between the umbilical margin and the keel. At maturity the keel becomes depressed and the ridges sometimes cross it, giving to it a beaded appearance. The keel furrows are obscure in adolescence but become distinct at maturity. There are faint spiral lines on the outer shell, stronger on the venter than on the sides.

The septa are ammonitic but not deeply digitate, the lobes more so than the saddles. The external lobe is divided by a nearly rectangular siphonal saddle into two narrow and short monacanthian lobes. The first lateral lobe is deep and broad; the second lateral lobe, just above the umbilical margin, is broad and shallow. On the inner slope of the umbilical walls there are two distinctly individualized auxiliaries. The first and second lateral saddles are narrower than the lobes and much narrower at the top than at the base. The antisiphonal lobe is narrow and is flanked by a pair of similar laterals on each side.

At maturity the spiral becomes wider, and the whorl does not keep up its rate of increase, showing the phenomenon of egression, so that not only the umbilical margins on the inner whorls but also part of their flanks may be seen in the umbilicus. At this stage also the umbilical nodes usually become obsolete.

The young stages of *Tropites subbullatus* are keg-shaped and have a broad umbilicus, sharp umbilical margins, no flanks, and very low whorls. The innermost volutions are nearly globose, but the whorl soon begins to flatten and the umbilical margin becomes angular; they have constrictions but no other sculpture. The keel appears at a diameter of 2 millimeters. The umbilical nodes and the spiral striae appear at the diameter of 5 or 6 millimeters. A specimen, figured in Plate XXXIV, Figures 12–14, which shows the beginning of the umbilical nodes, gave the following dimensions:

Dimensions of young specimen of Tropites subbullatus

	Millimeters
Diameter	7. 3
Height of last whorl	2. 6
Height of last whorl from preceding	1. 9
Width of last whorl	7. 3
Involution	. 7
Width of umbilicus	3. 5

The septa pass from the goniatite to the ammonite stage at a diameter of 4.5 millimeters, and the nodes begin to be prolonged as ribs on the venter at a diameter of 7 or 8 millimeters. At a diameter of about 10 millimeters the venter begins to arch, and from then on there is a steady progression toward mature characters. An adolescent specimen, which is figured in Plate XXXIV, Figures 6–8, gave the following dimensions:

Dimensions of adolescent specimen of Tropites subbullatus

	Millimeters
Diameter	16. 5
Height of last whorl	6. 5
Height of last whorl from preceding	5
Width of last whorl	16. 5
Involution	1. 5
Width of umbilicus	6. 5

Successively larger specimens gave the following dimensions:

Dimensions of older specimens of Tropites subbullatus

	1	2	3	4
	Mm.	*Mm.*	*Mm.*	*Mm.*
Diameter	25	40	60	80
Height of last whorl	10	15. 5	22	32
Height of last whorl from preceding	7	11	15	19
Width of last whorl	25	37	44	56
Involution	3	4. 5	7	13
Width of umbilicus	7. 5	14. 5	25	30

These measurements show that the whorl increases slowly in height but becomes more highly arched, whereas the relative width of the last whorl decreases. The umbilicus widens with age and shows egression, exposing the shoulders of the inner whorls as the spiral widens. This egression takes place at a diameter between 40 and 60 millimeters, when full maturity is reached. At a diameter of 80 millimeters the shell is already senile and shows degeneration in loss of distinct sculpture.

The Alpine specimens of *Tropites subbullatus* are extremely variable, so that it is almost impossible to define the limits of the species. The same thing is true of the Californian specimens. There are, however, some slight differences, such as the stronger spiral lines, deeper keel furrows, and broader whorl, which seem to be characteristic of the American types, and it was not possible to separate these from those identical in every other particular with the European forms. If the American forms should eventually be found to require a special designation the writer proposes for them the name *Tropites subbullatus* var. *pacifica* Smith, n. var.

Occurrence: *Tropites subbullatus* is characteristic of the upper Karnic horizon of the Upper Triassic in the Tyrolian Alps; in California it is common at the same horizon and in the same faunal association in the Hosselkus limestone in the *Trachyceras* subzone, in Shasta County, on the ridge between Squaw Creek and Pit River, about 3 miles east of Madison's ranch, where it was first discovered by Dr. H. W. Fairbanks. The specimens figured in this paper were collected at that locality by J. P. Smith, who also found it on Bear Mountain, near Sherman's ranch, about 18 miles northeast of Redding. A species identical with this one has been found by the Geological Survey of India in the Upper Triassic of the Himalayas.

Tropites armatus Smith, n. sp.

Plate XXXIII, Figures 1–7; Plate LXIX, Figures 1–12

1905. *Tropites subbullatus* (part). Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, pl. 33, figs. 1–7.

Form very robust, moderately umbilicate, with broad, low-arched, deeply embracing whorls. Keel high, with deep bordering furrows. Surface with strong umbilical knots and weak ribs running with gentle curve to the venter. Spiral lines strongly developed. Septa moderately digitate, like those of *Tropites subbullatus*.

The type of *Tropites armatus* was erroneously included in *Tropites subbullatus* by Hyatt and Smith.[34] It differs from that species in the broader whorl, higher arch, fewer and stronger umbilical knots, and much deeper keel furrows. It differs from *Tropites morloti* Mojsisovics in the narrower whorl and umbilicus and stronger ventral knots. It is distinguished from *Tropites telleri* Mojsisovics in its somewhat more compressed form and weaker ribs.

Occurrence: Rather rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, lower horizon (*Trachyceras* subzone), 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Tropites morloti Mojsisovics

Plate LXIX, Figures 13–24

1893. *Tropites morloti*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 195, pl. 110, fig. 5.

Form robust; whorls broad, depressed with broadly arched venter, wide umbilicus, and subangular ventral shoulders. Surface with strong umbilical knots, faint ribs, and strong spiral lines. Septa brachyphylloid, with the first lateral lobe moderately digitate.

Tropites morloti is very like *Tropites occidentalis* Smith, from which it differs in its narrower and more highly arched whorls. It is broader than *Tropites subbullatus* Hauer, has a wider umbilicus, coarser umbilical knots, stronger spiral lines, and deeper keel furrows.

Mojsisovics[35] says that the only distinction between *Tropites morloti* and *Tropites fusobullatus* Mojsisovics is in the more highly arched whorls of *morloti*, which also has much weaker sculpture than *fusobullatus*.

Occurrence: Rare in the Upper Triassic, Hosselkus limestone, in the zone of *Tropites subbullatus*, lower horizon (*Trachyceras* subzone), 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was first found at the same horizon in the Tyrolian Alps, at Hallstatt, Austria, along with a kindred fauna.

Tropites occidentalis Smith, n. sp.

Plate LXX, Figures 1–20

Form very broad, depressed, low, widely umbilicate, with broad, low-arched venter and almost no flanks. Whorl little embracing and little indented by the inner volutions. Surface with very weak umbilical knots and faint ribs. Spirals strong. Septa moderately digitate as in all the bullati.

Tropites occidentalis is nearest to *Tropites morloti* Mojsisovics, differing in the more depressed and broader whorl and narrower umbilicus. It differs from *Tropites fusobullatus* Mojsisovics in its weaker sculpture and more highly arched whorl. A nearly perfect series—*Tropites discobullatus*, *Tropites torquillus*, *Tropites dilleri*, *Tropites subbullatus*, *Tropites subbullatus* var. *pacifica*, *Tropites morloti*, *Tropites occidentalis*—forms a "gross Art" or nearly related group

[34] Hyatt, Alpheus, and Smith, J. P., The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, pl. 33, figs. 1-3, 1905.

[35] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 195, 1893.

of species that diverge little from a common ancestor. All these species occur together in the same zone, and natural selection had not yet had time to segregate the distinct types.

Occurrence: Rather rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, lower horizon (*Trachyceras* subzone), on Brock Mountain, 3 miles east of Madison's ranch, on the divide between Squaw Creek and Pit River, Shasta County, Calif.

Tropites fusobullatus Mojsisovics

Plate LXX, Figures 21–28

1893. *Tropites fusobullatus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 194, pl. 109, figs. 1–3.

1906. *Tropites fusobullatus.* Diener, Fauna of the *Tropites* limestone of Byans: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 145, pl. 5, fig. 3.

Form very broad, with low, trapezoidal whorls and broad, nearly flat venter, without flanks. Umbilicus wide and egressing, the suture outside of the row of umbilical knots on the inner whorls. Surface with coarse umbilical knots, strong bifurcating ribs, and deep keel furrows. Spiral lines very strong.

Tropites fusobullatus bears a close resemblance to *Tropites rotatorius* Smith, from which it differs in its narrower whorl, lower arch, and weaker sculpture. It is more evolute and has more depressed whorls than *Tropites morloti* Mojsisovics and also has coarser ribs and umbilical knots. It is distinguished from *Tropites boehmi* Smith by the absence of spines at the bifurcation of the ribs between venter and umbilicus.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, lower horizon (*Trachyceras* subzone), 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was first described from the same horizon and fauna in the Tyrolian Alps at Hallstatt, Austria; later it was found in the same zone in the Himalayas of India.

Tropites brockensis Smith, n. sp.

Plate LXXIV, Figures 1–6

Form laterally compressed, involute, high-whorled, narrowly umbilicate, and deeply embracing. Sides flattened, venter narrow and arched, ventral shoulders abruptly rounded. Surface with rather coarse flattened ribs starting out in pairs from the blunt umbilical knots and bifurcating halfway up the flanks, without shoulder knots. Spiral lines nearly obsolete. Septa brachyphylloid but not deeply digitate.

Tropites brockensis differs from *Tropites mojsvarensis* Smith in its larger size, narrower umbilicus, more finely divided ribs, and greater compression. In spite of its form it unmistakably belongs to the bullati.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), of Bear Cove, north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

GROUP OF TROPITES MOJSVARENSIS

Tropites mojsvarensis Smith, n. sp.

Plate LXXIV, Figures 7–9

Form somewhat compressed laterally, with wide umbilicus, moderately high whorl, and flattened venter. Cross section trapezoidal, with strong ventral shoulders. Surface with strong ribs that start out in pairs from the sharp umbilical knots and run up to the ventral furrow without further bifurcation, meeting the periphery at a low angle. Spiral lines weak. Septa, as in all the bullati, only moderately digitate.

Tropites mojsvarensis resembles *Tropites traski* Smith but differs in its broader whorl and stronger sculpture. It is also closely allied to *Tropites quenstedti* Mojsisovics [36] but is slightly less evolute and has stronger sculpture. Its cross section is more trapezoidal than that of *Tropites telleri* Mojsisovics,[37] and the ribs are sharper.

Named in memory of Dr. E. Mojsisovics von Mojsvar, the greatest authority on Triassic Cephalopoda.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Tropites rotatorius Smith, n. sp.

Plate LXXI, Figures 1–3

Form robust, large; whorl broad and high, trapezoidal in cross section; evolute and egressing, the outer whorl leaving bare the row of umbilical knots of the inner, being little impressed by the inner volutions. Surface with coarse ribs that start from large knots on the umbilical shoulder and swing forward, without bifurcation, to the ventral keel furrows. The spiral lines of the shell are almost obsolete but may be seen on some parts of the whorl. There are 24 umbilical knots to a revolution, and 32 lateral ribs, showing some intercalaries. Keel furrows very deep, keel strong but not prominent.

Dimensions of type specimen of Tropites rotatorius

	Millimeters
Diameter	94
Height of last whorl	30
Height of last whorl from preceding	23
Width of umbilicus	44

The septa were not seen on the two specimens found.

Tropites rotatorius is related to *Tropites fusobullatus* Mojsisovics, from which it differs in larger size,

[36] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 202, pl. 127, fig. 10, 1893.

[37] Idem, p. 201, pl. 111, figs. 6–9.

coarser sculpture, and higher and more trapezoidal whorls. It may be a descendant of *fusobullatus*, modified in the interval between the two subzones of the *Tropites subbullatus* zone.

It resembles *Tropites morloti* Mojsisovics in the broad evolving whorl but differs in the higher trapezoidal cross section and the rugose sculpture.

Tropites rotatorius is the largest known species of the genus and is very different from any other species in shape as well as in sculpture.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the *Tropites subbullatus* zone, upper horizon (*Juvavites* subzone), at the north end and west side of Brock Mountain, Squaw Creek, Shasta County, Calif.

GROUP OF TROPITES WELLERI

Tropites keili Mojsisovics

Plate LXXII, Figures 24–28

1893. *Tropites keili.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 220, pl. 113, fig. 16.

Shell small, laterally compressed, sides and venter somewhat flattened, with distinct ventral shoulders; high-whorled and narrowly umbilicate. Keel and keel furrows small but distinct. Surface ornamented with very fine umbilical knots and lateral ribs that swing forward in a broad curve to the keel. Septa moderately digitate, as in all *Tropites*, but more so than in the *subbullatus* group.

Tropites keili is the most compressed member of the group of *Tropites welleri*, differing from the others in its extreme compression and fineness of ornamentation, in this respect resembling somewhat *Paratropites*, but easily distinguished from that group by the fine spiral lines on the shell and the character of the ornamentation. It also resembles *Tropites morani*, from which it is distinguished by the strongly curved ribs and finer sculpture. It has even greater resemblance to *Tropites discobullatus* but is distinguished by its flattened instead of rounded flanks and its strongly curved ribs.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), of Brock Mountain, north end and west side, between Squaw Creek and Pit River, Shasta County, Calif. It is associated with *Tropites welleri*, *Juvavites subinterruptus*, *Halobia gigantea*, and other species. It was first found in the Tyrolian Alps, in the same association and at the same horizon.

Tropites wodani Mojsisovics

Plate LXXII, Figures 29–31

1893. *Tropites wodani.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 221, pl. 116, fig. 6.

1906. *Tropites wodani.* Diener, Fauna of the Tropites limestone of Byans: Geol. Survey India Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 152, pl. 5, fig. 6.

Shell small, laterally compressed, involute, with flattened sides and pronounced ventral shoulders. Keel and keel furrows well developed. Septa digitate but not more so than is customary with *Tropites*.

Tropites wodani is nearly related to *Tropites keili* but differs in its slightly wider umbilicus, stronger lateral ribs, and less digitate septa.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), at the northwest end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was first described from the same horizon in the Tyrolian Alps and was later found in the *Tropites subbullatus* zone of the Himalayas in India.

Tropites ursensis Smith, n. sp.

Plate LXXVIII, Figures 18–26

Form moderately robust, somewhat compressed laterally, with narrow but open umbilicus and abruptly rounded ventral shoulders. Whorls deeply embracing, and not deeply indented. Surface with fine sharp dichotomous ribs that start out, generally in pairs, from fine umbilical knots, curve gently forward on the flanks, bifurcate again on the shoulders and then swing sharply forward. Keel higher than usual on *Tropites*, keel furrows shallow. Spiral lines strong and fine. Septa moderately digitate.

Tropites ursensis is more compressed than *Tropites welleri* and has finer sculpture and slightly narrower umbilicus. It is also apparently closely allied to *Tropites acutangulus*? Mojsisovics,[38] but the Indian species has less pronounced sculpture and much greater indentation.

Occurrence: Quite common in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), at the north end of Brock Mountain, in Bear Cove (whence the name), between Squaw Creek and Pit River, Shasta County, Calif.

Tropites welleri Smith, n. sp.

Plate LXXVIII, Figures 5–17

Form subglobose, rather involute, with open but narrow umbilicus, high-arched and rounded whorls, deeply embracing and deeply impressed by the inner whorls. Surface with strong bifurcating ribs that start from strong umbilical knots, generally in pairs, and fork a second time about halfway up the flanks, then bend sharply forward to the ventral keel furrow. There are about 13 umbilical knots to a revolution, about 20 lateral ribs, and about 49 ribs on the ventral slope. Spiral lines sharply defined.

Tropites welleri is very closely related to *Tropites schellwieni* Smith, with which it is associated, but

[38] Mojsisovics, E. von, Beiträge zur Kenntniss der obertriadischen Cephalopoden Faunen des Himalaya: K. Akad. Wiss Wien Denkschr., Band 63, p. 38, pl. 11, figs. 4a–b, 1896.

differs in its smaller size, greater compression, narrower and more highly arched whorls, narrower umbilicus, and finer sculpture. It differs from *Tropites ursensis* Smith in its more robust whorls, wider umbilicus, and coarser sculpture. It is distinguished from *Tropites telleri* Mojsisovics by its narrower umbilicus and sharp, forward-bending ribs. It differs from *Tropites johnsoni* Smith in its round instead of trapezoidal whorl, in its sharper dichotomous ribs, and in lacking the shoulder knots. It is distinguished from *Tropites laestrigonus* Gemmellaro by its broader whorl, narrower umbilicus, and sharper ribs, but it is more nearly related to that species than to any other in the Mediterranean fauna.

Named in honor of Dr. Stuart Weller.

Occurrence: *Tropites welleri* is very abundant in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), at the north end of Brock Mountain, Squaw Creek, Shasta County, Calif.

Tropites schellwieni Smith, n. sp.

Plate LXXVII, Figures 1–11

Large subglobose, moderately involute, with open umbilicus and arched whorls, deeply embracing but little impressed by the inner volutions. Surface of shell and cast with strong, forward-bending, dichotomous ribs, starting from umbilical knots. Spiral lines sharply defined. Septa of the type that is common in *Tropites*, as in members of the *Tropites subbullatus* group.

Tropites schellwieni is closely allied with *Tropites welleri* Smith but differs in its greater size, broader whorl, wider umbilicus, and stronger sculpture. It is more robust than *Tropites telleri* Mojsisovics and has narrower umbilicus and stronger ribs and knots. It differs from *Tropites fusobullatus* Mojsisovics in the narrower umbilicus, sharp, sickle-shaped, forward-bending ribs, and the high arch of the venter. Both of these species are the extremes of their groups and resemble each other superficially more than they do the more compressed members in their own series, but each one intergrades with a series of species fundamentally different. *Tropites schellwieni* also has a certain superficial resemblance to *Tropites boehmi* Smith but differs in the higher arch of the whorls and the absence of spines on the ribs.

Named in memory of Dr. E. Schellwien.

Occurrence: Common in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), at the north end of Brock Mountain, Squaw Creek, Shasta County, Calif.

Tropites kellyi Smith, n. sp.

Plate LXXVII, Figures 12–15

Form robust, evolute, widely umbilicate. Whorl low, broad, little embracing and little indented by the inner volutions; cross section trapezoidal at maturity. Surface with very coarse umbilical knots, about 17 to a revolution, from which arise forking ribs in pairs that usually bifurcate a second time halfway toward the venter. These ribs bend very sharply forward toward the ventral keel borders. Keel strong but not high; keel furrows deep. Septa rather strongly digitate, the fingerlike extensions of the first lateral lobe being unusually long. The height of the whorl is one-third of the diameter of the shell, and the width is twice the height. The width of the umbilicus is half the diameter of the shell.

Tropites kellyi is most nearly related to *Tropites shastensis* Smith but differs in its much wider umbilicus, more depressed whorl, stronger ribs and umbilical knots. It differs from *Tropites schellwieni* Smith in its trapezoidal outline, more depressed whorl, and coarser sculpture. In form it is more like *Tropites fusobullatus* than any other European species but differs in the sharp, forward-bending dichotomous ribs.

Named for Kelly's ranch.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Tropites shastensis Smith, n. sp.

Plate LXXVIII, Figures 1–4

Form robust, evolute, widely umbilicate, deeply embracing and not deeply indented. Whorls rather highly arched, inclining toward trapezoidal. Surface with fine, sharp ribs that start out, usually in pairs, from the umbilical knots and fork halfway up the flanks and occasionally on the ventral shoulders. Spiral lines very fine but visible. Keel strong; keel furrows deeply incised. There are 18 umbilical knots to a revolution to about 30 primary lateral ribs. Septa brachyphylloid, like those of all typical *Tropites*.

Tropites shastensis resembles *Tropites welleri* Smith but differs in its wider umbilicus and much finer sculpture. It also is related to *Tropites laestrigonus* Gemmellaro but is distinguished by its greater compression and more numerous ribs.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the *Tropites subbullatus* zone, upper horizon (*Juvavites* subzone), on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch.

GROUP OF TROPITES RETICULATUS

Tropites reticulatus Smith, n. sp.

Plate LXXVI, Figures 8–18

Form laterally compressed, rather involute, discoidal. Sides flattened, umbilicus narrow, venter narrow with rounded shoulders, and ventral keel bordered by shallow furrows. Body chamber long, considerably more than a revolution. Surface ornamented by fine, dichotomous, radial ribs that run nearly straight up to the venter. The ribs are crossed by fine, closely set spiral lines, giving a sharply reticulate aspect to the outer shell. Septa of the type that is common in *Tropites*, ammonitic, and deeply digitate, more so than in the group of *Tropites subbullatus*.

Tropites reticulatus is the commonest member of the group of reticulati and is most nearly related to *Tropites dieneri* Smith, from which it differs in the more compressed form and finer sculpture. It is the most compressed of all known *Tropites* and might on this account be assigned to *Discotropites*. There is, however, an unbroken series—*Tropites reticulatus, Tropites dieneri, Tropites kokeni*—and the last-named species of this group has no resemblance to *Discotropites* but shows further transition to another group—*Tropites philippii, Tropites johnsoni, Tropites boehmi*. The end member of this last group is more robust and more highly sculptured than *Tropites subbullatus*.

Occurrence: Rather common at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone of the Upper Triassic Hosselkus limestone, on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch; also in the same beds in Bear Cove, Brock Mountain, north end and east side, between Squaw Creek and Pit River, Shasta County, Calif.

Tropites dieneri Smith, n. sp.

Plate LXXVI, Figures 19–28

Form moderately compressed, involute, discoidal, with narrow venter and distinct ventral shoulders. Surface ornamented with rather fine radial ribs and sharp, spiral lines, giving a strongly reticulate aspect to the surface of the shell. Septa rather complex and more deeply digitate than they are on most species of *Tropites*.

Tropites dieneri resembles *Tropites reticulatus* Smith but is more robust, with broader whorl and stronger sculpture. This species also resembles *Tropites quintini* Mojsisovics,[39] from which it differs in the finer ribs, more compressed whorl, and greater reticulation of the surface.

Tropites dieneri forms the link in the series *Tropites reticulatus, Tropites dieneri, Tropites kokeni*, which shows almost complete intergradation.

Named in honor of Dr. Carl Diener.

Occurrence: Rather common in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

[39] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 202, pl. 127, fig. 10, 1893.

Tropites kokeni Smith, n. sp.

Plate LXXVI, Figures 1–7

Form involute, somewhat compressed laterally, robust, with flattened venter and rounded ventral shoulders. Surface ornamented with fine, sharp radial ribs that bifurcate on the sides and run with very gentle curves to the furrow bordering the keel; also with sharp, close-set spiral lines, reticulating the surface of the shell. Septa rather deeply digitate, as in all members of this group.

Tropites kokeni is most nearly related to *Tropites dieneri* Smith, from which it differs in its more robust whorl and stronger sculpture. It also resembles *Tropites philippii* Smith but differs in the finer sculpture and lack of distinct knots at the bifurcation of the ribs on the sides. There are, however, rudimentary knots at the bifurcation, so that it forms a nearly complete intergradation between *Tropites dieneri* and *Tropites philippii*.

Named in memory of Dr. E. Koken.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), of North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Tropites traski Smith, n. sp.

Plate LXXV, Figures 1, 2

Form robust, moderately compressed, involute, with abruptly rounded ventral shoulders. Surface with sharp umbilical knots, 18 to a revolution. Ribs commonly bifurcate on the umbilical knots and again on the flanks. Weak shoulder knots in some places are developed at the second bifurcation. Spiral lines weak. Septa moderately digitate, as in other members of this group.

Tropites traski is most nearly related to *Tropites mojsvarensis* Smith, from which it differs in the greater compression and finer sculpture. It also resembles *Tropites alexis* Mojsisovics [40] but differs chiefly in the strong development of the umbilical knots.

The height of the last whorl is one-third of the diameter of the shell, and the width is slightly greater than the height. The width of the umbilicus is one-third of the diameter of the shell.

Named in memory of Dr. John B. Trask, the first State geologist of California and a pioneer paleontologist.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), at the north end and west side of Brock Mountain, Squaw Creek, Shasta County, Calif.

[40] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 215, pl. 111, fig. 4, 1893.

Tropites philippii Smith, n. sp.

Plate LXXV, Figures 12–16

Form robust, somewhat compressed laterally, involute, with arched venter and rounded ventral shoulders. Surface with strong ribs that bifurcate just below the ventral shoulders and extend obliquely forward, forming weak knots on the umbilicus at the bifurcation and also terminal knots on the ridge bordering the keel furrows. Spiral lines rather coarse and close set but without forming distinct reticulation.

Tropites philippii is closely related to *Tropites johnsoni* Smith but is more compressed and has weaker sculpture. The series *Tropites philippii, Tropites johnsoni, Tropites boehmi* is complete, but the extremes are far apart. The intergradation toward *Tropites kokeni* of the more compressed series is not so complete.

Named in memory of Dr. E. Philippi, whose monograph of the *Ceratites nodosus* fauna is a lasting monument.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Tropites johnsoni Smith, n. sp.

Plate LXXIV, Figures 10–15

Form thick set, trapezoidal, moderately involute, somewhat compressed laterally, with open umbilicus, angular ventral shoulders. Whorls deeply embracing but not deeply indented by the inner volution. Surface with strong ribs, starting from strong umbilical knots, bifurcating on the ventral shoulders with the formation of blunt spines at the bifurcation and ending in knots at the keel furrows. Spiral lines weakly developed. Septa brachyphylloid.

This is the middle member of the series *Tropites philippii, Tropites johnsoni, Tropites boehmi*, all of which have strong bifurcating ribs and shoulder knots or spines and show a superficial resemblance to *Margarites* Mojsisovics. It is somewhat like *Tropites subbullatus* Hauer but differs in the angular outline of the whorl and the shoulder knots. *Tropites johnsoni* has also some resemblance to *Tropites laestrigonus* Gemmellaro and possibly has kinship with that species but is more involute, has stronger sculpture, and more trapezoidal outline. Probably, however, this resemblance is simply convergence in two nearly parallel but different series, both grading from compressed to broad and depressed forms, each really a "gross Art," in the sense that this term is used by German paleontologists.

Named in honor of H. R. Johnson, who assisted in collecting this fauna.

Occurrence: Rather common in the Upper Triassic Hosselkus limestone, in the *Tropites subbullatus* zone, upper horizon (*Juvavites* subzone), on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch and at the same horizon at the north end of Brock Mountain, Squaw Creek, Shasta County, Calif. It was also found in the *Juvavites* subzone on Admiralty Island, Alaska, at locality 10180, a point between Herring Bay and Chapin Bay.

Tropites boehmi Smith, n. sp.

Plate LXXV, Figures 3–11

Form very robust, broad, depressed, with angular shoulders, wide and egressing umbilicus, and flattened broad venter. Surface with strong ribs forming spines on the umbilicus, on the bifurcation of the ribs, and on the ventral ridges. The spiral lines on the shell are weaker than on less highly sculptured members of the group. Septa of the type common in *Tropites*.

Tropites boehmi is most nearly related to *Tropites johnsoni* in the same series but is much broader and more rugose. It also resembles *Tropites fusobullatus* Mojsisovics but is more involute and not so depressed, and it also has stronger ribs and spines. In youth the shell is low, broad, and barrel-shaped, as in *Tropites fusobullatus*, at which stage the resemblance between the two is greater than it is at maturity.

Named in memory of Dr. G. Boehm.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), at the north end of Brock Mountain, Squaw Creek, Shasta County, Calif.

GROUP OF TROPITES MORANI

Tropites morani Smith, n. sp.

Plate LXXIII, Figures 7–18

Form laterally compressed, with narrow umbilicus, flattened sides, narrow arched venter, and rounded shoulders. Keel and keel furrows not strong. Surface with rather fine and nearly straight ribs, multiplying by intercalation. No knots on umbilicus. Spiral lines nearly obsolete. Septa as on *Tropites subbullatus*, brachyphylloid, not deeply digitate. The width of the whorl is about one-third the diameter of the shell, and the height is slightly greater than the width. The whorl is deeply embracing and is deeply indented by the inner volution.

Tropites morani is the most compressed member of the series *Tropites morani, Tropites hessi, Tropites arthaberi, Tropites stearnsi*, in which the whorl becomes steadily more depressed and the sculpture gradually stronger, until the end member is nearly spherical. It also resembles *Tropites keili* Mojsisovics, of the group of *Tropites welleri*, but differs in the nearly straight ribs. It has also a superficial resemblance to *Tropites reticulatus* Smith and *Tropites dieneri* Smith but differs in the lack of reticulation on the shell. *Tropites morani* differs from the flatter members of the group of *Tropites mojsvarensis* in lacking the bifurcation of the ribs on the flanks and in the nearly straight course of the ribs to the keel without the forward bend on the shoulders.

Named in honor of R. B. Moran, who assisted in collecting this fauna.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the *Tropites subbullatus* zone, upper horizon (*Juvavites* subzone), at the north end and west side of Brock Mountain, Squaw Creek, Shasta County, Calif.

Tropites hessi Smith, n. sp.

Plate LXXIII, Figures 1–6

Form laterally compressed, discoidal, narrowly umbilicate, with somewhat arched venter. Whorl deeply embracing and increasing rapidly in height. Surface with fine radial simple ribs running nearly straight to the venter, starting from small umbilical knots. Spiral lines on the shell nearly obsolete. Septa moderately digitate, as in all members of the series.

Tropites hessi falls between *Tropites morani* and *Tropites arthaberi*, being more robust than *T. morani* and more compressed than *T. arthaberi*. Its form is almost exactly like that of *Tropites torquillus* Mojsisovics in the series of *Tropites subbullatus*, but it differs in its coarser ribs and less defined spirals.

Named in honor of F. L. Hess, of the United States Geological Survey.

Occurrence: Rather rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), at the north end and west side of Brock Mountain, Squaw Creek, Shasta County, Calif.

Tropites arthaberi Smith, n. sp.

Plate LXXII, Figures 13–23

Form robust, subglobose, involute, narrowly umbilicate, with rounded whorls twice as wide as the height, deeply embracing, and not deeply impressed. Surface with fine ribs that do not bend sharply forward nor bifurcate but multiply by intercalation and are without knots, either umbilical or ventral. Furrows bordering the low keel are shallow. The width is three-fourths the diameter and twice the height of the whorl. The width of the umbilicus is less than one-fourth the diameter of the shell. The septa are brachyphylloid, as in all true *Tropites*.

Tropites arthaberi is in the series between *Tropites hessi* Smith and *Tropites stearnsi* Smith; it is more robust and depressed than *hessi* and less robust and depressed than *stearnsi*. Its sculpture is also intermediate, affording an almost complete intergradation. There is no European species nearly related to this nor to any other member of the group.

Named in honor of Dr. G. von Arthaber.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch, and at the same horizon at the north end of Brock Mountain, Squaw Creek, Shasta County, Calif.

Tropites stearnsi Smith, n. sp.

Plate LXXII, Figures 1–12

Form robust, involute, subspherical, with narrow umbilicus, broad, low whorl, deeply embracing and not deeply impressed by the inner volution. Surface with rather fine radial dichotomous ribs that meet the ventral keel border nearly at right angles. No knots, either umbilical or ventral. Spiral lines very weak. Septa slightly digitate, brachyphylloid. The width of the whorl is nearly equal to the diameter and nearly twice as great as the height. The umbilicus is only about one-fifth of the diameter.

Tropites stearnsi is closely related to *Tropites arthaberi*, with which it is associated, but differs in its broader, more depressed whorl, wider umbilicus, and slightly coarser ribs. There is some resemblance to a species figured by Arthaber [41] under the name of *Tropites subbullatus*. If the figures of *Tropites subbullatus* given by Mojsisovics are correct Arthaber's species can not belong to *T. subbullatus*, and it may be a European representative of the series under discussion.

Named in memory of Dr. R. E. C. Stearns, whose contributions to the conchology of the Californian province are a lasting monument.

Occurrence: Rather rare in the Upper Triassic Hosselkus limestone, in the *Tropites subbullatus* zone, upper horizon (*Juvavites* subzone), at the north end and west side of Brock Mountain, Squaw Creek, Shasta County, Calif.

Tropites rothpletzi Smith, n. sp.

Plate LXXI, Figures 4–8

Form thick set, with rather low, broadly rounded whorl, showing slight egression, exposing the umbilical shoulders of the inner whorls. Umbilicus moderately wide. Surface with coarse, nearly straight ribs that bifurcate occasionally on the flanks and meet the keel border almost at right angles. Spiral lines obsolete. Septa of the usual digitation.

Tropites rothpletzi is related to *Tropites arthaberi* Smith but is distinguished by its wider umbilicus, egression of the whorl, and much coarser sculpture. It is much more compressed than *Tropites stearnsi* and lacks the barrel-shaped whorl.

Named in honor of Dr. A. Rothpletz.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper

[41] Arthaber, G. von, Die Alpine Trias des Mediterran-Gebietes: Letha Geognostiac, Theil 2, Das Mesozoicum, Band 1, pl. 45, figs. 6a, b, c, 1906

horizon (*Juvavites* subzone), at the north end and west side of Brock Mountain, Squaw Creek, Shasta County, Calif.

Tropites stantoni Smith, n. sp.

Plate CII, Figures 25–27

Form robust, moderately involute, with whorl helmet-shaped, rounded sides and venter, without pronounced ventral shoulders but with abrupt umbilical shoulders and deep umbilicus exposing the inner coils in step form. Outer coil only slightly indented by the inner volution and embracing about two-thirds of the inner. Ventral keel strong, bordered by deep furrows. Surface of the shell with fine radial ribs that start from weak knots just above the umbilical shoulder and bifurcate nearly halfway up the flanks and again on the ventral shoulder just below the keel furrows. Length of body chamber more than a revolution. Septa unknown.

Named in honor of Dr. T. W. Stanton.

Occurrence: Very rare in the beds of upper Karnic age in Alaska; Chitistone limestone at locality "No. 6319, locality 571, short distance west of Potter's tunnel" (quotation from the original label) Nizina district, Alaska.[42]

Genus DISCOTROPITES Hyatt and Smith

1879 *Eutomoceras.* Mojsisovics, Vorläufige kurze Uebersicht der Ammoniten-Gattungen der Mediterranen und Juvavischen Trias: K.-k. geol. Reichsanstalt Wien Verh., p. 136.

1893. *Eutomoceras.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 283.

1904. *Eutomoceras.* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 77.

1905. *Discotropites.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 61.

1906. *Eutomoceras.* Diener, Fauna of the *Tropites* limestone of Byans: Geol. Survey India Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 136.

1908. *Discotropites.* Diener, Upper Triassic and Liassic fauna of the exotic blocks of Malla Johar in the Bhot Mahals of Kumaon: Geol. Survey India Mem., Palaeontologia Indica, ser. 15, vol. 1, pt. 1, p. 26.

(Not 1877. *Eutomoceras* Meek, U. S. Geol. Expl. 40th Par. Rept., vol. 6, p. 126.)

Type.—Ammonites sandlingensis Hauer.

Involute, discoidal, laterally compressed; whorls deeply embracing and deeply indented by the inner whorls. Sides flattened; venter narrow, acute, and surmounted by a high keel, which in some species is hollow and in others is solid. Surface ornamented with dichotomous sickle-shaped ribs, which bend forward on the flanks and become obsolete at the base of the keel; in some species the enlargement of these ribs on the abdomen forms rounded shoulders. Umbilical knots are invariably present, and knots or rudimentary spines may be present on the ribs but are not numerous. Besides the ribs the shell is ornamented with distinct spiral lines, which give a reticulated aspect to the surface. No constrictions or varices are known. The septa are ammonitic, the lobes and saddles being digitate but not deeply so. The external lobe is long and deeply divided by a siphonal saddle. There is only one principal lateral lobe, but there is one well-developed auxiliary and a second smaller auxiliary on the umbilical shoulder. The body chamber is long and comprises the last volution.

Discotropites is very common in Upper Triassic rocks of Karnic age in the Californian province. It is represented by species that belong to the two artificial groups Punctati and Striati, established by Mojsisovics. As there are all possible intergradations from the striate to the punctate forms, the writer does not consider these groups as having any significance.

GROUPS OF DISCOTROPITES IN THE CALIFORNIAN TRIASSIC

I. Group of *Discotropites sandlingensis* Hauer (Striati): With fine spirals, sharp ribs, and no knots on the ribs.

Discotropites formosus Smith.
sandlingensis Hauer.

II. Group of *Discotropites theron* Dittmar: With fine spirals, sharp ribs, and rudimentary fine knots on the ribs where they are crossed by the spiral lines.

Discotropites empedoclis Gemmellaro.
theron Dittmar.

III. Group of *Discotropites mojsvarensis* Smith (Punctati): With fine spirals, stronger ribs, and distinct knots on the ribs where crossed by the spirals.

Discotropites davisi Smith.
gemmellaroi Smith.
lineatus Smith.
laurae Mojsisovics.
mojsvarensis Smith.
sengeli Mojsisovics.
davisi Smith.

Of these groups the group of *Discotropites sandlingensis* is the only one found at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, and it is almost confined to that horizon. The other species are confined to the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, where they are very abundant.

Discotropites is also well represented in the Karnic stage of the Alpine region and of the Indian region, and *Discotropites sandlingensis* is present in all three great Triassic regions—western America, the Mediterranean, and the Indian.

All known members of *Discotropites* have dichotomous falcoid ribs, umbilical knots or remnants of them, a ventral keel, spiral lines on the shell, and

[42] Moffit, F. H., and Capps, S. R., Geology and mineral resources of the Nizina district, Alaska: U. S. Geol. Survey Bull. 448, p. 25, 1911.

digitate septa. They all show a gastrioceran stage in the young, indicating an origin from *Gastrioceras*. They also show such similarity to the compressed species of *Tropites* that a common origin of the two genera is a certainty, and the common ancestor was not very far back. The relation to *Tropites* is much closer than that to *Paratropites*.

GROUP OF DISCOTROPITES SANDLINGENSIS

Discotropites sandlingensis (Hauer)

Plate XXXV, Figures 1–12; Plate XXXVI, Figures 1–26

1849. *Ammonites sandlingensis*. Hauer, Ueber neue Cephalopoden aus den Marmorschichten von Hallstatt und Aussee: Haidinger's Naturwiss. Abh., Band 3, p. 10, pl. 3, figs. 10–12.
1866. *Ammonites sandlingensis*. Dittmar, Zur Fauna der Hallstätter Kalke, in Benecke, E. W., Geognostische-palaeontologische Beiträge, Band 1, p. 370.
1893. *Eutomoceras sandlingense*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, pt. 2, p. 285, pl. 130, figs. 11–13; pl. 131, figs. 1–11.
1904. *Eutomoceras sandlingense*. Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 77, pl. 8, figs. 8–10.
1904. *Eutomoceras sandlingense*. Smith, The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., vol. 1, p. 397, pl. 46, fig. 10; pl. 48, figs. 5, 6.
1905. *Discotropites sandlingensis*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 63, pl. 35, figs. 1–12; pl. 36, figs. 1–26.

Type.—Discotropites Hyatt and Smith.

Involute, laterally compressed, discoidal, deeply embracing, and deeply indented by the inner volution. Umbilicus narrow, one-eighth of the diameter of the shell, but exposing the umbilical shoulders of the inner whorls. Umbilical shoulders abruptly rounded. Sides flattened convex, curving gently to the acute venter with hardly any abdominal shoulders. Venter narrow and acute, surmounted by a high hollow keel, which is thinner at the base than at the top and is without bordering furrows. The outer whorl is half the diameter of the shell, and its breadth is half the height. It is indented to one-third of its height by the inner volution and conceals three-fourths of that volution.

Surface ornamented with numerous fine but distinct sickle-shaped ribs that show in the middle of the flanks a gentle backward curve and then bend forward to the base of the keel, where they become obsolete. These ribs are either single or dichotomous, the division taking place nearly halfway up the flanks. The ribs are rounded, low, and narrower than the intercostal spaces; there are about 60 to a revolution on the mature shell. In addition to the ribs there are numerous fine spiral lines, which in crossing the ribs give to them a beaded appearance. Both ribs and spiral lines show distinctly on the cast as well as on the shell. Around the umbilicus there is a row of small knots, the remnant of coarse umbilical ribs in the *Tropites* stage of growth.

Septa ammonitic but comparatively simple; lobes and saddles all digitate but not deeply so. External lobe divided by a shallow siphonal saddle into two short branches. First lateral broader and deeper; second lateral less than half the size of the first; auxiliary shallow and composed of two or three indentations on the umbilical shoulder. The antisiphonal lobe is flanked by three internal laterals.

Mojsisovics described the second lateral as an auxiliary, but it is too well developed to be so considered, especially as the occurrence of the real auxiliary on the umbilical shoulder makes such a definition incorrect. The septa figured by Mojsisovics were taken from a small specimen on which the auxiliary was not yet distinctly developed.

The young of *Discotropites sandlingensis* are robust and not discoidal, resembling *Paratropites;* they can, however, be distinguished from that genus by their sharper venter. In the earlier stages the sculpture is much rougher than at maturity, resembling that of *Tropites;* but in *Discotropites sandlingensis* the ribs appear before the keel at a diameter of 0.9 millimeter, whereas the keel does not appear until a diameter of 2.7 millimeters is reached. In all species of *Tropites* and *Paratropites* that have been examined by the writer the keel appears before the lateral ribs are developed. From the development of this species it is clear that *Paratropites* was near the parent stock and that *Discotropites* has departed less from that radicle than has *Tropites*. The earlier larval stages of this species are like *Gastrioceras*, as is shown by two specimens figured on Plate XXXVI, Figures 10–13, 17, and 18, that have the following dimensions:

Dimensions of two specimens of Discotropites

	1	2
	Mm.	*Mm.*
Diameter	1. 36	2. 68
Height of last whorl	. 52	1. 32
Height of last whorl from preceding	. 37	. 92
Width of last whorl	. 70	1. 92
Involution	. 15	. 40
Width of umbilicus	. 43	. 65

1. Specimen shown in Pl. XXXVI, Figs. 17, 18.
2. Specimen shown in Pl. XXXVI, Figs. 10–13.

This gastrioceran stage makes it evident that *Discotropites* developed out of the Glyphioceratidae, probably from *Gastrioceras* itself, and the transition to the tropitoid characters teaches us to look in the Lower Triassic for some form with lateral ribs, highly arched acute venter, incipient keel, and simple goniatitic septa. Such a genus is yet unknown, but the young stages of *Discotropites*, *Paratropites*, and *Tropites* show what it is like. *Styrites* fills part of these requirements, but it has lost the ribs and become more involute and is thus itself highly specialized in most respects. *Tropiceltites*, too, has preserved many of the characters of the unknown primitive form but has also acquired some that the primitive form could not have possessed. These two genera are known only from the Upper Triassic and could hardly be expected to preserve all the ancestral characters, but they are valuable in interpreting the meaning of the young stages of *Discotropites*.

The California specimens of *Discotropites sandlingensis* show as much variation as those from the Alps, there being no constancy in the size and number of the ribs. They also show in some prematurely adult specimens the development of abdominal shoulders, where the ribs thicken just as they bend forward near the base of the keel, giving a decided resemblance to *Harpoceras*.

The agreement with the figures and descriptions given by Mojsisovics of *Discotropites sandlingensis* of the Alpine province is as perfect as could be wished. The only possible difference is in the development of a distinct auxiliary lobe, but the figure of the septa given by Mojsisovics was taken from a small specimen, where the auxiliary lobe would not have been developed. Many of the California specimens are certainly more like the type than some of the figures given by Mojsisovics are like each other.

Mojsisovics assigned *Ammonites sandlingensis* Hauer to *Eutomoceras* Hyatt, which was based on a single imperfect specimen from the Middle Triassic of Nevada. Further collections of the type, *Eutomoceras laubei* Meek, have shown that its septa are ceratitic and that it belongs to the Ceratitoidea, being closely allied to *Hungarites*. The generic diagnosis of *Eutomoceras* given by Mojsisovics was based on *Ammonites sandlingensis*, and therefore this group has been renamed by Hyatt and Smith *Discotropites*, with *Ammonites sandlingensis* Hauer as the type.

Dimensions of a large specimen of Discotropites sandlingensis

[See Pl. XXXV, Figs. 1, 2]

	Millimeters
Diameter	70
Height of last whorl	37
Height of last whorl from preceding	25
Width of last whorl	19
Involution	12
Width of umbilicus	9

Occurrence: *Discotropites sandlingensis* is common in the Upper Triassic Hosselkus limestone, in the subzone of the zone of *Tropites subbullatus*, 3 miles east of Madison's ranch, on the divide between Squaw Creek and Pit River, Shasta County, Calif. This locality is 6 miles northeast of Winthrop and half a mile north of the trail from Madison's to Brock's ranch on Pit River. In the Alps this species is common in the same horizon and in the same association as in California. It was also found in the *Juvavites* subzone of Herring Bay, Admiralty Island, Alaska, locality 10180, a point between Chapin Bay and Herring Bay.

Discotropites formosus Smith, n. sp.

Plate XI, Figures 23–28

Form involute, strongly compressed laterally, with gently convex sides, sharp narrow venter without shoulders, and with high, sharp keel. Surface with fine dichotomous falcoid ribs, with fine spiral lines close set and small umbilical knots. There are no knots on the ribs at the crossing of the spiral lines. Body chamber long. Septa rather strongly digitate.

Discotropites formosus is most nearly related to *Discotropites sandlingensis*, from which it differs only in its greater compression and finer sculpture. The two forms may intergrade and the differences may be only varietal, as they occur together, but such intergradations are not known. It is treated as an independent species until further information may be obtained.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

GROUP OF DISCOTROPITES THERON

Discotropites theron (Dittmar)

Plate IX, Figures 1–3

1866. *Ammonites theron.* Dittmar, Zur Fauna der Hallstätter Kalke, in Benecke, E. W., Geognostische-palaeontologische Beiträge, Band 1, p. 52, pl. 21, figs. 15–17.

1893. *Eutomoceras theron.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 289, pl. 130, figs. 4–6.

1904. *Eutomoceras theron.* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 79, pl. 29, fig. 28.

Form completely involute, discoidal, strongly compressed laterally, thin, high-whorled, completely embracing and deeply indented by the inner volutions. Venter narrow and angular, with low keel. Surface with broad low dichotomous ribs, narrow interspaces, and fine distinct spiral lines. Here and there rudiments of fine knots may be seen on the ribs. Body chamber long. Septa moderately digitate, very like those of *Discotropites sandlingensis*.

Discotropites theron is most nearly related to *Discotropites kraffti* Diener [43] but has the ribs straighter and the spirals weaker and lacks the spiral knots almost entirely. It seems to the writer that these characters are hardly specific, but they may be due to differences in age of the individuals.

Discotropites theron also resembles *Discotropites mojsisovicsi* Diener, from which it differs in the finer spirals, coarser umbilical knots, and less complex digitation of the septa.

[43] Diener, C., Fauna of the *Tropites* limestone of Byans: Geol. Survey India Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 136, pl. 5, fig. 1, 1906.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end and west side of Brock Mountain, Shasta County, Calif. Doubtful specimens were also found at the lower horizon (*Trachyceras* subzone). It was first described from the same horizon in the Hallstatt limestone of the Tyrolian Alps.

Discotropites empedoclis (Gemmellaro)

Plate XI, Figures 1–7

1904. *Eutomoceras empedoclis.* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 86, pl. 15, fig. 17.

Strongly compressed laterally, discoidal, completely involute, with high thin whorls, narrow angular venter, and low keel. Ribs flattened and narrow, with sharply incised interspaces, falcoid. Spiral lines weak, with no traces of the spiral knots. Body chamber long. Septa moderately digitate.

Discotropites empedoclis differs from *Discotropites theron* in its flatter ribs, weaker spiral lines, and absence of any traces of the spiral rows of knots. It may be only a variety of *Discotropites theron.*

Occurrence: Very rare in the Upper Triassic Hosselkus limestone at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif., where it is associated with *Tropites welleri, Discotropites theron, Juvavites subinterruptus, Arcestes pacificus, Proclydonautilus triadicus, Halobia superba,* and other species. It was first described from the same horizon in Sicily.

GROUP OF DISCOTROPITES MOJSVARENSIS SMITH

Discotropites lineatus Smith, n. sp.

Plate X, Figures 20–29

Shell very involute, strongly compressed laterally, with flattened sides, narrow venter with subangular shoulders, and low keel. Radial dichotomous ribs exceedingly fine. Spiral lines on the outer shell fine and sharp, forming very small and closely spaced spiral rows of knots where they cross the ribs. Body chamber more than a revolution in length. Septa moderately digitate.

Discotropites lineatus resembles *Discotropites acutus* Mojsisovics but differs in the ribs, which are finer in youth and coarser at maturity than those of *acutus.* It differs from *Discotropites formosus* Smith in its abrupt ventral shoulders, finer ribs, finer spiral lines, and rows of knots. It is the beginning of the series of Punctati, a group that is very homogeneous and forms a "gross Art."

Occurrence: Very common in the Upper Triassic Hosselkus limestone at the upper horizon (*Juvavites* subzone) of *Tropites subbullatus* zone, Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was also found rarely at the lower horizon (*Trachyceras* subzone), on Brock Mountain.

Discotropites gemmellaroi Smith, n. sp.

Plate X, Figures 1–13

Form involute, discoidal, narrowly umbilicate, deeply embracing, and deeply indented by the inner volutions. Whorls strongly compressed, thin, with narrowly rounded venter and sharp keel. Surface with sharp falciform ribs bifurcating on the sides, sharp spiral lines, and very fine knots arranged in spiral rows on the ribs; there are also weak umbilical tubercles. The body chamber is long. The septa are moderately digitate, as in all members of *Discotropites.*

Discotropites gemmellaroi is probably identical with a form from Sicily described by Arthaber[44] as *Discotropites sandlingensis.*

Discotropites gemmellaroi falls between *Discotropites lineatus* and *Discotropites laurae;* it is thicker and has coarser sculpture than *D. lineatus* and is thinner and has finer sculpture than *D. laurae.* It is more compressed than *Discotropites sandlingensis* and has finer ribs and less rounded venter. It differs from *Discotropites theron* in its broader venter, finer and sharper ribs, and stronger knots on the spiral lines. It also resembles *Discotropites kraffti* Diener, which is probably equal to *Discotropites theron,* and differs from it in the same details. It differs from *Discotropites euhemerae* Gemmellaro in its slightly more compressed form, finer sculpture, and knots at the ends of the ribs, which do not bend forward at such a sharp angle as those on the Sicilian species.

In poorly preserved material *Discotropites gemmellaroi* is difficult to distinguish from *Discotropites sandlingensis,* but there is no difficulty when the outer shell is preserved, as the fine rows of knots on *D. gemmellaroi* are so diagnostic.

Named in memory of Prof. G. Gemmellaro, whose work on Triassic faunas is a credit to Italy and a valuable legacy to paleontology.

Occurrence: Rather common in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end of Brock Mountain, both on the west and the east sides, between Squaw Creek and Pit River, Shasta County, Calif. It is associated with *Tropites welleri, Juvavites subinterruptus, Discotropites theron, Arcestes pacificus, Sagenites herbichi, Proclydonautilus triadicus, Halobia superba,* and other species.

[44] Arthaber, G. von, Die Alpine Trias des Mediterran Gebietes: Lethaea Geognostica, Teil 2, Das Mesozoicum, Band 1, p. 461, text fig., 1906.

Discotropites laurae (Mojsisovics)

Plate XI, Figures 8–22

1893. *Eutomoceras laurae.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 294, pl. 131, figs. 13, 16–18; pl. 193, fig. 3.
1904. *Eutomoceras laurae.* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 91, pl. 8, figs. 13, 14.

Form strongly compressed laterally, narrowly umbilicate, sides flattened, venter narrow, with abrupt shoulders and strong keel. Surface with radial falcoid dichotomous ribs, coarse spiral lines, and spiral rows of moderately coarse knots where the lines cross the ribs. Body chamber long. Septa digitate but not unusually so.

Discotropites laurae falls in the series between *Discotropites gemmellaroi* and *Discotropites sengeli;* it is more robust than *D. gemmellaroi* and has finer and coarser ribs and knots; it is less robust than *D. sengeli* and has more numerous and finer ribs, knots, and spiral lines. The ventral shoulders are more abrupt than on *Discotropites gemmellaroi,* especially in youth, and the differences as to ribs, knots, and spirals persist down to a very small size.

Occurrence: Common in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, of Bear Cove, north end and east side of Brock Mountain, between Squaw Creek and Pit River; also on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif. It was first described from the same horizon in the Hallstatt limestone of the Tyrolian Alps, Austria.

Discotropites sengeli (Mojsisovics)

Plate X, Figures 15–19

1893. *Eutomoceras sengeli.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 294, pl. 121, fig. 14.

Form involute, discoidal, with flattened sides sloping up to the subangular ventral shoulders, narrow venter, and high sharp keel. Falcoid dichotomous ribs, coarse, and bending sharply forward at the venter. Spiral lines strong and forming blunt knots where they cross the ribs. In youth there are five rows of spiral knots, increasing to nine at maturity. Body chamber long. Septa digitate but not strongly so.

Discotropites sengeli resembles *Discotropites laurae* and *Discotropites mojsvarensis,* being thicker and with coarser sculpture than *D. laurae* and thinner and with finer sculpture than *D. mojsvarensis.* It is a link in the series *Discotropites lineatus, Discotropites laurae, Discotropites sengeli, Discotropites mojsvarensis,* which forms a "gross Art" with almost complete intergradation; all the species occur together, yet the extremes are widely separated.

Occurrence: Rather rare in the Upper Triassic Hosselkus limestone at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch; also on Brock Mountain between Squaw Creek and Pit River, Shasta County, Calif. It was first described from the same horizon in the Hallstatt limestone in the Tyrolian Alps.

Discotropites mojsvarensis Smith, n. sp.

Plate VIII, Figures 1–18

Form robust, moderately involute, open but narrow umbilicus, with flattened sides, strong ventral shoulders, and thick keel. Strong falcoid dichotomous ribs, bending abruptly forward on the venter. Very strong spiral lines, forming tubercles where they cross the ribs. Body chamber long. Septa like those of all typical *Discotropites,* moderately digitate. The form and ornamentation are decidedly arietiform and bear some resemblance to the arietiform *Eutomoceras* (*Halilucites*) of the Middle Triassic but differ in the spiral lines, long body chamber, and digitate septa. *Discotropites mojsvarensis* clearly belongs to the Tropitidae, whereas *Eutomoceras* is a member of the Hungaritidae.

Discotropites mojsvarensis is most nearly related to *Discotropites davisi,* from which it differs in its greater compression, finer ribs, and slightly narrower umbilicus.

Named in memory of Dr. E. Mojsisovics von Mojsvar, the great master of Triassic paleontology.

Occurrence: Rather rare in the Upper Triassic Hosselkus limestone in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone of Bear Cove, at the north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was also found in the *Juvavites* subzone of Admiralty Island, Alaska, at locality 10180, a point between Chapin and Herring bays.

Discotropites davisi Smith, n. sp.

Plate IX, Figures 4–6

Form robust, only moderately involute, compressed laterally, but with abrupt shoulders and relatively broad venter. Keel high and strong. Heavy falcoid dichotomous ribs; spiral lines and rows of knots in youth, nearly obsolete in age. Body chamber long. Form decidedly arietiform, more so than that of any other species of *Discotropites.* Septa digitate.

Discotropites davisi resembles *Discotropites mojsvarensis* but is more robust, with stronger ribs, and has less developed spines and spiral lines.

Named in honor of C. H. Davis, who assisted in collecting this fauna.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone in the upper horizon (*Juvavites* subzone) of *Tropites subbullatus* zone, on Brock Mountain, between Squaw Creek and Pit River, Shasta

County, Calif. It was found in the *Juvavites* subzone of Admiralty Island, Alaska, at locality 10180, a point between Chapin and Herring bays.

Genus PARATROPITES Mojsisovics

1893. *Paratropites*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 184.

1904. *Paratropites*. Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 109.

1904. *Paratropites*. Smith, The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., vol. 1, p. 396.

1905. *Paratropites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 53.

Mojsisovics gave this name to what he considered a subgenus under *Tropites* and did not name any type nor mention any species under the diagnosis. The first species described by him under this group, *Paratropites bidichotomus* Mojsisovics,[45] would then, according to usage, become the type, but it is neither characteristic nor well known. The commonest and best-known species of the group, *Paratropites saturnus* Dittmar, would seem to afford a much better basis for the generic diagnosis, and this form, along with *Paratropites sellai* Mojsisovics, must have served the author as prototype of the group.

The form is laterally compressed, deeply embracing, and deeply indented by the inner whorls. The sides are flattened convex, the venter narrow, and the whorls usually much higher than wide. The umbilicus is narrow, the inner volutions usually being concealed. Umbilical knots are present on most species, and from these knots dichotomous ribs run with gentle forward curve up the flanks and bend forward on the abdominal shoulders. On the venter there is a distinct central keel that generally has furrows on each side, at which lateral ribs end. The keel is smooth and is not crenulated by the ribs. No spines occur and knots only on the umbilicus. Constrictions have not been observed on any of the numerous species of the group.

The septa are ammonitic but not deeply digitate, dolichophyllic, of the *Tropites* type. The ventral lobe is divided by a shallow siphonal saddle. There are generally two principal laterals and an auxiliary, but in some species there is only one principal lateral, and the second must be regarded as an auxiliary. The body chamber is long, and at maturity shows a tendency to obsolescence of the ribs and also an egression of the whorl.

Most species of this group are compressed laterally and high-whorled, but some are subglobose in shape. *Paratropites* seems to be equally as nearly related to *Discotropites* as to *Tropites* and may possibly be a connecting link between them, or, more properly speaking, it seems to have departed less from the ancestral type than they. This relation is emphasized by the fact that in *Paratropites* the adult whorls differ little from the youthful stages, whereas in *Tropites* and *Discotropites* great changes take place in growth.

Under this genus three groups of species may be recognized: (I) Group of *Paratropites sellai* Mojsisovics, characterized by the strong lateral ribs, *Paratropites* s. s. (II) Group of *Paratropites americanus* Hyatt and Smith, subgenus *Gymnotropites* Hyatt and Smith, characterized by obsolescence of the ribs, which persist faintly only in early youth. (III) Group of *Paratropites janus*, subgenus *Paulotropites* Mojsisovics, characterized by obsolescence of sculpture and strong development of paulostomes.

Paratropites appears in the Mediterranean region and in California, in the Karnic stage of the Upper Triassic. According to our present knowledge, it is entirely confined to that horizon.

In the zone of *Tropites subbullatus* of Shasta County, Calif., *Paratropites* is represented by two species identical with Alpine forms, *Paratropites sellai* Mojsisovics and *Paratropites dittmari* Mojsisovics, besides a large number of new species closely related to Alpine forms.

The subgenus *Gymnotropites* is not recorded outside of California, although *Paratropites marii* Mojsisovics, of the Alpine province, may be a form transitional to this group.

Paratropites antiselli Smith, n. sp.

Plate XXIV, Figures 1–8

Form very robust, subglobose, involute, with rounded flanks and broadly rounded venter, without shoulders. Ribs coarse, with deeply incised narrow interspaces, bending forward in a broad curve high up on the flanks. Keel strong but low, bordered by deep furrows. Body chamber long. Septa of moderate digitation.

Paratropites antiselli is nearest to *Paratropites arnoldi*, from which it differs in its more robust subglobose form, coarser and fewer ribs, and greater size. It differs from *Paratropites sellai* even more in these characters and is the most globose member of *Paratropites*. This characteristic persists even in extreme youth, specimens only 10 millimeters in diameter being easily distinguished from the kindred forms.

Named in memory of Dr. Thomas Antisell, a pioneer geologist of California.

Occurrence: Rather common in the Upper Triassic Hosselkus limestone at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

[45] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 234, pl. 127, fig. 11, 1893.

Paratropites arnoldi Smith, n. sp.

Plate XXV, Figures 3–9

Form very robust, subglobose, involute, somewhat compressed laterally, with sides sloping steeply up to the rounded venter, without distinct shoulders. Ribs broad, with narrow interspaces, running nearly straight, obliquely forward up to the flanks and bending abruptly forward on the shoulders. Keel strong but low, bordered by deeply incised furrows. Body chamber long. Septa moderately digitate, with divided ventral lobe, large first lateral, slightly smaller second lateral, and small auxiliary lobe on the umbilical shoulder, all with about the same amount of digitation. The internal lobes consist of a dorsal and three laterals.

Paratropites arnoldi differs from *Paratropites sellai* only in its more robust and thick-set form. The details of ribs, septa, keel, and furrows are very similar on the two species. It differs from *Paratropites gabbi* in its lack of compression and of distinct shoulders and in its more distinct ribs. It has a greater resemblance to *Paratropites antiselli*, from which it differs in its less obese form and rather finer ribs, which in *Paratropites antiselli* are fewer, coarser, and more regularly curved.

Named in honor of Dr. Ralph Arnold, who assisted in collecting this fauna.

Occurrence: Rare in the Upper Triassic Hosselkus limestone at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Paratropites dittmari Mojsisovics

Plate XXV, Figures 1, 2

1893. *Tropites (Paratropites) dittmari.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 245, pl. 115, fig. 4.

1904. *Paratropites dittmari.* Smith, The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., vol. 1, No. 10, p. 396, pl. 46, fig. 1; pl. 47, fig. 1.

Involute, discoidal, laterally compressed, high-whorled; whorls deeply embracing, deeply indented by the inner volutions. Sides flattened convex, with abruptly rounded umbilical shoulders and gently rounded ventral shoulders. Venter narrow and arched with keel and marginal furrows. Umbilicus narrow, almost closed at maturity, becoming slightly wider with advancing age. Surface ornamented with sharply incised bifurcating ribs, running nearly straight up the flanks and bending abruptly forward on the shoulders. The ribs branch near the umbilicus and again on the flanks in an irregular manner. The height of the whorl is about half of the total diameter, and the width is two-thirds of the height. Umbilical knots are not developed at maturity.

Septa digitate, like those of all *Paratropites*, but of simple pattern and not deeply divided.

Paratropites dittmari is closely allied to *Paratropites sellai*, with which it is associated in both the Alpine region and in California. It differs from that species in its more compressed whorl, fewer and flatter ribs, and the obsolescence of the umbilical knots. These same characters also distinguish it from *Paratropites saturnus* Dittmar, on which also the lateral ribs are not straight but curve broadly forward on the flanks.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, lower horizon (*Trachyceras* subzone), on Brock Mountain, on the divide between Squaw Creek and Pit River, about 3 miles east of the forestry station and half a mile north of the trail to Pit River, Shasta County, Calif. It was first described from the Tyrolian Alps, at the same horizon and in the same association as in California.

Paratropites gabbi Smith, n. sp.

Plate XXIV, Figures 9–13

Form large, involute, high-whorled, laterally compressed, with closed umbilicus, sides sloping steeply up to the abrupt shoulders; venter rather narrow and somewhat flattened. Ribs broad and weak, running nearly straight, obliquely up the flanks to the shoulder, then curving sharply forward on the venter. Keel strong, keel furrows deep. Body chamber long. Septa moderately digitate, like those of all *Paratropites*.

Paratropites gabbi resembles *Paratropites sellai*, from which it is distinguished by the tendency to obsolescence of the ribs, by the abrupt ventral shoulders, and by its greater size. It is somewhat similar to *Paratropites arnoldi* but differs in being less robust and more compressed, in having distinct shoulders, and in showing obsolescence of the ribs.

Named in memory of W. M. Gabb.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Paratropites gracilis Smith, n. sp.

Plate XXV, Figures 10–13

Shell small, high-whorled, involute, very much compressed laterally, sides flattened, ventral shoulders subangular, venter narrow and flat. Keel sharp, keel furrows deeply incised. Dichotomous ribs very fine, little wider than the interspaces. The body chamber is long. Septa digitate but not so strongly as in larger species of the genus. The height of the whorl is more than half the total diameter of the shell, and the width is three-fifths of the height.

Paratropites gracilis is the smallest and slenderest species of the genus. It resembles the young stages of *Discotropites theron* but differs in the total lack of spiral lines and rows of fine tubercles characteristic of that genus and species. Its septa are also more complex than those of the young of any species of *Discotropites* of the same size.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Paratropites sellai Mojsisovics

Plate XXIV, Figures 14–16; Plate XXX, Figures 6–10; Plate XXXI, Figures 1–26

1893. *Tropites (Paratropites) sellai.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 242, pl. 114, figs. 2, 4–10; pl. 115, figs. 5, 6, 9, 10, 11; pl. 113, fig. 23.

1905. *Paratropites sellai.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 54, pl. 30, figs. 6–10; pl. 31, figs. 1–26.

1866. *Ammonites saturnus* (part). Dittmar, Zur Fauna der Hallstätter Kalke, in Benecke, E. W., Geognostische-palaeontologische Beiträge, Band 1, p. 367, pl. 16, figs. 4, 5, 6, 8 (not figs. 1, 2, 3, 7).

Form involute, robust, somewhat compressed laterally; whorl high, deeply embracing, and deeply indented by the inner whorls. In youth the whorl is highly arched, with convex sides and rounded venter, but in age the sides become flattened, the abdominal shoulders pronounced, and the venter somewhat flattened. The umbilicus is narrow and conceals the inner volutions; its breadth ranges from one-eighth to one-twelfth of the diameter of the shell. The outer whorl is about half the diameter of the shell and approximately as wide as high; the greatest breadth is at the base of the whorl, just above the umbilical shoulders. It is indented to half its height by the inner whorl and conceals the inner whorl entirely. In the younger stages the form is subglobose and the umbilicus virtually closed. On the venter there is a low median keel, bounded by shallow but distinct marginal furrows; these furrows are very distinct on the cast but less so on the shell.

Surface ornamented with radial ribs that begin in bundles on the umbilical border, run up the sides with a forward curve, and bend abruptly forward on the umbilical shoulder to the margins of the keel furrows. These ribs are usually dichotomous, the division taking place at one-third of the height of the whorl; they are broad and rounded, much wider than the intercostal spaces. In old age the ribs become weaker and the shell is nearly smooth, only the keel remaining distinct.

Septa ammonitic but simple, not deeply digitate. The external lobe is divided by a rectangular siphonal saddle into two short branches; the first lateral lobe is larger than the external and the second lateral about as large as the external; the auxiliary lobe on the umbilical shoulder is distinctly individualized but smaller than the second lateral. The antisiphonal lobe is flanked by three internal laterals and an auxiliary on each side.

The larval stages of *Paratropites sellai* resemble *Gastrioceras* in their wide umbilicus and low helmet-shaped whorls. The keel appears at a diameter of 2 millimeters, but the lateral ribs do not develop until a diameter of 3.5 millimeters is reached. The septa begin to be ammonitic at a diameter of 4 millimeters. The development of the species is unusually simple for such a highly specialized ammonite, and the little change that takes place from the larval period to maturity shows that this genus has departed very little from its ancestral characters. It is therefore highly probable that the early adolescent stage of *Paratropites* gives a good indication as to what the ancestor of *Tropites* was like—involute, robust, with highly arched whorl, rounded abdominal shoulders, strong keel without bordering furrows, obscure umbilical ribs, and simple goniatite septa. No mature form is yet known that possesses these characters, but they are seen also in the young of *Tropites* and *Discotropites*, and many of them are preserved, although considerably modified, in mature forms of *Styrites* and *Tropiceltites*.

Paratropites sellai is most nearly related to *Paratropites saturnus* Dittmar, but, according to Mojsisovics, it differs from that species in having one more lateral lobe, in the straighter lateral ribs, and in the fewer and weaker umbilical nodes. The figures of the two species given by Mojsisovics are indistinguishable, and from a careful examination of the original specimens of the two Hyatt was convinced that there are intergradations between *Paratropites sellai* and *Paratropites saturnus*. Among more than 400 American specimens of this species, however, the writer could find none with the characters attributed to *Paratropites saturnus*, and he has retained the name proposed by Mojsisovics.

This species is also closely related to *Paratropites dittmari* Mojsisovics, with which it is associated both in the Alps and in California, but differs from that species in its more robust, thicker whorl. *Paratropites dittmari* is thinner and more discoidal.

Occurrence: *Paratropites sellai* is very common in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, *Trachyceras* subzone, Shasta County, Calif. The figured specimens all came from Brock Mountain, on the divide between Squaw Creek and Pit River, about 2½ miles northeast of Madison's ranch, 6 miles northeast of the Bully Hill mine. It was found in this horizon in the Hosselkus limestone at several places along Squaw Creek, invariably in the same association, with *Tropites subbullatus* Hauer, *Discotropites sandlingensis* Hauer, *Proclydonautilus triadicus* Mojsisovics, *Sagenites herbichi* Mojsisovics, and *Halobia superba* Mojsisovics.

Subgenus GYMNOTROPITES Hyatt and Smith

1905. *Gymnotropites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 56.

Type.—Paratropites americanus Hyatt and Smith.

Involute, laterally compressed, discoidal, deeply embracing, and deeply indented by the inner whorls. Sides flattened, venter narrow, surmounted by a keel, with little or no marginal furrows. Umbilicus narrow. Sides almost smooth, ornamented only with cross striae. In some forms transitional to *Paratropites* s. s. there are in the adolescent stage obscure rudiments of the lateral ribs. Septa ammonitic; external lobe divided by a siphonal saddle. There are usually two laterals and a small auxiliary lobe.

This subgenus is distinguished from *Paratropites* s. s. only by its smooth shell, the other characters being identical; it is connected with that group by transitional species and undoubtedly has developed out of *Paratropites*. It also resembles *Styrites* but differs from that genus in its more robust form and ammonitic septa.

Gymnotropites is known only from the Upper Triassic Hosselkus limestone of Shasta County, Calif., in the zone of *Tropites subbullatus*, *Trachyceras* subzone, where it is represented by several species.

Paratropites (Gymnotropites) americanus Hyatt and Smith

Plate XXXII, Figures 1–10

1905. *Paratropites* (*Gymnotropites*) *americanus*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 56, pl. 32, figs. 1–10.

Involute, discoidal, laterally compressed. Whorl deeply embracing and deeply indented by the inner whorl. Sides flattened, venter narrow with obscure abdominal shoulders, and low median keel, without bordering furrows. Cross section of whorl high and narrow. Umbilicus closed, umbilical shoulders abruptly rounded. The height of the whorl is one and one-third times the width and slightly more than half the total diameter of the shell. The outer whorl covers the inner almost entirely and is indented by it to nearly half the height. Surface of the shell nearly smooth, ornamented only with fine cross striae, which are bundled into faint folds. The septa are ammonitic, both lobes and saddles being weakly digitate. The divided external lobe is flanked by two laterals and an auxiliary, decreasing in size toward the umbilicus. The antisiphonal lobe is flanked by three internal laterals and an auxiliary. In the young stages the folds are stronger, forming true ribs like those of *Paratropites*, thus indicating the origin of this group of smooth forms.

This species resembles *Paratropites marii* Mojsisovics but is thinner and smoother. It has a stronger external resemblance to *Styrites reinischii* Mojsisovics[46] but differs from that species in having ammonitic instead of goniatitic septa.

Occurrence: *Paratropites* (*Gymnotropites*) *americanus* Hyatt and Smith was found in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, *Trachyceras* subzone, 3 miles east of Madison's ranch, on the divide between Squaw Creek and Pit River, half a mile north of the trail from Madison's to Brock's ranch on Pit River, Shasta County, Calif. This locality is about 6 miles northeast of the Bully Hill mine.

[46] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 281, pl. 21, fig. 3.

Paratropites (Gymnotropites) californicus Smith, n. sp.

Plate LVII, Figures 1–11

Form high-whorled, involute, laterally compressed, with nearly flat sides, narrow arched venter, and moderately high keel without furrows. Umbilicus closed. Body chamber long. Surface smooth, with only fine striae of growth. Septa moderately digitate.

Paratropites californicus is closely related to *Paratropites americanus*, from which it differs only in its thicker whorl, which is very like that of *Paratropites dittmari* Mojsisovics, without the sculpture of that species. It is less robust than *Paratropites laevis*. The group of *Gymnotropites* forms a "gross Art"—*Paratropites americanus*, *Paratropites californicus*, *Paratropites laevis*, *Paratropites rotundus*—all closely related and possibly intergrading forms and yet separated widely at the extremes. These species have as yet diverged but little from their common ancestor, and all are probable retrogrades by loss of sculpture from *Paratropites*.

Occurrence: Very common in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Paratropites (Gymnotropites) laevis Smith, n. sp.

Plate XXV, Figures 16–20

Form moderately robust, involute, laterally compressed, with closed umbilicus, gently convex sides, and narrow arched venter, with distinct keel without bordering furrows. Surface smooth, with only striae of growth. Body chamber long. Septa only moderately complex.

Paratropites laevis resembles *Paratropites californicus* but differs in its more robust shape, which is very like that of *Paratropites sellai*, without the ribs of that species. It is considerably more compressed than *Paratropites rotundus*.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Paratropites (Gymnotropites) rotundus Smith, n. sp.

Plate XXV, Figures 14, 15

Form robust, subspherical, involute, with rounded flanks and venter, without shoulders. Umbilicus closed. Keel strong, without furrows. Surface smooth, with only striae of growth. Body chamber long. Septa moderately complex.

Paratropites rotundus is very similar to *Paratropites laevis* but differs in its more rotund form, which is nearly as robust as *Paratropites antiselli*, without the ribs of that species. It is the most rotund species of the group of *Gymnotropites* and stands at the end of its series.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Paratropites (Gymnotropites) yatesi Smith, n. sp.

Plate XXV, Figures 21–24

Form laterally compressed, involute, high-whorled, with somewhat flattened sides, narrow venter, and rounded shoulders. Keel well developed, with furrows. Surface with very weak ribs and umbilical knots, becoming obsolete at maturity. Body chamber long. Septa digitate.

Paratropites yatesi is closely related to *Paratropites marii* Mojsisovics,[47] but differs in its narrower umbilicus and weaker umbilical nodes. In shape it is very like *Paratropites californicus* but is distinguished by its vestigial sculpture. It is probably transitional from *Gymnotropites* to *Paratropites* s. s., being not so arrested in the development of the sculpture as are the other species of the subgenus.

Named in memory of Dr. Lorenzo G. Yates, a pioneer naturalist of California.

Occurrence: Quite common in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Subgenus PAULOTROPITES Mojsisovics

1893. *Paulotropites.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 185.

1904. *Paulotropites.* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 118.

Type.—Tropites janus Dittmar.

This group was established by Mojsisovics to include the group of *Tropites labiati*, which differ from other members of the family in the possession of periodic paulostomes that replace the ordinary sculpture of the Tropitidae. It is evidently a partly degenerate and atavistic form from *Paratropites* and hence is included as a subgenus under that group.

Paulotropites is confined to the Upper Triassic Karnic stage of the Mediterranean region and is present at the same horizon in California.

Paratropites (Paulotropites) colei Smith, n. sp.

Plate LVII, Figures 22–23

Form very robust, depressed, broad, involute, subspherical. Surface at maturity nearly smooth, with only weak paulostomes forming a forward-pointing sinus; in youth with weak ribs parallel to the paulostomes. Keel and furrows much reduced at maturity, strong in youth. Body chamber long. Septa digitate.

Paratropites colei is more robust than *Paratropites shastensis* and has stronger development of the paulostomes. It is broader and more robust than any European members of *Paulotropites*.

Named in honor of Frank L. Cole, who assisted in collecting this fauna.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Paratropites (Paulotropites) shastensis Smith, n. sp.

Plate LVII, Figures 12–21

Form robust, subspherical in youth, laterally compressed at maturity, with whorl becoming higher and narrower, and developing subangular ventral shoulders. Keel low and keel furrows nearly obsolete at maturity, both very strongly developed in youth. Surface nearly smooth at maturity, except vestiges of the paulostomes or ridges and constrictions of the temporary apertures; in youth with very strong forward-curving ribs, with deeply incised interspaces and paulostomes. Body chamber long. Septa digitate.

Paratropites shastensis is somewhat like *Paratropites seelandi* Mojsisovics[48] but differs in the obsolescence of the ribs and the weakening of the keel and furrows. It belongs to the same group as *Paratropites labiatus* Mojsisovics and *Paratropites janus* Dittmar but has much weaker paulostomes than those species. It is less divergent from *Gymnotropites* than any of the European members of *Paratropites*.

Occurrence: Common in the Upper Triassic Hosselkus limestone in the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus MICROTROPITES Mojsisovics

1893. *Microtropites.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 186.

1904. *Microtropites.* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 117.

Type.—Ammonites galeolus Hauer.

Includes dwarfed, arrested, degenerate forms of the Tropitidae, with compact whorl, ventral keel, re-

[47] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 244, pl. 115, figs. 2, 3, 1893.

[48] Mojsisovics, E. von., op. cit., p. 217, pl. 112, fig. 6.

duced and simplified septa, and obsolescence of sculpture. This is the group of *Tropites galeoli* of Mojsisovics.

Confined to the Upper Triassic Karnic stage of the Mediterranean region and is present at the same horizon in California.

Microtropites tubercularis Mojsisovics

Plate LIX, Figures 14–20

1893. *Microtropites tubercularis.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 258, pl. 113, fig. 8; pl. 129, figs. 11, 12.

Dwarf form, small, completely involute, thick set, somewhat compressed laterally, with flattened sides, abruptly rounded shoulders, and rather low venter. High, sharp ventral keel, bordered by deep furrows. Surface smooth, with only lines of growth. Body chamber long. Septa with rounded saddles and slightly serrated lobes of very simple type. This species is an arrested form, reversionary toward the ancestral stock. It greatly resembles *Protropites* Arthaber,[49] from the Lower Triassic. This resemblance may indicate that *Protropites* is really the ancestral stock of *Tropites,* or it may indicate an accidental convergence of forms with a common ancestry, one progressive and the other retrogressive and arrested in some of the characters of the common ancestor but diverging in others.

Occurrence: Rare in the Upper Triassic Hosselkus limestone in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end and west side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. *Microtropites tubercularis* was first described from the same horizon in the Hallstatt limestone of the Tyrolian Alps.

Genus MARGARITES Mojsisovics

1893. *Margarites.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 297.

1904. *Margarites.* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 124.

1906. *Margarites.* Diener, Fauna of the *Tropites* limestone of Byans: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 139.

Forms small, compact, somewhat evolute, with trapezoidal cross section, ventral keel and lateral ribs armed with sharp spines. Septa somewhat simplified; body chamber long.

This group is somewhat arrested and reversionary from *Tropites*; it is distinguished especially by the development of the spines, a phylogerontic character. It is, however, by no means so far degenerate as *Microtropites* or *Anatropites.*

Confined to the Upper Triassic Karnic stage of the Mediterranean region, the Himalayas, and California.

[49] Arthaber, G. von, Die Trias von Albanien: Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, Band 24, p. 255, pl. 29, figs. 9-16, 1911.

Margarites jokelyi (Hauer)

Plate LVIII, Figures 24–29

1855. *Ammonites jokelyi.* Hauer, Beiträge zur Kenntniss der Cephalopoden-Fauna der Hallstätter Schichten: K. Akad. Wiss. Wien Denkschr., Band 9, p. 11, pl. 4, figs. 1, 2, 7.

1893. *Margarites jokelyi.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 301, pl. 117, figs. 11–14; pl. 118, figs. 1–4, 7.

1904. *Margarites jokelyi.* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 125.

Form robust, evolute, little embracing, widely umbilicate. Whorls robust, with abrupt ventral shoulders, convex flanks, rounded ventral shoulders, and rather high venter. Keel very high and sharp, bordered by shallow furrows. Surface with coarse umbilical ribs, curving on the flanks and bifurcating on the shoulders, then swinging sharply forward, becoming much finer on the ventral slope. There is a row of nodes or blunt spines on the ribs at the shoulders. Body chamber long. Septa not seen on the American specimens. In youth the whorl is low and broad, distinctly trapezoidal, and very gastrioceran, except that the keel persists to a very early stage.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif. It is associated with *Tropites welleri, Discophyllites insignis, Juvavites subinterruptus, Homerites semiglobosus, Proclydonautilus triadicus, Halobia superba,* and other species. It was also found in the *Juvavites* subzone of Admiralty Island, Alaska, at locality 8848, at the north entrance to Herring Bay.

Margarites moffiti Smith, n. sp.

Plate CIII, Figures 1–3

Form robust, thick set, evolute, widely umbilicate. Whorls trapezoidal, with abrupt umbilical shoulders, convex flanks, and rounded venter. Ventral keel low, bordered by deep furrows. Surface ornamented with bifurcating ribs and blunt spines. There are three rows of spines—one just above the umbilical shoulder, a second in the middle of the flanks where the ribs bifurcate, and a third on the ventral shoulder, immediately below the keel furrows. Septa and length of body chamber unknown.

Margarites moffiti resembles *Margarites auctus* Dittmar, of the *Tropites subbullatus* fauna in the Alpine region, but differs from that species in being more robust and slightly more involute and in having stronger sculpture and deep keel furrows.

Named in honor of F. H. Moffit.

Occurrence: Very rare in the *Juvavites* subzone of the zone of *Tropites subbullatus*, at locality 4810, south side of Chitistone River, Nizina district, Alaska.[50]

[50] Moffit, F. H., and Capps, S. R., Geology and mineral resources of the Nizina district, Alaska: U. S. Geol. Survey Bull. 448, p. 24, 1911.

Margarites senilis Mojsisovics

Plate LVIII, Figures 33–36

1893. *Margarites senilis.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 307, pl. 118, figs. 1, 8–10, 12, 14–16.

Dwarf form, small, moderately evolute, thick set, with low and rather broad whorl, with angular ventral shoulders, narrow flanks, abrupt ventral shoulders and arched venter; keel sharp, with distinct bordering furrows. There is a row of sharp nodes on the umbilical shoulders and a similar row of coarser ones on the ventral shoulders. There are also radial ribs, rather strong on the flanks, which swing abruptly forward and become obsolete on the ventral slope. Body chamber long. Septa weakly digitate.

Margarites senilis differs from *Margarites septentrionalis* in its broader whorl, angular shoulders, flattened flanks, and the double row of nodes on the sides. Both are arrested, dwarf, reversionary forms, and both probably resemble the primitive ancestral type, though still retaining the keel and the digitate septa.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif. It is associated with *Tropites welleri, Discophyllites patens, Juvavites subinterruptus, Homerites semiglobosus, Proclydonautilus triadicus, Halobia superba,* and other species.

Margarites septentrionalis Smith, n. sp.

Plate LIX, Figures 27–33

Dwarf form, small, rather evolute, medium widely umbilicate, whorl deeply embracing but not deeply indented by the inner whorls. Somewhat compressed laterally, with abruptly rounded shoulders, low venter, and strong keel bordered by deep furrows. Surface with fine dichotomous ribs that curve forward on the flanks and bend sharply forward to the keel furrows. Body chamber long. Septa slightly digitate, though not so greatly as in progressive Tropitidae.

Margarites septentrionalis greatly resembles *Margarites senilis,* from which it differs in its greater lateral compression, higher shoulders, and more flattened venter and in the absence of the double row of spines on the sides. In youth the resemblance of the two species is much greater, both having low broad trapezoidal whorls, with a row of nodes on the umbilical shoulder, and both lacking ventral shoulders, but even in youth *Margarites septentrionalis* is not so broad nor so depressed and has weaker nodes. Both are arrested forms, reversionary toward the ancestral type, being almost gastrioceran in form, though tropitoid in keel and septa.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Genus ANATROPITES Mojsisovics

1893. *Anatropites.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 187.

1904. *Anatropites.* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 120.

1905. *Anatropites.* Diener, Fauna of the *Tropites* limestone of Byans: Geol. Survey India Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 153.

Form slender, evolute, little embracing, with lateral ribs, ventral keel and keel furrows, and umbilical nodes. Septa simple, only slightly digitate. Body chamber long.

This group is a degenerate one, reversionary by arrest of development toward *Celtites* but retaining the more complex septation and the tropitoid keel. It is represented in the Upper Triassic of America by a single species, *Anatropites hauchecornei* Mojsisovics.

Anatropites hauchecornei Mojsisovics

Plate LVIII, Figures 21–23

1893. *Tropites (Anatropites) hauchecornei.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 226, pl. 127, figs. 14, 15.

Form extremely slender, evolute, with wide, shallow umbilicus and whorls scarcely embracing. Surface ornamented with lateral ribs, umbilical and marginal nodes, and strong keel and keel furrows. Septa only slightly digitate.

In youth this species resembles a very slender *Margarites* and no doubt is merely a further degeneration from that genus.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the *Tropites subbullatus* zone, upper horizon (*Juvavites* subzone), on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.; associated with *Tropites welleri, Sagenites herbichi, Homerites semiglobosus, Juvavites kellyi,* and other species. It was first described from the same horizon in the Tyrolian Alps.

Genus TROPICELTITES Mojsisovics

1893. *Tropiceltites.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 369.

1906. *Tropiceltites.* Diener, Fauna of the *Tropites* limestone of Byans: Geol. Survey India Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 156.

(Not 1905. *Tropiceltites* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 58. = *Metasibirites* Mojsisovics.)

1911. ?*Tropiceltites.* Arthaber, Die Trias von Albanien: Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, Band 24, p. 268.

Tropiceltites caducus (Dittmar)

Plate LVIII, Figures 1–5

1866. *Ammonites caducus.* Dittmar, Zur Fauna der Hallstätter Kalke, in Benecke, E. W., Geognostische-palaeontologische Beiträge, Band 1, p. 361, pl. 14, figs. 14, 15.

1893. *Tropiceltites caducus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 383, pl. 121, fig. 57; pl. 128, figs. 10–12.

Dwarf form, arrested in development, reversionary. Evolute, slender, little embracing and little indented. Surface with weak lateral ribs and slender ventral keel, without bordering furrows. Body chamber long.

Tropiceltites caducus is unlike any other known species of the genus and does not belong to the typical group. The American specimens are exactly like the figures and descriptions given by Mojsisovics of those of the Hallstatt limestone.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif. It is associated with numerous species of *Tropites, Juvavites, Arcestes, Discotropites, Proclydonautilus, Halobia superba,* and other species. It was first described from the Karnic Hallstatt limestone of the Tyrolian Alps.

Genus TORNQUISTITES Hyatt and Smith

1905. *Tornquistites.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 59.

Type.—*Tornquistites evolutus* Hyatt and Smith.

Evolute, discoidal, little embracing, laterally compressed, low whorls, increasing very slowly in height. Cross section of whorl helmet-shaped; sides flat convex, venter narrowly rounded. Umbilicus very wide and shallow. At maturity there is a faint threadlike central elevation, which is the rudiment of a keel that is prominent in the adolescent period. Surface ornamented with fine ribs that are sigmoidal on the sides and cross the venter. Septa apparently goniatitic but show under the lens a faint serration of the lateral lobe.

The young stages of this genus are more involute, with higher whorls, and a distinct ventral keel, like *Styrites* Mojsisovics. This genus resembles *Lecanites* Mojsisovics but differs from it in the faint serration of the lateral lobe, the much stronger sculpture, and in the young stages.

Tornquistites evolutus Hyatt and Smith

Plate XXXII, Figures 11–21

1905. *Tornquistites evolutus.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 60, pl. 32, figs. 11–21.

Evolute, laterally compressed, widely umbilicate. Whorls laterally compressed, low, and increasing slowly in height, little embracing, and little indented by the inner whorl. Cross section of the whorl elongate oval, with rounded abdominal shoulders and narrow arched venter. In the middle of the venter is a faint threadlike elevation, which is the remnant of a keel that is prominent in the young stages. The height of the whorl is slightly less than one-third of the total diameter, and the width is about two-thirds of the height. The indentation is about one-eighth of the height. The width of the umbilicus is about one-third of the diameter of the shell. The body chamber is at least one revolution long. The surface of the shell and of the cast is ornamented with weak folds that bend sharply forward on the abdominal shoulders, forming a narrow sinus on the venter. Septa faintly ceratitic, the first lateral lobe being slightly serrated, all the others being goniatitic. The external lobe is divided by a small siphonal notch into two short branches; the first lateral lobe is larger, and occasionally shows under the lens faint traces of serration; the second is smaller and entire; on the umbilical shoulder is a very small auxiliary. The antisiphonal lobe is long and narrow, flanked by a single short internal lateral on each side. This species is nearest to "*Isculites*" *obolinus* Dittmar, which probably belongs to the same genus but differs from it in the greater evolution and stronger sculpture.

Occurrence: *Tornquistites evolutus* is rather common in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus* (*Trachyceras* subzone), 3 miles east of Madison's ranch, on the divide between Squaw Creek and Pit River, Shasta County, Calif. It was most abundant at a place half a mile north of the trail from Madison's to Brock's ranch on Pit River.

Tornquistites obolinus (Dittmar)

Plate LVIII, Figures 12–15

1886. *Ammonites obolinus.* Dittmar, Zur Fauna der Hallstätter Kalke in Benecke, E. W., Geognostische-palaeontologische Beiträge, Band 1, p. 356, pl. 14, figs. 7–9.

1893. *Isculites obolinus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 66, pl. 87, figs. 4a–d.

A dwarfed, arrested, degenerate form, reversionary toward the ancestral type. Involute, widely umbilicate, with flattened sides and narrowly rounded venter. Very weak folds, almost invisible, on the flanks. Septa said to be goniatitic, not observed on the American specimens. Body chamber long.

Mojsisovics assigned this species to *Isculites,* although it has no resemblance to the type of that genus, which is a rotund, involute, *Arcestes*-like form, with distinctly serrated septa. It is closely related to *Tornquistites evolutus* from which it differs only in its greater involution, narrower umbilicus, and weaker sculpture.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. Also found in the Karnic stage of the Tyrolian Alps.

Genus ARNIOTITES Hyatt

1889. *Arniotites*. Hyatt, in Whiteaves, J. F., The fossils of the Triassic rocks of British Columbia: Geol. Survey Canada, Contr. Canadian Paleontology, vol. 1, pt. 2, p. 144.

Type.—Arniotites vancouverensis Hyatt.

Form evolute, discoidal, widely umbilicate, laterally compressed; whorls rather slender, with subquadratic outline, little embracing, and little indented by the inner whorls. Surface with strong, simple, nearly straight radial ribs and high ventral keel with marginal furrows. Septa and length of body chamber unknown.

This genus probably belongs to the Tropitidae and may furnish a connecting link between that group and the Arietidae. It is decidedly arietiform and can hardly belong to the Ceratitidae.

Professor Hyatt included in *Arniotites* members of *Balatonites* Mojsisovics, to which it has no resemblance nor kinship, but as he specifies the type species of *Arniotites*, there need be no confusion in determining the limits of the genus. It is certainly not congeneric with the group of *Balatonites arietiformis* nor with *Eutomoceras*.

Occurrence: Upper Triassic, in beds of Noric age, on Vancouver Island, Queen Charlotte Islands, Alaska, and in California.

Arniotites vancouverensis Whiteaves

Plate CVIII, Figure 2

1889. *Arniotites vancouverensis*. Whiteaves, The fossils of the Triassic rocks of British Columbia: Geol. Survey Canada, Contr. Canadian Paleontology, vol. 1, pt. 2, p. 146, pl. 19, fig. 2.

Shell arietiform, small, laterally compressed; widely umbilicate, evolute; whorls barely embracing, cross sections subquadratic. Surface with strong simple nearly straight lateral ribs; ventral keel and marginal furrows distinct. Septa and length of body chamber unknown.

Occurrence: Upper Triassic, presumably in the *Pseudomonotis* zone, at Crescent Inlet, Moresby Island, Queen Charlotte Islands, British Columbia; also at Forward Inlet, near Observatory Rock, on the northwest coast of Vancouver Island, British Columbia; also in Sailor Canyon, American River, Placer County, Calif.; also probably in the McCarthy formation, *Pseudomonotis* zone, of Alaska.

Family CELTITIDAE Mojsisovics

Genus CELTITES Mojsisovics

1882. *Celtites*. Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 145.

1892. *Celtites*. Hauer, Beiträge zur Kenntniss der Cephalopoden aus der Trias von Bosnien: K. Akad. Wiss. Wien Denkschr., Band 59, Theil 1, p. 273.

1893. *Celtites*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 345.

1895. *Celtites*. Waagen, Fossils from the Ceratite formation; Salt Range fossils: India Geol. Survey Mem., Palaeontologia Indica, ser. 13, vol. 2, p. 69.

1905. *Celtites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 125.

1911. *Celtites*. Arthaber, Die Trias von Albanien: Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, Band 24, p. 266.

1914. *Celtites*. Smith, The Middle Triassic marine invertebrate faunas of North America: U. S. Geol. Survey Prof. Paper 83, p. 34.

Celtites steindachneri Mojsisovics

Plate LVIII, Figures 8–11

1903. *Celtites steindachneri*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 355, pl. 122, figs. 34a–d.

Dwarf form, slender, evolute, little embracing, widely umbilicate, whorls subrectangular in cross section, body chamber long. Weak periodic constrictions. Fine, sharp, straight ribs that cross the venter.

Celtites steindachneri lacks the robust trapezoidal whorl so characteristic of the typical *Celtites* of the Middle Triassic and is probably much more degenerate than they are. As compared with *Celtites gabbi* Smith, of the Middle Triassic of Nevada, it is arrested in development.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif. It is associated with *Tropites welleri*, *Homerites semiglobosus*, *Juvavites subinterruptus*, *Discotropites lineatus*, *Proclydonautilus triadicus*, *Halobia superba*, and other species. In the Hallstatt region of Austria it was found in the middle Karnic *Trachyceras aonoides* beds, a somewhat lower horizon than that in California.

Family HALORITIDAE Mojsisovics

The phylogeny of the Haloritidae has already been discussed under the heading "Tropitoidea." (See pp. 23–25.) All members of this group of which the ontogeny is known have adolescent stages resembling *Thermalites* and young stages resembling *Juvenites* and the group of *Gastrioceras globulosum*. Arthaber has split off *Acrochordiceras* and its kindred as a family, Acrochordiceratidae, which, however, is not more than a subfamily.

The Haloritidae are represented in the Upper Triassic of North America by *Sagenites* Mojsisovics; subgenus *Trachysagenites* Mojsisovics; *Halorites* Mojsisovics; *Jovites* Mojsisovics; subgenus *Bacchites* Smith; *Juvavites* Mojsisovics; subgenus *Anatomites*

Mojsisovics; *Gonionotites* Gemmellaro; *Leconteiceras* Smith; *Homerites* Mojsisovics; and *Metasibirites* Mojsisovics.

All these except *Halorites* occur in the zone of *Tropites subbullatus* of the Hosselkus limestone, of Shasta County, Calif., and all except *Leconteiceras* occur in the Upper Triassic of the Mediterranean region.

Genus HALORITES Mojsisovics

1878. *Halorites*. Mojsisovics, Die Dolomitriffe von Südtirol und Venetien, p. 50.
1879. *Halorites*. Mojsisovics, Vorläufige kurze Uebersicht der Ammoniten-Gattungen der Mediterranen und Juvavischen Trias: K.-k. geol. Reichsanstalt Wien Verh., p. 136.
1893. *Halorites*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 11.
1896. *Halorites*. Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 578.
1904. *Halorites*. Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 145.
1905. *Halorites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 41.

Halorites americanus Hyatt

Plate XXIX, Figures 1, 2

1864. *Ammonites ramsaueri*. Gabb (not Quenstedt), California Geol. Survey, Paleontology, vol. 1, p. 27, pl. 3, figs. 21, 21a.
1892. *Halorites americanus*. Hyatt, Geol. Soc. America Bull., vol. 3, p. 398.
1905. *Halorites americanus*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 42, pl. 29, figs. 1, 2.
(Not 1846. *Ammonites ramsaueri*. Quenstedt in von Hauer, F., Die Cephalopoden des Salzkammergutes aus der Sammlung des Fürsten Metternich, p. 32, pl. 8, figs. 1, 2.)

Subglobose, involute, deeply embracing; whorls highly arched, with convex sides and rounded broad venters. Umbilicus closed. Surface ornamented with distinct ribs that start from the umbilicus and run without interruption straight across the center. On these ribs are closely arranged tubercles, which do not seem to be in regular spirals. Septa unknown.

Gabb compared this species to *Halorites ramsaueri*, but it is not a member of that group of Acatenati; its nearest affinities are with the group of *Halorites catenati*, although on account of the imperfect preservation of the California specimens no direct comparison with any European species may be made.

Genus HOMERITES Mojsisovics

1893. *Homerites*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 13.
1905. *Homerites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 42.

merites semiglobosus (Hauer)

Plate XXVIII, Figures 19–24; Plate LIX, Figures 21–26

1855. *Ammonites semiglobosus*. Hauer, Beiträge zur Kenntniss der Cephalopoden-Fauna der Hallstätter Schichten: K. Akad. Wiss. Wien Denkschr., vol. 9, p. 155, pl. 4, figs. 10–13.
1860. *Ammonites semiglobosus*. Hauer, Nachtrag zur Kenntniss der Cephalopoden-Fauna der Hallstätter Schichten: K. Akad. Wiss. Wien Sitzungsber., Band 41, p. 145, pl. 4, figs. 8–10.
1893. *Homerites semiglobosus*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 57, pl. 89, figs. 1–6.
1905. *Halorites* (*Homerites*) *semiglobosus*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 43, pl. 28, figs. 19–24.

Shell small, robust, involute, subglobose, deeply embracing, and deeply indented by the inner whorls. Whorl somewhat compressed laterally, highly arched, with convex sides and rather broad venter. The surface is ornamented with radial ribs that run nearly straight up the sides. In the middle of the venter there is a weak keel, bounded by a row of spines on each side. These spines are generally placed at the ends of the lateral ribs but may also occupy intermediate spaces. They begin with a large pair of hornlike protuberances at the beginning of the body chamber. The inner whorls are rounded, with ribs like those of *Halorites* running from the umbilicus across the low and arched venter, with no interruption. On the chambered part of the shell there are no spines and no keel, so that the appearance of the rough sculpture marks the mature stage of the body chamber. The septa are ceratitic; the external lobe is divided by a siphonal notch into two short simple branches. The first and second laterals are serrated. The saddles are all rounded and entire. Inner septa not seen. The specimens from California agree with those figured and described by Mojsisovics from the Alpine province.

Occurrence: *Homerites semiglobosus* was found in the Upper Triassic, 3 miles north of Kelly's ranch, on the west side of North Fork of Squaw Creek, 18 miles northeast of the Bully Hill mine, Shasta County, Calif. The horizon at which it was found is in the upper part of the Hosselkus limestone, above the *Tropites subbullatus* zone, in the *Juvavites* subzone. It was also found 2 miles northwest of Brock's ranch, on the divide between Squaw Creek and Pit River, at the same horizon as that at the first-named locality. In the Alpine province this species is associated with *Tropites subbullatus*, but in California it occurs somewhat later than that species.

Genus JOVITES Mojsisovics

1893. *Jovites*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 13.

1896. *Jovites.* Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 589.
1904. *Jovites.* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 146.
1906. *Jovites.* Diener, Fauna of the Tropites limestone of Byans: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 118.
1908. *Jovites.* Diener, Ladinic, Carnic, and Noric faunae of Spiti: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 3, p. 86.

Form globose, involute, with egressing and narrowing body whorls. Surface with rather fine radial ribs that alternate on the venter, at the threadlike central keel ridge. There are also fine longitudinal striae.

The type of *Jovites* is *Halorites dacus* Mojsisovics,[51] and nearly all species of the genus, whether in Europe, India, or America, agree pretty well with the type. It differs from *Halorites* in lacking the rows of knots and in possessing spiral striae and the rudimentary keel. Its septa are also reduced or arrested, as compared with those of *Halorites*.

Jovites is represented in America by one species and by the subgenus *Bacchites* Smith, with three species.

Jovites pacificus Smith, n. sp.

Plate XIII, Figures 11–13

Subspherical, involute, with strong, straight, commonly dichotomous ribs that alternate at the ventral threadlike keel ridge. The bifurcation of the ribs takes place one-third of the distance up the flanks. Body chamber long. Septa not observed on the specimens found thus far, but the form and ornamentation make the reference to *Jovites* certain.

Jovites pacificus has some resemblance to *Jovites spectabilis* Diener, of the Upper Triassic of India, but differs in its somewhat more globose form and coarser ribs.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, of Bear Cove, north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.; associated with *Tropites welleri*, *Discotropites lineatus*, *Juvavites subinterruptus*, *Metasibirites frechi*, *Arcestes pacificus*, *Proclydonautilus triadicus*, *Halobia superba*, and other species.

Subgenus BACCHITES Smith, n. subgen.

Type.—Juvavites bacchus Mojsisovics.[52]

Form involute, subspherical, closed umbilicus, whorls rounded. Surface almost smooth, with faint transverse ribs, vestigial constrictions, and faint threadlike keel ridge. Septa only slightly digitate. Body chamber long.

[51] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 49, pl. 84, figs. 1–8, 1893.

[52] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 143, pl. 86, fig. 7; pl. 87, figs. 14–21, 1893.

This group was placed by Mojsisovics under *Juvavites* but has much closer affinities with *Jovites*, to which it bears the same relation that *Gymnotropites* does to *Paratropites*. It is partly arrested and slightly reversionary, though not yet very far from the *Jovites* group.

Bacchites is represented in America, in the *Tropites subbullatus* zone, by three species—*Jovites bacchus* Mojsisovics, *Jovites pinguis* Smith, and *Jovites sphaericus* Smith. It also occurs in the Mediterranean region in the same horizon.

Jovites (Bacchites) bacchus (Mojsisovics)

Plate XIV, Figures 1–5

1893. *Juvavites (Anatomites) bacchus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 143, pl. 86, fig. 7; pl. 87, figs. 14–21.

Form subglobose, somewhat compressed laterally, with rounded flanks and venter; narrowly umbilicate surface nearly smooth but with faint spiral lines, weak traces of lateral ribs, vestiges of periodic constrictions, and a very weak threadlike keel ridge. Body chamber more than a revolution in length. Septa very weakly ammonitic, with ventral divided lobe, a large lateral lobe, a smaller second lateral lobe, and two small auxiliary lobes.

This species was assigned by Mojsisovics to his subgenus *Anatomites*, but the rudimentary keel, the reduced sculpture, and the partly arrested lobes and saddles show that the species can not belong to that group. It bears the same relation to *Jovites* as *Gymnotropites* does to *Paratropites* and is therefore taken as the type of the new subgenus *Bacchites*.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. The American specimens agree in all details with those from the Hallstatt limestone of the Tyrolian Alps, Austria.

Jovites (Bacchites) pinguis Smith, n. sp.

Plate XIV, Figures 10–12

Form large, involute, high whorled, laterally compressed, narrowly umbilicate, sides and venter rounded, without development of shoulders. Surface of shell nearly smooth but with a weak low keel ridge and a few weak folds. Body chamber long. Septa digitate but simple.

Jovites pinguis resembles *Jovites bacchus* but differs in its more robust form and more pronounced sculpture.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the zone of *Tropites subbullatus*, on Brock Mountain, 1 mile north of the trail from Squaw Creek to Pit River, Shasta County, Calif.

Jovites (Bacchites) sphaericus Smith, n. sp.

Plate XIV, Figures 6–9

Form globose, involute, narrowly umbilicate, deeply embracing. Surface with faint spiral lines, nearly obsolete ribs, weak traces of periodic constrictions, and rudimentary keel ridge. Body chamber long. Septa barely ammonitic.

Jovites sphaericus is closely related to *Jovites bacchus*, from which it differs in its more globose whorl. Together with that species it is assigned to the new subgenus *Bacchites*, which is a further degenerate form of *Jovites*.

Occurrence: Very rare in the Upper Triassic. Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus JUVAVITES Mojsisovics

1879. *Juvavites*. Mojsisovics, Vorläufige kurze Uebersicht der Ammoniten-Gattungen der Mediterranen und Juvavischen Trias: K.-k. geol. Reichsanstalt Wien Verh., p. 136.

1893. *Juvavites*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 74.

1896. *Juvavites*. Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 603.

1904. *Juvavites*. Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 182.

1905. *Juvavites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 45.

1906. *Juvavites*. Diener, Fauna of the *Tropites* limestone of Byans: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 3, p. 114.

1908. *Juvavites*. Diener, Ladinic, Carnic, and Noric faunae of Spiti: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 3, p. 114.

Type.—Ammonites ehrlichi Hauer.[53]

Involute, laterally compressed, with convex sides and rounded venter. Umbilicus narrow. Whorls deeply embracing and deeply indented by the inner whorls. Form subglobose but in some specimens flattened to subdiscoidal.

Surface ornamented with dichotomous ribs that extend over the rounded abdomen, although they may be interrupted along the siphonal area. Besides these ribs, constrictions generally occur at short intervals.

Septa ammonitic but not deeply digitate. The external lobe is divided by a siphonal saddle; there are two principal lateral lobes present and commonly two small auxiliaries.

Mojsisovics[54] divides the genus into five groups, forming three subgenera:

Juvavites s. s.:
- Continui.
- Interrupti.

Subgenus Anatomites:
- Scissi.
- Intermittentes.

Subgenus Dimorphites:
- Dimorphi.

In the Continui the ribs run uninterruptedly across the venter. In the Interrupti the ribs are interrupted in the center of the siphonal area and alternate on opposite sides. Both these groups appear to lack constrictions. In the Scissi and the Intermittentes the ribs are interrupted by a slight ventral furrow but do not alternate on opposite sides. In both groups there are periodic constrictions of the shell, accompanied by an elevation or rib parallel to the constriction. Neither the constrictions nor the ribs parallel to the constrictions are interrupted by the ventral furrow but run across the abdomen. In the Intermittentes the constrictions divide the sculpture into distinct fields, in which a bundling of the ribs is visible.

The Dimorphi are laterally compressed, with high whorls and narrow venters, and lack the constrictions. The ribs cross the venter and form abdominal shoulder angles.

The groups of Scissi and Intermittentes make up the subgenus *Anatomites* Mojsisovics, for which no type was cited but of which *Juvavites rotundus* Mojsisovics[55] is first described under the group Scissi.

Juvavites s. s., and *Anatomites* are both characteristic of the Upper Triassic Karnic and Noric horizons, in which they are found in the Alpine province, in the Himalayas, and in California.

Juvavites? carlottensis (Whiteaves)

Plate CVIII, Figure 1

1889. *Acrochordiceras? carlottense*. Whiteaves, The fossils of the Triassic rocks of British Columbia: Contr. Canadian Palaeontology, vol. 1, pt. 2, p. 141, pl. 19, fig. 1.

Shell involute, laterally compressed, deeply embracing, with narrow umbilicus and somewhat flattened venter. Surface ornamented with fine dividing ribs, which on the flanks break into elongate tubercles. Length of body chamber and septa unknown; hence the generic reference is doubtful. The species can not be assigned to *Acrochordiceras*, and only *Juvavites* is left for it.

Occurrence: Very rare in the Upper Triassic beds, probably in the *Pseudomonotis subcircularis* zone, of Houston Stewart Channel, Queen Charlotte Islands, British Columbia.

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[53] Hauer, F. von, Beiträge zur Kenntniss Cephalopoden-Fauna der Hallstätter Schichten: K. Akad. Wiss. Wien Denkschr., Band 9, p. 155, pl. 4, figs. 14–15 (not figs. 16–18), 1855. Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 79, pl. 89, fig. 11, 1893.

[54] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 74, 1893.

[55] Idem, p. 98, pl. 80, figs. 6–8; pl. 126, fig. 11; pl. 195, fig. 11.

Juvavites kellyi Smith, n. sp.

Plate XVIII, Figures 8–25

Form involute, strongly compressed laterally, with narrow rounded venter. Constrictions lacking at maturity. Ribs fine, branching low down on the flanks and often a second time on the abdominal shoulders. They alternate on the venter without median furrow. Septa rather strongly digitate. Body chamber long.

Juvavites kellyi is very closely related to *Juvavites subinterruptus* Mojsisovics, from which it differs only in the general lateral compression and the finer ribs. The two forms may be male and female of the same species, but the difference is constant, and there is no intergradation, in spite of the constant association of the two.

Named for Kelly's ranch, in recognition of the hospitality of the Kelly family to visiting geologists for a quarter of a century.

Occurrence: Very common in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Juvavites knowltoni Smith, n. sp.

Plate XV, Figures 16–19

Form large, robust, laterally compressed, completely involute, completely embracing, and deeply indented by the inner whorl. Surface with moderately coarse bifurcating ribs that alternate, without furrows, on the median line. Constrictions obsolete, so that there is no separation of the shell into areas of different ornamentation. Body chamber long. Septa deeply digitate, in keeping with the size.

Juvavites knowltoni is nearest to *Juvavites subinterruptus,* from which it differs in its larger size, coarser ribs, and broader whorl.

Named in honor of Dr. F. H. Knowlton.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif. It was also found in the *Juvavites* subzone of Admiralty Island, Alaska, at locality 10180, a point between Chapin and Herring bays; also at locality 8848, a point at the north entrance of Herring Bay.

Juvavites subinterruptus Mojsisovics

Plate XVIII, Figures 1–7; Plate XXX, Figures 1, 2

1893. *Juvavites subinterruptus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, pl. 89, fig. 13; pl. 90, figs. 2, 3; pl. 126, fig. 16.

1905. *Juvavites subinterruptus.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 46, pl. 30, figs. 1, 2.

Form robust, involute, laterally compressed. Whorl high with flattened convex sides, sloping abdominal shoulders, and highly arched venter. Deeply embracing and deeply indented by the inner whorls. Umbilicus narrow, almost closed, showing none of the interior volutions. The height of the whorl is somewhat more than half the total diameter, and it is indented to half its height by the inner volution. The width of the whorl is slightly less than the height, and the point of greatest width falls just above the umbilical shoulders. The surface is ornamented with radial dichotomous ribs that branch at a point about one-third of the height of the whorl and often a second time on the abdominal shoulders. These ribs are interrupted on the venter and alternate on the two sides. There is no ventral furrow, and no constrictions have been seen. The septa are ammonitic, deeply digitate. The external lobe is divided by a siphonal saddle into two rather short branches. The first lateral lobe is long and wide, followed by a similar but smaller second lateral. There are also three auxiliaries. The antisiphonal lobe is long and narrow, flanked by five internal laterals on each side, growing smaller and simpler toward the umbilicus.

The California specimens agree exactly with those described by Mojsisovics from the Alpine province. This species differs from *Juvavites interruptus* Mojsisovics in its greater thickness, more complex septa, and greater curvature of the ribs on the abdominal shoulders.

Occurrence: *Juvavites subinterruptus* was first found in the Alps in the Upper Triassic middle Karnic stage, below the zone of *Tropites subbullatus.* It was found by the writer in the Upper Triassic Hosselkus limestone, in the upper or *Juvavites* subzone of the zone of *Tropites subbullatus,* near Terrup Chetta (Cottonwood Flat), on Squaw Creek, 9 miles northeast of the Bully Hill mine and 6 miles above Madison's ranch, also on Brock Mountain about 3 miles east of Madison's ranch on the divide between Squaw Creek and Pit River, all in Shasta County, Calif. The figured specimens were collected near Terrup Chetta, on the divide between Squaw Creek and Pit River, Shasta County, Calif. The species was also found in the *Juvavites* subzone of Admiralty Island, Alaska, at locality 8848, a point at the north entrance of Herring Bay.

Subgenus ANATOMITES Mojsisovics

1893. *Anatomites.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 74.

1896. *Anatomites.* Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 31.

1904. *Anatomites.* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 186.

1905. *Anatomites.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 47.

1906. *Anatomites.* Diener, Fauna of the *Tropites* limestone of Byans: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 128.

Juvavites (Anatomites) adalberti Mojsisovics

Plate XVIII, Figures 26–32

1893. *Juvavites (Anatomites) adalberti.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 115, pl. 93, figs. 12–14.

Form laterally compressed, with flattened sides, rather distinct shoulders, and low, narrowly rounded venter. Surface with four or five constrictions and numerous bifurcating ribs, all swinging obliquely forward in a broad curve. The ribs fork first low down on the flanks and a second time at the shoulder. Body chamber long. Septa moderately digitate, like all the group.

Juvavites adalberti differs from *Juvavites subinterruptus* in the obliquity of the ribs and in the possession of constriction. It belongs to the group of *Anatomites*, but there is no separation into areas of different ornamentation.

Occurrence: Not uncommon in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Juvavites (Anatomites) brockensis Smith, n. sp.

Plate XVI, Figures 15–24

Form robust, involute, somewhat compressed laterally, with convex sides and rounded venter. Three or four periodic constrictions divide the volution into areas of distinct sculpture, which begins anew after each constriction and dies out rapidly. The rather coarse bifurcating ribs alternate at the median interruption without a furrow. The body chamber is long. Septa moderately digitate.

Juvavites brockensis falls in the series between *Juvavites subintermittens* and *Juvavites damesi* Mojsisovics; it is more robust than *J. subintermittens* and more compressed than *J. damesi*, and it grows much larger than either. It also is very closely related to *Juvavites fischeri* Mojsisovics, from which it differs in the more distinct alternation of the ribs on the venter and the stronger division of the sculpture into areas between which there are nearly smooth spaces.

In age the ribs are nearly obsolete, and only the constrictions remain distinct; the shell then resembles *Gonionotites*, except that there is no change in the shape of the whorl. The young stages resemble the compressed group of *Gastrioceras*.

Occurrence: Very common in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was also found in the *Juvavites* subzone of Admiralty Island, Alaska, at locality 10180, a point between Chapin and Herring bays.

Juvavites (Anatomites) damesi Mojsisovics

Plate XIX, Figures 23–29

1893. *Juvavites (Anatomites) damesi.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 118, pl. 93, figs. 19, 22.

Form robust, involute, subglobose, with somewhat compressed sides, indistinct shoulders and broadly rounded venter. Surface sculpture divided by constrictions into four areas to a revolution, in which the ribs become coarser toward the constriction, then beyond it for a little distance are weak, becoming gradually stronger until another climax is reached. Body chamber long. Septa only moderately digitate.

Juvavites damesi is very closely related to *Juvavites brockensis*, from which it differs in being somewhat more robust and in having somewhat coarser sculpture. The details of septation and ornamentation are on the same general plan. It resembles *Juvavites edgari* Mojsisvics but differs in its fewer and coarser ribs, which alternate on the venter without the furrow of *Juvavites edgari*, and with a distinct grouping of sculpture into areas, which is lacking on *Juvavites edgari*.

Occurrence: Rather common in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on the north end and west side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was described from the same horizon in the Hallstatt limestone of the Tyrolian Alps, Austria.

Juvavites (Anatomites) edgari Mojsisovics

Plate XVI, Figures 11–14

1893. *Juvavites (Anatomites) edgari.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 125, pl. 92, figs. 13, 14.

Form very robust, subglobose, with even rounding of flanks and venter, without shoulders. Surface with numerous rather coarse dichotomous ribs alternating at the median line with a small furrow. There are about four obscure constrictions to a revolution, but there is no division by these into areas of differentiated sculpture.

Juvavites edgari resembles *Juvavites damesi* but differs in its more globose form and in not having the surface sculpture differentiated into areas. It differs from *Juvavites strongi* in being less globose and in having coarser ribs alternating at a median furrow.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end and west side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Juvavites (Anatomites) externiplicatus Mojsisovics

Plate XIX, Figures 1–5

1893. *Juvavites (Anatomites) externiplicatus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 137, pl. 93, figs. 1, 2.

Shell small, very much compressed laterally; involute; venter narrow with abruptly rounded ventral shoulders. Sculpture almost obsolete on the sides, rather distinct on the shoulders and venter. The ribs are very fine, bundled in four distinct areas, between which there are barren spaces, and marked by faint constrictions. The ribs alternate on opposite sides of the ventral band and bend sharply forward at the shoulders. The body chamber is long. Septa distinctly ammonitic but not so digitate as those on *Juvavites subinterruptus* and *Juvavites kellyi.*

This species resembles *Juvavites konnincki,* from which it differs in its greater compression and stronger sculpture.

The height of the whorl is half the diameter of the shell, and the width is slightly more than half the height.

Occurrence: Rather rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif. It was first found at the same horizon in the Hallstatt limestone of the Tyrolian Alps, Austria. It was also found in the *Juvavites* subzone on Admiralty Island, Alaska, at locality 10180, a point between Herring and Chapin bays.

Juvavites (Anatomites) intermittens Mojsisovics

Plate XIX, Figures 6–13

1893. *Juvavites (Anatomites) intermittens.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 112, pl. 93, figs. 6–10.

Form entirely involute, rather strongly compressed laterally, with narrowly rounded venter, without distinct shoulders. Sculpture broken up into four areas to a revolution, interrupted by constrictions at which the ribs take a new start, leaving nearly obsolete areas between. The ribs are fine, bifurcate on the sides, and alternate on the median line without furrow. The body chamber is long. Septa moderately digitate, with divided ventral lobe, two laterals, and two auxiliaries.

Juvavites intermittens is closely related to *Juvavites subintermittens,* from which it differs in greater lateral compression, finer ribs, and less distinct division of the sculpture into areas.

Occurrence: Rather common in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end and west side of Brock Mountain; also in Bear Cove, on the east side of the same mountain, between Squaw Creek and Pit River, Shasta County, Calif. It is associated with *Tropites welleri, Discotropites lineatus, Juvavites subinterruptus, Proclydonautilus triadicus, Halobia superba,* and other species.

Juvavites (Anatomites) konnincki Mojsisovics

Plate XIX, Figures 14–22

1893. *Juvavites (Anatomites) konnincki.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 123, pl. 91, fig. 11; pl. 92, fig. 2.

Form small, involute, laterally compressed, completely embracing, with flattened sides, and narrowly rounded umbilicus. Sculpture nearly obsolete, showing only as faint ribs, divided into ill-defined areas. Septa of the type common in *Juvavites.*

Juvavites konnincki is very like *Juvavites obliterans* Mojsisovics in the obsolescence of sculpture but is thicker. It differs from *Juvavites externiplicatus* chiefly in the more complete obsolescence of the ribs. It also resembles *Juvavites toulai* Mojsisovics but differs in being thicker and in having the fine ribs much closer together and not separated into distinct areas.

Occurrence: Rather common in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, in Bear Cove, at the north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Juvavites (Anatomites) mendenhalli Smith, n. sp.

Plate XV, Figures 9–15

Form large, robust, involute, with convex sides, compressed laterally, and arched venter without distinct shoulders. Constrictions only faintly indicated at maturity, strong in youth. Bifurcating ribs very fine and not distinctly separated into areas, alternating on the venter, without furrow. Sculpture very uniformly distributed over the surface. Body chamber long. Septa moderately digitate.

Juvavites mendenhalli resembles *Juvavites crasseplicatus* Mojsisovics but differs in its more compressed whorl. It has no close resemblance to any other described species. In youth the ribs and constrictions are stronger, as in all species of *Juvavites.*

Named in honor of W. C. Mendenhall.

Occurrence: Rather rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at Bear Cove, at the north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Juvavites (Anatomites) obsoletus Smith, n. sp.

Plate XV, Figures 1–8

Form large, robust, completely involute, with flattened sides, abruptly rounded ventral shoulders, and broad, slightly convex venter. Four or five strong constrictions to a revolution, bending forward in a broad curve on the venter. Ribs nearly obsolete at maturity. In youth the ribs are developed, in the manner common in *Juvavites*, though they are much weaker than on most species. Body chamber long.

Juvavites obsoletus resembles *Juvavites mendenhalli* but differs in the strong constrictions, weaker ribs, and pronounced shoulders.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, in Bear Cove, at the north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Juvavites (Anatomites) septentrionalis Smith, n. sp.

Plate XIX, Figures 33–34

Form robust, somewhat compressed laterally, with flattened sides, and rounded venter. Whorls involute, narrowly umbilicate, deeply embracing, and deeply indented by the inner volution. Surface ornamented with coarse ribs that bifurcate in the middle of the flanks and cross the venter without interruption or alternation. There is also an intercalary rib between every second pair of ribs. Septa unknown.

Juvavites septentrionalis is very closely related to *Juvavites gelonis* Gemmellaro[56] but differs from the Mediterranean species in greater lateral compression and in having the periodic constrictions almost obsolete.

Occurrence: Very rare in the Nizina district, Nicolai Creek, Alaska, locality 6312, in the *Juvavites* subzone of the zone of *Tropites subbullatus*.

Juvavites (Anatomites) shastensis Smith, n. sp.

Plate XIX, Figures 30–32

Shell of medium size, robust, oval in cross section. Whorls broad, high helmet-shaped, deeply embracing, and deeply indented by the inner whorls. The height of the whorl is half the diameter of the shell and the breadth slightly greater than the height. The outer whorl is impressed to half its height by the inner whorl. The umbilicus is narrow, being one-seventh of the total diameter of the shell. The surface is ornamented with fine ribs that bifurcate low down on the flanks, and cross the venter in a broad forward-extending sinus without interruption or alternation. Traces of constrictions are seen on the shell, but they are almost obsolete. Septa moderately digitate, as is common in *Juvavites*.

Juvavites shastensis is very closely related to *Juvavites alterniplicatus* Hauer, as figured by Mojsisovics,[57] but differs from the European species in its slightly coarser ribs in the mature stage. This difference would hardly be significant if the two species occurred in the same region.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the *Juvavites* subzone of the zone of *Tropites subbullatus*, 1 mile north of the quarry, on the west side of Brock Mountain, Shasta County, Calif.

Juvavites (Anatomites) strongi Smith, n. sp.

Plate XVI, Figures 1–10

Form almost spherical, involute, whorls curving from umbilicus to venter without shoulders, completely embracing, and very deeply impressed by the inner whorl. Surface with distinct, numerous, rather coarse bifurcating ribs, not separated into areas of different sculpture; about five indistinct constrictions to a revolution. The ribs usually alternate at the median line without furrow, but they sometimes cross the venter without interruption or alternation. Body chamber long. Septa moderately digitate, though not more so than in typical species of *Juvavites*.

Juvavites strongi has some resemblance to *Juvavites edgari* in shape but differs in its more robust form, finer ribs, and less distinct constrictions. Both species are intermediate between *Juvavites* s. s. and *Anatomites*. In the opinion of the writer there should be no such subgeneric distinction.

Named in honor of A. M. Strong, who has assisted the writer in collecting Triassic fossils in many parts of the West.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end and west side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Juvavites (Anatomites) subintermittens Hyatt and Smith

Plate XVI, Figures 25–39; Plate XXX, Figures 3–5

1905. *Juvavites (Anatomites) subintermittens*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 47, pl. 30, figs. 3–5.

Involute, laterally compressed, deeply embracing, and deeply indented by the inner whorls. Sides somewhat flattened, venter rounded and narrow, without prominent abdominal shoulders. Umbilicus narrow, exposing none of the interior volutions. Surface ornamented with radial dichotomous ribs which divide about midway up the flanks and again at the abdominal shoulders, curving gently forward. These

[56] Gemmellaro, G. G., I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 213, pl. 17, figs. 3, 4, 1904.

[57] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 138, pl. 94, figs. 1–5, 1893.

ribs are interrupted in the middle of the venter, and alternate on the two sides, but there is no furrow. There are also three or four deep constrictions to each revolution, dividing the sculpture into well-marked periods. The septa are ammonitic, divided into a number of lobes and saddles.

Juvavites subintermittens is nearest of kin to *Juvavites intermittens* Mojsisovics[58] but differs from that species in the greater lateral compression of the whorl and the coarser ribs.

Occurrence: *Juvavites subintermittens* was found by the writer in the Upper Triassic Hosselkus limestone, in the upper part (*Juvavites* subzone) of the *Tropites subbullatus* zone, near Terrup Chetta, on Squaw Creek, about 9 miles northeast of the Bully Hill mine, and 6 miles northeast of Madison's ranch, Shasta County, Calif. It was also found by the writer on the west side of the North Fork of Squaw Creek, Shasta County, 3 miles north of Kelly's ranch, and 15 miles northeast of Madison's ranch. The figured specimens were collected on the divide between Squaw Creek and Pit River, near Terrup Chetta, Shasta County, Calif.

Genus GONIONOTITES Gemmellaro

1904. *Gonionotites*. Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 124.
1908. *Gonionotites*. Diener, Upper Triassic and Liassic faunae of the exotic blocks of Malla Johar in the Bhot Mahals of Kumaon: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 1, No. 1, p. 47.
1920. *Gonionotites*. Diener, Neue Tropitoidea aus den Hallstätter Kalken des Salzkammergutes: Akad. Wiss. Wien Denkschr., Band 97, p. 490.
1923. *Gonionotites*. Diener, Ammonoidea Trachyostraca aus der mittleren und oberen Trias von Timor, in 2e Nederlandsche Timor-Expeditie, 1916, onder leiding van Dr. H. G. Jonker: Jaarboek van het Mijnwezen in Ned. O. Indie, 1920, Verh., pt. 4, p. 145.

Type.—Gonionotites italicus.[59]

Involute, laterally compressed, high-whorled, completely embracing and deeply indented. Greatest thickness at the umbilical shoulder. Umbilicus entirely closed. On the body chamber at maturity the whorl widens abruptly, giving a broad and flattened venter. Surface at maturity nearly smooth, with faint vestiges of ribs and ventral ridge; in youth with stronger sculpture, somewhat like *Juvavites*. Septa very weakly ammonitic, evidently degenerate and arrested. Body chamber more than a revolution long.

Gonionotites is evidently a somewhat arrested form, descendant from some group of *Juvavites*, as indicated by the form and by the sculpture in youth. The degeneration is indicated by the lack of sculpture and the simplification of the septa at maturity.

[58] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 112, pl. 93, figs. 6–10, 1893.

[59] Gemmellaro, G. G., I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 158, pl. 5, figs. 6–7; pl. 9, fig. 7; pl. 21, figs. 4–6; pl. 30, fig. 8, 1904.

Gonionotites is abundant in the Upper Triassic of Sicily and India. In the California province it is abundant in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone.

Gonionotites hyatti Smith, n. sp.

Plate XIII, Figures 1–10

Form entirely involute, laterally compressed, entirely embracing and deeply indented by the inner whorls. Flanks sloping steeply from the closed umbilicus to the indistinct ventral shoulders. Venter roof-shaped, with low angle. At full maturity the venter flattens out and the angle disappears. Surface at maturity nearly smooth but with vestiges of the ventral ridge and faint traces of the ribs on the ventral shoulders. Body chamber more than a revolution in length. Septa weakly ammonitic, with divided ventral lobe, large broad lateral, small second lateral, and still smaller auxiliary lobe, all with weak crenulations of the septal line and no digitation. The height of the last whorl is half the diameter of the shell, and the width is half the height.

In youth the stronger sculpture indicates derivation from *Juvavites*, from which it is a degenerate by partial arrest of development in sculpture and septation. It is rather closely related to *Gonionotites italicus* Gemmellaro, from which it is distinguished by its less compressed whorl and simpler septa.

Named in memory of Prof. Alpheus Hyatt.

Occurrence: Rather common in the Upper Triassic Hosselkus limestone, in the *Tropites subbullatus* zone, upper horizon (*Juvavites* subzone), in Bear Cove at the east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Gonionotites northi Smith, n. sp.

Plate XIV, Figures 13–18

Form robust, completely involute, somewhat compressed laterally. Whorls sloping upward to the distinct ventral shoulder; venter somewhat flattened, and with vestige of the rudimentary keel ridge. Surface with very fine radial ribs, almost obsolete but still showing alternation at the median line. Body chamber at maturity narrowing and becoming more compressed than in youth.

Gonionotites northi is more robust and has more distinct sculpture than *Gonionotites hyatti*. In form it has considerable resemblance to *Juvavites obsoletus* but differs in lacking the periodic constrictions.

Named in honor of Wheeler North, who assisted in collecting this fauna.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, of Bear Cove, north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus SAGENITES Mojsisovics

1879. *Sagenites*. Mojsisovics, Vorläufige kurze Uebersicht der Ammoniten-Gattungen der Mediterranen und Juvavischen Trias: K.-k. geol. Reichsanstalt Wien Verh., p. 141.
1893. *Sagenites*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 155.
1896. *Sagenites*. Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 608.
1904. *Sagenites*. Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 139.
1904. *Sagenites*. Smith, The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., vol. 1, p. 399.
1905. *Sagenites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 37.
1908. *Sagenites*. Diener, Ladinic, Carnic, and Noric faunae of Spiti: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 3, p. 82.

Sagenites dickersoni Smith, n. sp.

Plate XIV, Figures 19, 20

Form robust, narrowly umbilicate, with rounded flanks and venter. Surface with weak umbilical knots and ribs running from them in pairs across the venter without interruption, sometimes alternating on the opposite sides. Rather strong spiral lines on the outer shell. The width of the last whorl is 1½ times the height, and more than half the diameter of the shell.

The form has some suggestion of *Juvavites*, but the width of the umbilicus and the spiral lines prevent assignment to that genus.

Named in honor of Dr. R. E. Dickerson, of the California Academy of Sciences.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end and west side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Subgenus TRACHYSAGENITES Mojsisovics

1893. *Trachysagenites*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 156.
1905. *Trachysagenites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 38.

Sagenites (Trachysagenites) erinaceus (Dittmar)

Plate XII, Figures 1–8

1866. *Ammonites erinaceus*. Dittmar, Zur Fauna der Hallstätter Kalke, in Benecke, E. W., Geognostische-palaeontologische Beiträge, Band 1, p. 380, pl. 17, figs. 15–17.
1893. *Sagenites* (*Trachysagenites*) *erinaceus*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 179, pl. 100, figs. 2–4.

Form robust, involute, with rounded whorls; umbilicus very narrow and deep, with steep inner whorls. Curvature of flanks and venter uniform, without shoulders. Surface with fine simple ribs, a few of them dichotomous, running straight up the sides and across the venter, without interruption or furrow. There are 12 rows of fine blunt spines arranged equidistantly on the ribs. Septa ammonitic, rather deeply digitate, with divided ventral lobe, large first lateral, small second lateral, and still smaller auxiliary. Body chamber more than a revolution in length.

Sagenites erinaceus differs from *Sagenites herbichi* in its more robust shape, coarser ribs, and fewer rows of spines. It is also very similar to *Sagenites galeatus* Diener, from which it is distinguished by its more depressed whorl and fewer rows of knots.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, of Bear Cove, north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Sagenites (Trachysagenites) herbichi Mojsisovics

Plate XXVI, Figures 1, 2; Plate XXVII, Figures 1–4; Plate XXVIII, Figures 1–18

1893. *Sagenites* (*Trachysagenites*) *herbichi*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 180, pl. 101, fig. 3; pl. 102, figs. 1–6.
1904. *Sagenites* (*Trachysagenites*) *herbichi*. Smith, The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., vol. 1, p. 399, pl. 46, figs. 7, 8; pl. 47, figs. 5, 6.
1905. *Sagenites* (*Trachysagenites*) *herbichi*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 39, pl. 26, figs. 1, 2; pl. 27, figs. 1–4; pl. 28, figs. 1–18.
1908. *Sagenites* (*Trachysagenites*) *herbichi*. Diener, Ladinic, Carnic, and Noric faunae of Spiti: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 3, p. 82, pl. 15, fig. 2.
1920. *Sagenites herbichi*. Diener, Neue Tropitoidea aus den Hallstätter Kalken des Salzkammergutes: Akad. Wiss. Wien Denkschr., Band 97, p. 500.
1920. *Sagenites smithii*. Diener, Neue Tropitoidea aus den Hallstätter Kalken des Salzkammergutes: Akad. Wiss. Wien Denkschr., Band 97, p. 500.

Form subglobose, somewhat compressed laterally, robust, involute. Whorl highly arched, helmet-shaped, deeply embracing, increasing rapidly in height, and not deeply indented by the inner volutions. Sides convex, curving to the broad venter without any marked abdominal shoulders. Umbilical shoulders abruptly rounded with the inner walls steep. Umbilicus deep and narrow but exposing the umbilical shoulders of the inner whorls and becoming wide with age. Body chamber long, apparently comprising an entire revolution.

Surface ornamented with numerous closely set small radial ribs that run nearly straight from the umbilicus across the venter, usually dividing on the flanks. On these ribs there are spiral rows of short spines or knots, ranging from 9 to 13 rows on each half of the shell, showing only on the outer shell and not on the cast. This sculpture is the same over all parts of the whorl, and there is no interruption on the venter nor is there any ventral furrow. This character easily distinguishes *Trachysagenites* from *Trachyceras*, with which it is associated, and the spiral arrangement of the spines separates it from *Halorites*.

The septa are ammonitic and more deeply digitate than is common in the Tropitoidea. The external lobe is divided by a shallow siphonal saddle into two short narrow branches. The first lateral lobe is long and moderately broad and is divided into two branches at the end. The second lateral lobe is shorter and narrower but also digitate. On the umbilical shoulder is a distinctly individualized auxiliary lobe, not unlike the second lateral but smaller. There are three lateral saddles, all narrow but long and deeply digitate. The antisiphonal lobe is long and narrow and is flanked by two similar internal laterals on each side. This species grew to a very large size. The specimen figured in Plate XXVI, Figures 1 and 2, as shown below, has a diameter of 110 millimeters and is broken at the very beginning of the body chamber, so another revolution must have been added to its size, which would make the total diameter of the completed whorl more than 200 millimeters.

Dimensions and proportions of a chambered specimen of Sagenites herbichi

	Dimensions (millimeters)	Ratio
Diameter	110	1.00
Height of last whorl	57	.51
Height of last whorl from preceding	46	.41
Width of last whorl	57	.10
Involution	11	.10
Width of umbilicus	16	.14

The greatest width is at about one-third the height of the whorl. The height and breadth of the whorl are equal, and slightly more than half the total diameter. The outer volution conceals three-fourths of the inner and is indented to less than one-fifth of the height by it. These dimensions are remarkably constant from adolescence to maturity, as the measurements of a small specimen show:

Dimensions and proportions of a small specimen of Sagenites herbichi

	Dimensions (millimeters)	Ratio
Diameter	30	1.00
Height of last whorl	16	.53
Height of last whorl from preceding	12	.40
Width of last whorl	19	.63
Involution	4	.13
Width of umbilicus	3.5	.11

In the adolescent shell the whorl is broader, the involution slightly less, and the umbilicus somewhat narrower.

The septa shown in Plate XXVII, Figure 2, were taken from a specimen at the diameter of 80 millimeters and are of course much more complex than those figured by Mojsisovics,[60] which were taken from a specimen at the diameter of 35 millimeters. At this size the septa of the specimens from California are like those shown on specimens from the Alps.

The young of *Sagenites herbichi* are subglobose and very like the adults in form, except that the whorl is proportionately broader and the umbilicus wider. At this larval stage the young are like the Carboniferous Glyphioceratidæ in form and septa and probably correspond to *Gastrioceras*.

The lateral ribs appear at a diameter of 4 millimeters and the spiral rows of knots at a diameter of 5 millimeters. The septa pass from the goniatite to the ammonite stage of development at a diameter of 2.8 millimeters. From there on little change occurs in the characters, except the increasing lateral compression and complexity of septation.

Sagenites herbichi is very like *Sagenites erinaceus* Dittmar, as figured by Mojsisovics,[61] but differs from that species in its greater lateral compression, more numerous spiral rows of knots, and much more numerous and finer radial ribs; also in *Sagenites erinaceus* the lobes are shorter and broader, the second lateral is small and scarcely divided, and the auxiliary is represented only by a small notch on the umbilical shoulder.

Occurrence: *Sagenites herbichi* Mojsisovics is common in the Upper Triassic of the Alps, in the zone of *Tropites subbullatus*. In California it is abundant at this same horizon in the Hosselkus limestone, in both subzones, *Trachyceras* and *Juvavites*, where it is associated with *Sagenites erinaceus*, *Tropites subbullatus*, *Discotropites sandlingensis*, and *Halobia superba*, and a number of other species characteristic of the Alpine province.

The figured specimens were collected on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch and 6 miles northeast of the Bully Hill mine, Shasta County, Calif.

Diener [62] proposes to segregate the specimen illustrated in Plate XXVII, Figures 1 and 2, as *Sagenites smithii*, because of the enlargement of the external saddle. However, this form intergrades perfectly with numerous other typical specimens and is an unusually large and probably old individual. All other figures published have been taken from much smaller specimens.

[60] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, pl. 101, fig. 3, 1893.

[61] Idem, pl. 100, figs. 2-4.

[62] Diener, C., Neue Tropitoidea aus den Hallstätter Kalken des Salzkammergutes: Akad. Wiss. Wien Denkschr., Band 97, p. 500, 1920.

Sagenites (Trachysagenites) shastensis Smith, n. sp.

Plate XII, Figures 9–11

Form robust, somewhat compressed laterally, with slightly flattened sides and narrowly arched venter. Umbilicus narrow, with walls nearly vertical. Whorls increasing rapidly in height, deeply embracing, and only moderately indented by the inner whorl. Surface ornamented with about 13 spiral rows of short blunt spines on each side of the shell, crossed by fine radial dichotomous ribs. Septa unknown, as the shell is preserved on the entire specimen which serves as the type.

Sagenites shastensis is closely related to *Sagenites herbichi*, with which it is associated in California, but differs from that well-known species in its much greater compression, narrower venter, and finer sculpture. It also differs from *Sagenites erinaceus* in the same characters and to a greater degree, as *S. erinaceus* is much thicker and coarser, in shape as well as in sculpture.

Occurrence: Very rare (one specimen) in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, lower or *Trachyceras* subzone, of Brock Mountain, on the divide between Squaw Creek and Pit River, about 3 miles east of Madison's ranch, Shasta County, Calif.; associated with *Tropites subbullatus, Trachyceras lecontei, Sagenites herbichi, Halobia superba*, and other species.

Genus METASIBIRITES Mojsisovics

1893. *Sibirites*. Mojsisovics (part), Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 327.

1896. *Metasibirites*. Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 616.

1905. *Tardeceras*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 44.

1905. *Tropiceltites*. Hyatt and Smith (part), The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 58.

1906. *Metasibirites*. Diener, Fauna of the Tropites limestone of Byans: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 135.

1914. *Metasibirites*. Smith, Acceleration of development in fossil Cephalopoda: Leland Stanford Junior Univ. Pub., univ. ser., p. 14.

Dwarf forms, robust, thick set, with whorls usually broad and depressed, but somewhat compressed laterally in some species; umbilicus usually wide and deep, but narrow in the compressed forms. Surface with umbilical knots and fine lateral ribs often becoming nearly obsolete on the venter, and a weak rudimentary or vestigial keel without bordering furrows. Septa very simple, with divided goniatitic ventral lobe, weakly serrated lateral, and simple auxiliary. Body chamber considerably more than a revolution in length.

Mojsisovics [63] first described this group as belonging to *Sibirites* Mojsisovics, and later he named the subgenus *Metasibirites* to include them. They certainly do not belong to the group of *Sibirites pretiosus*, the type of the genus, and are not even descendants of that group. Krafft [64] says that *Sibirites* has no kinship with *Metasibirites*. Arthaber [65] says that *Sibirites* belongs to the Ceratitoidea, whereas *Metasibirites* is placed under the Gastrioceratea.

Hyatt and Smith [66] named the genus *Tardeceras* to include the compressed forms of this group. But this genus can not stand, for the compressed species intergrade completely with those that are depressed and evolute. Mojsisovics [67] described "*Tropites*" *parvulus*, with entire saddles and weakly serrated lateral lobes. This species belongs to *Metasibirites*. Gemmellaro [68] described "*Styrites*" *tropitoides*, with umbilical knots, persistent keel, semilunular whorl, and serrated first lateral lobe. This species should probably be placed under *Metasibirites*. It is stretching *Styrites* entirely too much to include it. He also described *Tropites aloysii*, septa unknown, but with the form of *Metasibirites*.[69]

Mojsisovics [70] figured the following species, which were afterward described as typical *Metasibirites*: *M. spinescens*, the type of the genus; *M. protractus* Mojsisovics; *M. uhligi* Mojsisovics; *M. tietzei* Mojsisovics; *M. annulosus* Mojsisovics; *M. crassus* Mojsisovics, all from the lower Noric beds of the Hallstatt region in Austria. The septa of *Metasibirites spinescens* alone were known to him and are said to be entirely goniatitic, though Mojsisovics stated that the specimen had suffered from etching, and the delicate serration might have disappeared under the operation. All the American species of this genus, represented by hundreds of individuals, show the serration on the lateral lobe when the shell is removed carefully, and the delicate serration usually disappears on etching with acid.

Metasibirites is a dwarf and arrested in development. It is reversionary to the Paleozoic ancestral type—in form and sculpture to *Gastrioceras* or *Pericyclus* of the Carboniferous, in septa to some primitive genus of the Lower Triassic. In some respects it resembles *Acrochordiceras* Hyatt but differs in the possession of the rudimentary or vestigial keel. This same character is possessed by the contemporary

[63] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 327, 1893.

[64] Krafft, A. von, Lower Triassic Cephalopoda from Spiti, Malla Johar, and Byans: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 6, No. 1, pp. 124–130, 1909.

[65] Arthaber, G. von, Die Trias von Albanien: Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, Band 24, Heft 3, p. 254, 1911.

[66] Hyatt, Alpheus, and Smith, J. P., The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 44, 1905.

[67] Mojsisovics, E. von, op. cit., p. 255.

[68] Gemmellaro, G. G., I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 18, 1904.

[69] Idem, p. 39.

[70] Mojsisovics, E. von, op. cit., pl. 124.

Halorites Mojsisovics and may not be hereditary from keeled ancestors but is rather an old-age character of degenerate forms, for all of the later Tropitoidea tend to develop this keel.

Like all arrested forms this group is intensely variable, and it is nearly impossible to draw specific lines in it. The enormous material at hand from America could easily be sorted into 20 species instead of the 10 species that have been described. Some specimens showed complete obsolescence of the keel, others of the ventral ribs, and still others of the serrations on the lateral lobe, though they were connected by complete intergradations with the typical forms.

The following species are recognized in the American Upper Triassic: *Metasibirites parvus* Hyatt and Smith, *M. pusillus* Smith, *M. pygmaeus* Smith. *M. frechi* Hyatt and Smith, *M. gracilis* Smith, *M. mojsvarensis* Smith, *M. coei* Smith, *M. shastensis* Smith, *M. brockensis* Smith, and *M. modestus* Smith—all with rudimentary keels, and all with serrated lateral lobe, though the forms range from those that are broad and depressed to those that have laterally compressed and involute whorls.

Occurrence: Very common in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. The genus is rare in the Upper Triassic of the Alps and of the Himalayas in India. In the *Juvavites* subzone of Brock Mountain one could easily collect in half an hour more specimens than are known elsewhere in all the world.

Metasibirites brockensis Smith, n. sp.

Plate LX, Figures 47–53

Form small, broad-shouldered, depressed, evolute, widely umbilicate. Surface with coarse umbilical spines, lateral ribs that cross the venter. In youth, there are occasional constrictions. There are faint traces of the ventral keel. Septa have faint serrations on the first lateral lobe; the others are simple.

In youth this species is exactly like *Gastrioceras* with strong umbilical knots and ribs, flattened venter, occasional constrictions, and goniatitic lobes. In some respects it has reverted to *Pericyclus* in the surface ornamentation. Its sculpture and septation, however, suggest immediate derivation from *Acrochordiceras* or some other member of the Haloritidae and reversion by arrest of development toward *Gastrioceras*. *Metasibirites brockensis* is closely related to *Metasibirites spinescens* Hauer but differs in its broader whorls, coarser ribs, and fewer spines. Certainly neither species has any near kinship with *Sibirites pretiosus* Eichwald, and they are not even reversionary toward it. The Lower Triassic forms have no keel, either vestigial or rudimentary.

Occurrence: Rather rare in the Upper Triassic Hosselkus limestone in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone) at the north end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Metasibirites coei Smith, n. sp.

Plate LX, Figures 1–16

Form robust, moderately involute, whorl depressed, with arched venter and very abrupt umbilical walls. Surface with umbilical folds from which single or dichotomous ribs run across the venter. Rudimentary threadlike keel strongly developed. Body chamber low. Septa have strong serrations on the first lateral lobe; the others are goniatitic.

Metasibirites coei resembles *Metasibirites frechi* Hyatt and Smith but is much more robust and has coarser sculpture; it is more involute and has a more highly arched whorl and coarser ventral ribs than *Metasibirites mojsvarensis*. It has no close affinity with any of the European species of the genus.

Named for H. S. Coe, who assisted in collecting this fauna.

Occurrence: Very common in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), at the south end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Metasibirites frechi (Hyatt and Smith)

Plate LX, Figures 17–30; Plate LXXX, Figures 1–11

1905. *Tropiceltites frechi*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 59, pl. 80, figs. 1–11.

Moderately involute, with inflated whorls, highly arched, and somewhat compressed laterally, becoming relatively narrower with age. Abdominal shoulders rounded, venter broad, provided with a distinct low keel at maturity. Umbilicus rather narrow and deep. Surface ornamented with strong lateral ribs, which at maturity cross the keel in folds but in adolescence become obsolete on the abdominal shoulders. In the young shells there are only umbilical ribs without the keel. There are no keel furrows at any stage. Septa ceratitic; the external lobe is divided into two narrow, short branches; the lateral and the auxiliary are larger. The body chamber is at least a revolution in length.

In the young stages there is neither keel nor ventral ribs; the form is depressed and broad and resembles *Gastrioceras*, which may be the parent of this group. *Metasibirites frechi* in all essential characters agrees exactly with the group of *Metasibirites spinescens*.

Occurrence: Very common in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Metasibirites gracilis Smith, n. sp.

Plate LXI, Figures 34–37

Shell small, moderately evolute, not deeply embracing, umbilicate, somewhat compressed laterally. Surface with rather coarse and occasionally dichotomous ribs that cross the venter without interruption, showing the faint vestigial keel only in adolescence and early maturity. Body chamber more than a revolution long. Young stages coronate and gastrioceran but less so than in most species of the genus.

Metasibirites gracilis has some resemblance in shape to *Metasibirites parvus* but is more widely evolute and has much stronger sculpture; it is more compressed than *Metasibirites frechi* and has wider umbilicus, stronger ribs, and weaker keel. The septa are like those of all the other American species of *Metasibirites;* the lateral lobe is serrated and all the other lobes and saddles goniatitic.

Occurrence: Rather rare in the upper or *Juvavites* subzone of the Upper Triassic zone of *Tropites subbullatus*, in the Hosselkus limestone at the north end of Brock Mountain, about 5 miles north of Madison's ranch, on Squaw Creek, Shasta County, Calif.

Metasibirites modestus Smith, n. sp.

Plate LXI, Figures 38–47

Dwarf form, robust, very involute, narrowly umbilicate; whorls rounded and broad, with only slight indication of the ventral shoulder. Surface nearly smooth at maturity, with very weak umbilical ribs that run out into fine lines crossing the venter. Rudimentary keel very small but distinct. Body chamber long. Septa have first lateral lobe serrated.

In youth the whorl is gastrioceran in shape, with coarse umbilical ribs as in all *Metasibirites*.

Metasibirites modestus resembles *Metasibirites coei* but differs in the greater lateral compression and the obsolescence of the ribs. These differences persist even in youth.

Occurrence: Rare in the Upper Triassic Hosselkus limestone at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end and west side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Metasibirites mojsvarensis Smith, n. sp.

Plate LXI, Figures 8–21

Small, robust, thick set, broad whorl; form depressed, evolute, little embracing, widely umbilicate. Surface with sharp umbilical dichotomous ribs that cross the venter without interruption. In the young stages there are a few constrictions. There are faint remnants of the vestigial or rudimentary keel characteristic of the genus. Septa have first lateral lobe weakly serrated; the others are goniatitic.

Metasibirites mojsvarensis is very like *Metasibirites uhligi* Mojsisovics,[71] but is more involute, with narrower umbilicus and coarser sculpture, and has traces of the keel. It differs from *Metasibirites crassus* Mojsisovics in the narrower umbilicus and coarser sculpture but agrees with it in general shape and in possession of the vestigial keel. It is much more depressed and proportionally broader than *Metasibirites frechi* Hyatt and Smith.

Named in memory of Dr. E. Mojsisovics von Mojsvar.

Occurrence: Rather common in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), at the north end and west side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Metasibirites parvus (Hyatt and Smith)

Plate LX, Figures 31–46; Plate LXXIX, Figures 11–20

1905. *Tardeceras parvum.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 44, pl. 79, figs. 11–30.

Dwarf form, involute, deeply embracing, whorl laterally compressed, with flattened sides, rounded abdominal shoulders, and rather broad, flattened venter. Umbilicus very narrow, almost closed, concealing the inner volutions. Surface ornamented with fine dichotomous ribs that start from bundles on the umbilical shoulder and run nearly straight up the sides and across the abdominal shoulders. They become much weaker on the venter but are still visible. The septa are weakly ceratitic; the external lobe is divided by a siphonal notch; the lateral lobe is broad, shallow, and slightly serrated; the second lateral is small, rounded, and entire. The saddles are all entire.

This species resembles *Sibirites* but is too involute and the sculpture on the venter is too faint for that genus. It also resembles *Juvavites*, but the character of the sculpture, the flattened sides and venter, and the simple ceratitic septa forbid a reference to that genus.

In its early youth this species has a low, broad trapezoidal whorl, and umbilical ribs, with a few constrictions and nearly smooth venter, as in *Gastrioceras*.

In adolescence the form resembles *Gastrioceras*, and in later stages the ribs are prolonged until they cross the venter.

The generic name *Tardeceras*, which was based on this species, is now dropped, as the species intergrades completely with forms typical of *Metasibirites*.

Occurrence: *Metasibirites parvus* was found by the writer in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, in the upper or *Juvavites* subzone, 3 miles east of Madison's ranch, on the divide between Squaw Creek and Pit River, half a mile north of the trail across to Brock's ranch, in Shasta County, Calif.

[71] Mojsisovics, E. von, op. cit., p. 331, pl. 124, figs. 5–6.

Metasibirites pusillus Smith, n. sp.

Plate LXI, Figures 1–7

Shell small, robust, involute, rotund but somewhat compressed laterally; venter broadly rounded. Umbilicus narrow, disclosing very little of the inner whorls. Surface with fine sharp ribs that usually branch on the flanks and alternate at the meeting with the faint threadlike keel, which gives an aspect strongly reminiscent of *Juvavites*. The body chamber is more than a revolution in length. The septa are goniatitic, with the exception of the slightly serrated lateral lobe. The ventral lobe is divided as in all members of this genus.

Metasibirites pusillus resembles *Metasibirites pygmaeus* but is somewhat less compressed and differs also in its stronger *Juvavites*-like sculpture. It is less rounded and has finer and sharper ribs than *Metasibirites frechi.*

Occurrence: Rather rare in the upper or *Juvavites* subzone of the zone of *Tropites subbullatus* in the Hosselkus limestone (Upper Triassic), at the north end of Brock Mountain, about 5 miles north of Madison's ranch on Squaw Creek, Shasta County, Calif.

Metasibirites pygmaeus Smith, n. sp.

Plate LIX, Figures 34–47

Form laterally compressed, rather involute, with deep narrow umbilicus, flattened sides, subangular ventral shoulders, and arched venter. Surface with fine dichotomous curving ribs that cross the venter without interruption; also a threadlike keel that is nearly obsolete at maturity. Septa have the first lateral lobe weakly serrated, all others are goniatitic.

Metasibirites pygmaeus is closely related to *Metasibirites parvus* Hyatt and Smith, from which it differs in its slightly broader, more square shoulders and less compressed whorl, and finer, close-set ribs. It is distinguished from *Metasibirites frechi* by its finer sculpture, greater compression, and flattened venter. It belongs to the group named by Hyatt and Smith *Tardeceras*, which is no longer considered as a valid genus, as it is nothing môre than a group of species under *Metasibirites.* The writer does not even regard it as a subgenus.

Occurrence: Very common in the Upper Triassic Hosselkus limestone in the zone of *Tropites subbullatus*, upper horizon (*Juvavites* subzone), at the north end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Metasibirites shastensis Smith, n. sp.

Plate LXI, Figures 22–33

Shell small, robust, somewhat compressed laterally, moderately widely umbilicate, not deeply embracing. Whorls helmet-shaped, with broadly rounded venter and without distinct ventral shoulders. Umbilical shoulders sharp. Surface with strong and often dichotomous ribs, bundling on the umbilical shoulders, and forking about halfway up the flanks, crossing the venter without interruption. In adolescence and early maturity there is visible a very weak vestigial threadlike keel. Body chamber more than a revolution in length. Septa goniatitic, except the lateral lobe, which is weakly serrated.

Metasibirites shastensis is less robust and depressed than *Metasibirites coei;* it is more robust and less compressed than *Metasibirites frechi*, forming almost a connecting link between those two species.

In the young stages the form is decidedly coronate, as in most species of *Metasibirites*, but more so than in most of them.

Occurrence: Rather common in the upper or *Juvavites* subzone of the zone of *Tropites subbullatus*, in the Hosselkus limestone (Upper Triassic), at the north end and west side of Brock Mountain, 5 miles north of Madison's ranch, on Squaw Creek, Shasta County, Calif.

Genus LECONTEICERAS Smith

1905. *Leconteia.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 35.

(Not 1893. *Lecontia.* Champion, Biologia Centrali-Americana, Coleoptera, vol. 4, pt. 2, p. 453.)

1914. *Leconteiceras.* Smith, The Middle Triassic marine invertebrate faunas of North America: U. S. Geol. Survey Prof. Paper 83, p. 38.

Type.—Leconteiceras californicum Hyatt and Smith.

Whorls involute, subglobose, deeply embracing, and deeply indented by the inner volutions. Sides convex, rising to the highly arched venter without any abdominal shoulder. Umbilicus narrow, becoming wider at maturity. Body chamber at least a revolution in length. Septa ceratitic; external lobe narrow, goniatitic, divided by a small siphonal notch into two sharp branches; lateral lobe and auxiliary broad, shallow, and serrated. External saddle high, rounded, and entire; lateral saddle similar but lower; antisiphonal lobe long, narrow, and entire, flanked by a shorter internal lateral lobe. Internal saddles similar to the externals. Surface ornamented with strong, straight, or gently flexuous ribs, which pass without interruption across the venter but become much wider on that portion of the shell. The ribs are not all of equal height, every third or fourth one being stronger and higher than the intervening ones, which at maturity may become nearly obsolete. On the outer shell these ribs are smooth, without nodes, but internal casts show the ribs slightly interrupted by a ventral furrow, bounded by rows of knots on the ends of the ribs.

This genus resembles *Helictites* and *Polycyclus* but differs from them in the greater involution and the long body chamber. The young of *Leconteiceras* are not like those of the Ceratitidæ but subglobose like those of *Sagenites*. For these reasons the genus is assigned to the Haloritidae of the Tropitoidea.

Leconteiceras was named in honor of the late Prof. Joseph Le Conte. This genus is characteristic of the zone of *Tropites subbullatus* in the Upper Triassic of California and at present is known only in that province.

Leconteiceras californicum (Hyatt and Smith)

Plate XXIX, Figures 3–21

1905. *Leconteia californica.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 36, pl. 29, figs. 3–21.

1914. *Leconteiceras californicum.* Smith, The Middle Triassic marine invertebrate faunas of North America: U. S. Geol. Survey Prof. Paper 83, p. 38.

Form involute, subglobose. Whorls deeply embracing and deeply indented by the inner volutions; highly arched, rounded, with no abdominal shoulders. Cross section crescentic. Umbilicus narrow, almost closed, concealing the inner whorls. Umbilical shoulders abruptly rounded, with steep inner walls. The height of the whorl is half the total diameter, the width is about 1¼ times the height, and the whorl is indented to more than one-third of its height by the inner whorl. The surface is ornamented with simple coarse ribs that run nearly straight up the sides from the umbilicus and across the venter without interruption. These ribs are broad and rounded, much wider than the narrow, deep intercostal furrows; they show on the cast as strongly as on the outer shell but are interrupted by a shallow median furrow, which is bounded by a row of tubercles at the ends of the ribs. At maturity the ribs grow very much coarser and some become obsolete or nearly so. At this stage also the whorl becomes somewhat compressed laterally, so that it resembles *Lobites*. The body chamber is long, at least a revolution. The septa are ceratitic: the external lobe is divided by a small siphonal notch into two sharp branches; the lateral lobe is longer, broader, and serrated. The auxiliary is shallow, broad, and serrated. The antisiphonal lobe is long, narrow, simple, and pointed, flanked by a similar internal lateral on each side. The saddles, both internal and external, are all entire, broad, and rounded.

The development of this species is extremely simple, and the young stages are very like the mature forms. In the larval stage the shell is evolute, low whorled, with wide umbilicus and broad whorl with trapezoidal cross section, like *Gastrioceras*. At the diameter of 1.6 millimeters strong tubercles appear on the umbilical shoulders, still further increasing the resemblance to that Carboniferous genus, and the septa also are of that type. The glyphioceran constrictions appear at short intervals on the shell. At a diameter of 4 millimeters the ribs cross the venter and the constrictions cease, but the form is still like that of *Gastrioceras*. At a diameter of 4.5 millimeters the median furrow with the marginal tubercles appears on the inner cast, and at 5 millimeters the lateral lobe becomes ceratitic. This species preserves in its ontogeny an unusually perfect record of its race history, for even at maturity so many glyphioceran characters are still visible and in its larval and adolescent stages such perfect resemblance to Paleozoic goniatite genera may be seen.

Leconteiceras californicum has an external resemblance to *Polycyclus nasturtium* but is much more involute and has a long body chamber. Also the young stages point to the Glyphioceratidae as the Paleozoic radicle from which it came, whereas *Polycyclus* is supposed to belong to the stock of Ceratitidae.

Although *Leconteiceras* is classed in the Haloritidae, it is much simpler than any other members of that stock and is much nearer the parent family. It is a reversionary form but not a persistent ancestral type, such a genus as one would expect to find in the Lower Triassic or Permian. It is a connecting link between the Haloritidae and the Glyphioceratidae, showing kinship by reversion.

Occurrence: *Leconteiceras californicum* is common in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, *Trachyceras* subzone, 3 miles east of Madison's ranch, and half a mile north of the trail from Madison's to Brock's ranch on Pit River, Shasta County, Calif. It was also found in the same horizon on Bear Mountain, near Sherman's ranch, south of Pit River, 2 miles north of the road from Redding to Copper City, and at several other places on the divide between Squaw Creek and Pit River. It has not yet been found outside of Shasta County.

The figured specimens all came from Brock Mountain, on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch and half a mile north of the trail from Madison's to Brock's ranch, Shasta County, Calif.

Leconteiceras occidentale Smith, n. sp.

Plate LVIII, Figures 16–20

Form robust, only moderately involute, deeply embracing, somewhat compressed laterally, rather widely umbilicate. Surface with strong folds that run from the umbilicus across the venter, with a pair of ribs in the middle, forming a slight furrow, seen only on the inner cast. Septa slightly ceratitic. Body chamber more than a revolution in length.

Leconteiceras occidentale resembles *Leconteiceras californicum* but differs in its more compressed and widely umbilicate whorl; the two agree exactly in ornamentation and septa.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Suborder ARCESTOIDEA

Family POPANOCERATIDAE Hyatt

This family is represented in the Upper Triassic of North America only by the genus *Nathorstites* Boehm, which appears to be a boreal group; it occurs only in British Columbia and on Bear Island in the Arctic Ocean, in the *Dawsonites* zone, at the lower Karnic horizon.

Genus NATHORSTITES Boehm

1903. *Nathorstites.* Boehm, Ueber die obertriadische Fauna der Bäreninsel: K. svenska Vet.-Akad. Handl., vol. 37, No. 3, p. 61.

Type.—Popanoceras mcconnelli Whiteaves.

Forms compressed, somewhat arched, involute, narrowly umbilicate. Venter narrowed to a median angle. Surface smooth. Body chamber long. Septa with rounded, entire saddles, and serrated lobes.

Occurrence: In the Boreal facies of the Upper Triassic of Alaska and the Arctic Ocean. Represented by three species, *Nathorstites mcconnelli, Nathorstites lenticularis,* and *Nathorstites alaskanus.*

Nathorstites alaskanus Smith, n. sp.

Plate CII, Figures 11–13

Shell small, evolute, with broad, low trapezoidal whorl, and wide, deep umbilicus. Surface with weak cross folds and striae of growth. No ribs nor constrictions visible. Length of body chamber unknown. Septa ceratitic, with serrated lobes and rounded saddles. The ventral lobe is divided, and there are two laterals and two auxiliaries.

This species resembles *Nathorstites mojsvari* Boehm, from the *Dawsonites* zone of Bear Island, differing from the Arctic species only in its somewhat weaker sculpture and in its slightly greater breadth.

Occurrence: Very rare in beds of Karnic age, probably *Dawsonites* zone, at locality 9385, United States Geological Survey (=8849), on the south bank of Yukon River, opposite the mouth of Nation River, Alaska; the species is associated with *Pecten alaskanus, Trachyceras* cf. *T. lecontei, Eumorphotis nationalis,* and other forms.

Nathorstites lenticularis (Whiteaves)

Plate CVII, Figures 6, 7

1889. *Popanoceras mcconnelli* var. *lenticularis.* Whiteaves, The fossils of the Triassic rocks of British Columbia: Contr. Canadian Palaeontology, vol. 1, pt. 2, p. 140, pl. 18, fig. 3a.

1903. *Nathorstites lenticularis.* Boehm, Ueber die obertriadische Fauna der Bäreninsel: K. svenska Vet.-Akad. Handl., vol. 37, No. 3, p. 61, pl. 7, figs. 6–14, 44.

Shell sublenticular but invariably with umbilical depression. Greatest breadth less than half the diameter of the shell. Sides arched to the venter, curving without shoulders to the ventral angle, which is very obtuse. Umbilicus deep, with steep sides, and very narrow. Outer whorl deeply embracing, deeply impressed by the inner volution.

Nathorstites lenticularis differs from *Nathorstites mcconnelli* in its greater lateral compression and more acute venter. It agrees with that species in its long body chamber, almost total lack of sculpture, simple entire saddles, and weakly serrated lobes.

Occurrence: Very rare in the Upper Triassic, presumably at a lower Karnic horizon, 25 miles below Devils Portage, Liard River, British Columbia; also on Bear Island in the Arctic Ocean.

Nathorstites mcconnelli (Whiteaves)

Plate CVII, Figures 3–5

1889. *Popanoceras mcconnelli.* Whiteaves, The Triassic fossils of British Columbia: Contr. Canadian Paleontology, vol. 1, pt. 2, p. 138, pl. 18, figs. 2a, 2b.

1903. *Nathorstites mcconnelli.* Boehm, Ueber die obertriadische Fauna der Bäreninsel: K. svenska Vet.-Akad. Handl., vol. 37, No. 3, p. 61.

Shell globosely sublenticular, with umbilical depression; umbilicus narrow and deep, with steep sides. Height of whorl less than twice the width; deeply embracing and deeply impressed by the inner volutions. Cross section curving up to the bluntly subangular venter. Surface nearly smooth, with indistinct spiral striations and very weak transverse plications, which do not cross the venter. Septa with six simple external and six internal lobes on each side; the saddles are rounded and entire and the lobes finely serrated. This is evidently a very primitive arcestoid form.

Occurrence: In the *Dawsonites* zone, of lower Karnic age, on Liard River, 25 miles below Devils Portage, British Columbia; also in beds of the same age on Bear Island, in the Arctic Ocean.

Family ARCESTIDAE Mojsisovics

Genus ARCESTES Suess

1865. *Arcestes* (in part). Suess, Ueber Ammonites: K. Akad. Wiss. Wien Sitzungsber., vol. 52, p. 76.

1869. *Arcestes* (in part). Laube, Die Fauna der Schichten von St. Cassian: K. Akad. Wiss. Wien Denkschr., Band 30, p. 86.

1873. *Arcestes* (in part). Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, p. 71.

1879. *Arcestes.* Mojsisovics, Vorläufige kurze Uebersicht der Ammoniten-Gattungen der Mediterranen und Juvavischen Trias: K.-k. geol. Reichsanstalt Wien Verh., p. 134.

1882. *Arcestes.* Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 153.

1893. *Arcestes.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 785.

1896. *Arcestes.* Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 79.

1902. *Arcestes.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 261.

1904. *Arcestes.* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 255.

1905. *Arcestes.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 73.
1906. *Arcestes.* Diener, Fauna of the *Tropites* limestone of Byans: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 174.
1907. *Arcestes.* Diener, The fauna of the Himalayan Muschelkalk: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 2, p. 125.

Arcestes andersoni Hyatt and Smith

Plate LVI, Figures 1–9

1905. *Arcestes andersoni.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 74, pl. 56, figs. 1–9.

Form globose, involute, whorls depressed, deeply embracing, and deeply indented by the inner volutions. Umbilicus narrow and apparently closed in age. Venter broad and slightly flattened, flanks curving from the umbilicus without any ventral shoulders; umbilical shoulders abruptly rounded. Surface smooth, but on the inner whorls there are about four constrictions to a revolution; these constrictions bend gently forward, making a broad, shallow sinus on the venter. The surface of the outer whorl seems to be free from constrictions. The septa are extremely complex, deeply and finely digitate, and are divided into a large number of nearly equal lobes and saddles. There are five external and five internal lateral lobes. The height of the whorl is about half the total diameter of the shell, the width is about 1¼ times the height, and the indentation is about three-fifths of the height.

This species belongs to the group of *Arcestes coloni*, characteristic of the Upper Triassic, especially of the Noric horizon.

Occurrence: *Arcestes andersoni* was found first by F. M. Anderson in the Upper Triassic *Pseudomonotis* zone of Muttleberry Canyon, West Humboldt Mountains, in the road 8 miles southeast of Lovelocks, Nev. The writer found along with it *Pseudomonotis subcircularis* Gabb, *Rhabdoceras russelli* Hyatt, *Placites humboldtensis* Hyatt and Smith, *Halorites americanus* Hyatt.

Subgenus PROARCESTES Mojsisovics

1893. *Proarcestes.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 785.
1896. *Proarcestes.* Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 655.
1902. *Proarcestes.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 259.
1905. *Proarcestes.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 74.
1906. *Proarcestes.* Diener, Fauna of the *Tropites* limestone of Byans: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 177.
1914. *Proarcestes.* Smith, The Middle Triassic marine invertebrate faunas of North America: U. S. Geol. Survey Prof. Paper 83, p. 43.

Arcestes (Proarcestes) carpenteri Smith, n. sp.

Plate XXIII, Figures 1–11

Form laterally compressed, with gently convex flanks and narrowly rounded venter, without shoulders; umbilicus narrow but not closed, with very gentle slope of the umbilical walls. Surface with four or five labiae to a revolution. Septa moderately digitate.

Arcestes carpenteri is much more compressed than *Arcestes pacificus* and *Arcestes shastensis;* it has a much greater resemblance to *Arcestes antonii* Mojsisovics [72] but differs in its distinct labiae, not obsolete on the mature shell.

Named in memory of Dr. Philip P. Carpenter, the pioneer conchologist of California.

Occurrence: Common in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, of the North Fork of Squaw Creek, 3 miles north of Kelly's ranch; also in the same horizon on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Arcestes (Proarcestes) pacificus Hyatt and Smith

Plate XXIII, Figures 12–23; Plate XXXVII, Figures 1–9; Plate LXXXI, Figures 1–9

1905. *Arcestes* (*Proarcestes*) *pacificus.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 75, pl. 81, figs. 1–9; pl. 37, figs. 1–9.

Involute, globose; whorls broad, helmet-shaped, deeply embracing, and deeply indented by the inner volutions. Umbilicus very narrow, almost closed, umbilical shoulders abruptly rounded. Venter broad, with low arch and broadly rounded abdominal shoulders. The height of the whorl is about half the total diameter of the shell and about two-thirds of the width; it is indented by the inner volution to three-fifths of the height.

The surface is ornamented with fine radial striae of growth and with strong constrictions that occur about four to a revolution and are visible on both cast and shell. These constrictions curve gently forward on the flanks, forming a broad, shallow crest on the venter. The body chamber is more than a revolution in length.

The septa are divided into numerous lobes and saddles and are ammonitic but not deeply digitate. The ventral lobe is divided, and there are four principal lateral lobes and an auxiliary; all except the auxiliary are of about the same size and have the same long and narrow shape.

In the youthful stages this species illustrates clearly its phylogeny. The smallest stage that could be correlated with any known genus is that at a diameter of 1.7 millimeters, when the form and septa correspond to *Adrianites* Gemmellaro, of the Permian. The septa are goniatitic and tongue-shaped and have numerous

[72] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wein Abh., Band 6, Hälfte 1, p. 106, pl. 54, figs. 9–14, 1875.

lobes and saddles. At a diameter of 2.16 millimeters the lobes become slightly digitate at the end, as in *Stacheoceras* of the Permian. At a diameter of 3 millimeters the septa are more complex, as in *Popanoceras*. At a diameter of 5 millimeters the septa already are characteristic of *Arcestes*. The constrictions begin at a diameter of about 1 millimeter and continue throughout life; the whorl also undergoes little change in shape.

Occurrence: Very common in the Upper Triassic Hosselkus limestone, in the *Juvavites* subzone of the zone of *Tropites subbullatus*, on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch and half a mile north of the trail to Brock's ranch, in Shasta County, Calif. It is also common in the limestone east of Squaw Creek, near Terrup Chetta (Cottonwood Flat), a place about 6 miles north of the first-mentioned locality, in the same beds and in the same association of fossils.

Arcestes (Proarcestes) shastensis Smith, n. sp.

Plate XXII, Figures 7–26

Form of moderate size, subglobose, somewhat compressed laterally, involute. Surface with four or five oblique, sharply incised constrictions to a revolution, and fine striae of growth parallel to them. Septa moderately digitate. Body chamber long.

Arcestes shastensis is very closely related to *Arcestes pacificus* but differs in its more compressed form and more oblique constrictions. In septation the two are exactly alike, both being more complex than *Arcestes traski* and both being less globose than *Arcestes whitneyi*. *Arcestes shastensis* has also a close resemblance to *Arcestes sublabiatus* Mojsisovics [73] but is somewhat thicker and rounder than the European species. Possibly these two species may intergrade.

Occurrence: Exceedingly common in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch; also at the same horizon on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was also found in the *Juvavites* zone of Admiralty Island, Alaska, at locality 10180, a point between Chapin and Herring bays.

Arcestes (Proarcestes) traski Smith, n. sp.

Plate XXII, Figures 17–41

Shell small, subspherical, somewhat depressed, completely involute. Surface with four rather deeply incised constrictions only slightly oblique, and without forward-bending sinus on the venter. There are also varices bordering the constrictions. Both varices and constrictions are distinct on the cast as well as on the shell. Septa with numerous lobes and saddles, moderately digitate. Body chamber long.

The septa are simpler than those of *Arcestes pacificus* and *Arcestes shastensis*, and the form is more robust than that of those species, resembling small specimens of *Arcestes whitneyi*. It differs from *Arcestes whitneyi* in its much smaller size, fewer and less digitate lobes, and much stronger constrictions and varices. It has a great resemblance to *Arcestes ciceronis* Mojsisovics [74] but differs in its more depressed form and its stronger and more numerous constrictions.

Named in memory of Dr. John B. Trask.

Occurrence: Very common in the Upper Triassic Hosselkus limestone, in the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Arcestes (Proarcestes) whitneyi Smith, n. sp.

Plate XXII, Figures 1–6

Form nearly spherical, completely involute. Four or five weak labiae or constrictions pointing obliquely forward, also distinct varices with the labiae. These are stronger on the young shell, both constrictions and varices being nearly obsolete at maturity. Septa with numerous lobes and saddles, only moderately digitate. Body chamber long.

Arcestes whitneyi is closely related to *Arcestes pacificus*, from which it differs in its more globose form, the obsolescence of constrictions and varices, and in its much greater size. It is also similar to *Arcestes ausseeanus* Hauer, as figured by Mojsisovics,[75] but lacks the constrictions on the mature shell, which are still well developed on the European species.

Named in memory of Prof. J. D. Whitney.

Occurrence: Common in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch; also at the same horizon at the north end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Arcestes (Proarcestes) winnemae Smith, n. sp.

Plate XXIII, Figures 24–33

Form robust, involute, subspherical. Whorls low, broad, with broadly flattened venter, abruptly rounded ventral shoulders, and somewhat flattened flanks. Umbilicus almost closed, with abrupt walls. Surface with strong constrictions, four to a revolution, which bend strongly forward on the flanks and run straight across the venter. These constrictions are strongly impressed on the cast but only weakly developed on the outer shell. The varix or raised ridge along the side of the constriction is visible on the shell. In addition to these features there are fine growth lines and very faint cross ridges, which are seen on both shell and cast. Septa with divided external lobe and five laterals almost of equal size and only very slightly

[73] Idem, p. 94, pl. 55, fig. 12.

[74] Idem, p. 103, pl. 51, fig. 2; pl. 54, figs. 4–7.

[75] Idem, p. 99, pl. 51, figs. 1 and 4; pl. 53, figs. 2 and 31

digitate; internal septa with antisiphonal and five nearly equal-sized laterals, very like the external lobes. The body chamber is more than a revolution in length. The height of the whorl is 1½ times the width, and half the diameter of the shell; it is indented to five-eighths of the height and embraces the inner whorl entirely.

This species is a close relative of *Arcestes traski*, from which it differs in the broader, lower whorl and flattened venter. It is the probable ancestor of *Arcestes whitneyi*, from which it differs in its smaller size, less rounded form, and much stronger constrictions.

Occurrence: Rather rare in the Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the zone of *Tropites subbullatus*, at the stone quarry on Brock Mountain, on the divide between Squaw Creek and Pit River, on the trail to Brock's ranch, Shasta County, Calif. The specific name is given in honor of a traditional heroine of the Shasta tribe.

Family CLADISCITIDAE Mojsisovics

Genus CLADISCITES Mojsisovics

1879. *Cladiscites.* Mojsisovics, Vorläufige kurze Uebersicht der Ammoniten-Gattungen der Mediterranen und Juvavischen Trias: K.-k. geol. Reichsanstalt Wien Verh., p. 134.

1882. *Cladiscites.* Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 173.

1896. *Cladiscites.* Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 656.

1902. *Cladiscites.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 279.

Type.—"Arcestes" tornatus Bronn.

Involute, deeply embracing whorls, with long body chamber; without constrictions, ribs, or varices. Surface of shell shows fine spiral lines. Septa complex, digitate, with numerous lobes and saddles arranged serially.

This genus differs from *Arcestes* chiefly in the lack of constrictions or varices and in the possession of spiral lines on the shell.

Represented in the Upper Triassic of western America by two species.

Cladiscites martini Smith, n. sp.

Plate CII, Figures 17–20

Form thick set, involute, completely embracing, and deeply indented by the inner whorls. Umbilicus completely closed. Flanks and venter somewhat rounded, with distinct ventral shoulder, giving a subquadratic cross section. Surface without constrictions or varices but with fine spiral striae, visible only on the outer shell. Septa with narrow lobes and broad saddles, all rather deeply digitate. There are an external lobe, three laterals, and four auxiliaries, decreasing in size toward the umbilicus. Internal septa unknown.

This species is somewhat related to *Cladiscites tornatus*, the type of the genus being somewhat more quadratic than that species.

Named in honor of Dr. G. C. Martin.

Occurrence: Very rare in Upper Triassic rocks of Karnic age, associated with *Halobia superba* var. *cordillerana*, *Trachyceras* cf. *T. lecontei*, in Alaska, Yukon Valley, a third of a mile northeast of the mouth of Nation River; locality 9385, United States Geological Survey. Collected by Eliot Blackwelder.

Cladiscites mendenhalli Smith, n. sp.

Plate CII, Figures 21–24

Shell small, thick set, subspherical. Umbilicus completely closed. Venter broadly rounded, curving to the flanks without ventral shoulders. Surface with very fine spiral striae and without constrictions. Septa with eight external lobes of about the same width as the saddles; one external lobe, three lateral lobes, and four auxiliary lobes on each side.

Cladiscites mendenhalli differs from *Cladiscites martini* in being more robust and in not having the striking difference in the size of the lobes and saddles.

Named in honor of W. C. Mendenhall.

Occurrence: Very rare in Upper Triassic rocks, presumably of Karnic age, in Canning River region, Alaska. Locality 10304 (30B). Anglo-American Expedition. E. de K. Leffingwell, collector.

Suborder PTYCHITOIDEA

Family PTYCHITIDAE Mojsisovics

Genus PARAGANIDES Hyatt and Smith

1905. *Paraganides.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 77.

Type.—Paraganides californicus Hyatt and Smith.

Dwarf forms; involute, laterally compressed, deeply embracing, umbilicus narrow; all the inner whorls concealed by the outer. Sides flattened, whorl proportionally high, with somewhat narrowly rounded venter. Surface nearly smooth but ornamented with faint ribs, which bifurcate on the umbilical shoulders and run nearly straight up the sides and across the venter without interruption. No constrictions have been observed on this group. The septa are goniatitic; lobes and saddles all short; one principal lateral, and a second lateral or auxiliary on the umbilical shoulders. The antisiphonal (internal) lobe is like the external and is flanked by a pair of short laterals.

This genus differs from *Nannites* only in the undivided external lobe. It resembles *Aganides* Montfort of the Carboniferous and may be a reversion to that stock by arrested development. It differs from *Aganides* chiefly in the possession of the second lateral lobe.

Paraganides is known only from the Upper Triassic zone of *Tropites subbullatus* of Shasta County, Calif., where it is represented by a single species.

Paraganides californicus Hyatt and Smith

Plate LXXX, Figures 12–21

1905. *Paraganides californicus*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 78, pl. 80, figs. 12–21.

Involute, robust, laterally compressed. Umbilicus closed. Whorl high helmet-shaped, with flattened sides, and rounded venter, with rounded but distinct abdominal shoulders. The height of the whorl is slightly more than half the total diameter, and the width is about two-thirds of the height. It is indented to half its height by the inner whorl. The body chamber is at least a revolution long. The surface is ornamented with weak radial folds that start from the umbilical shoulders and run nearly straight across the venter without interruption. These folds are parallel to the fine cross striae of growth. The septa are goniatitic. The external lobe is undivided and rounded; there are two laterals very like the external, and the antisiphonal lobe is flanked by a pair of internal laterals, as in *Nannites*.

The young stages of this species are subglobose, with open umbilicus.

Occurrence: *Paraganides californicus* is rather common in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, *Trachyceras* subzone, on the limestone belt on the divide between Squaw Creek and Pit River, about 3 miles east of Madison's ranch, Shasta County, Calif.

Suborder PINACOCERATOIDEA

Forms laterally compressed, discoidal, narrowly umbilicate; venters narrow, in few genera rounded, generally either bicarinate and channeled or carinate. Septa generally lanceolate or ceratitic but digitate in the more highly specialized groups; in all families characterized by the tendency to form adventitious lobes.

The Gephyroceratidae are doubtless the ancestors of the Pinacoceratoidea, but not all groups under this suborder came from the same genus; some came from *Gephyroceras*, some from *Manticoceras*, some from *Timanites*, and some from *Beloceras*. The suborder is not polyphyletic but is a rapidly branching family tree.

This suborder includes four well-defined families:

I. Pronoritidae: Compressed, discoidal, with lanceolate septa, all derived from *Gephyroceras* through *Pronorites;* includes *Pronorites*, *Sicanites*, *Cordillerites*, and *Medlicottia*.

II. Thalassoceratidae: Compressed forms with rounded venters and strongly digitate lobes; includes *Dimorphoceras*, *Thalassoceras*, *Procarnites?*, *Carnites?*, *Ussuria*, and *Sturia*.

III. Haueritidae: Compressed, involute, bicarinate, with lanceolate-digitate lobes, connected with *Gephyroceras* through *Gonioloboceras* and *Texites;* includes *Lanceolites*, *Arthaberites*, *Fremontites*, *Hauerites*, and *Klamathites*.

IV. Sageceratidae: Compressed, involute, mostly carinate, with septa ranging from lanceolate to complex digitate; derived from *Timanites* or *Beloceras* through *Prodromites;* includes *Aspenites*, *Sageceras*, and *Pseudosageceras*. Arthaber[76] has prepared a very elaborate classification of this group, in which he uses the name Beloceratea for it instead of Pinacoceratoidea. The substitute can hardly stand, for only one of the four families could have come from *Beloceras*. Arthaber's classification is as follows:

Stamm Beloceratea

Family I. Beloceratidae: *Beloceras, Medlicottia, Propinacoceras, Sicanites, Pseudosageceras, Sageceras, Cordillerites.*

Family II. Noritidae: *Pronorites, Parapronorites, Daraelites, Norites.*

Family III. Prodromitidae: *Prodromites, Hedenstroemia Aspenites, Longobardites, Paranorites.*

Family IV. Pinacoceratidae: *Beatites, Pinacoceras, Pompeckjites, Placites.*

Family V. Carnitidae: *Procarnites, Ussuria, Arthaberites, Carnites, Metacarnites, Bambanagites, Tibetites, Pseudosirenites, Pseudohauerites.*

Of the genera cited above the great majority could not possibly have come from *Beloceras;* hence there is no reason for substituting a new name for the time-honored designation introduced by Mojsisovics many years ago, even though the limits of the group have been greatly changed.

The writer's ideas concerning the phylogeny of the descendants of the Gephyroceratidae are expressed in the table at the foot of this page.

[76] Arthaber, G. von, Die Trias von Albanien: Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, Band 24, pp. 177, 198–216, 1911.

Phylogeny of the descendants of the Gephyroceratidae

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                ┌---------------------------Lecanites┌--------------------------Lytoceratidae→Phylloceratidae
                │                                    └Xenodiscus→Meekoceras→Ceratitidae
                │                                                       ┌Norites→Noritidae┐
                │---------------------------Pronorites------------------┤Medlicottia------│
Gephyroceras────┤                                                       └Cordillerites----│
                │                  ┌Dimorphoceras--------------┌Thalassoceras→Ussuria→Sturia--│
                │                  │                           └Procarnites?→Carnites?--------│
                └Gonioloboceras────┤                                    ┌Fremontites------├ Pinacoceratoidea
                                   └Texites→Lanceolites→Arthaberites----┤Hauerites--------│
                                                                        └Klamathites------│
Beloceras----┌Prodromites--- Aspenites                                                    │
(Timanites)  └-------------┌Pseudosageceras----------------------------(?)Pinacoceras----┘
                           └Sageceras
```

Gephyroceras is the parent radicle of the entire suborder, with *Beloceras* as a branch, derived as follows: *Gephyroceras* → *Timanites* → *Probeloceras* → *Beloceras*. At present *Prodromites* is the only Carboniferous genus known to belong to the stock of *Beloceras*, but there must be others as yet unknown. The whole suborder is made up of thin-shelled forms not readily preserved, and so many additions have been made in the last few years that our knowledge of the group is just beginning.

In the above table it is very doubtful whether the Noritidae should be placed under the Pinacoceratoidea or the Ceratitoidea, for though they are related to the stock of *Pronorites* they form no adventitious lobes.

The four families given in the writer's classification of the Pinacoceratoidea are really superfamilies and will eventually be subdivided.

Family I. Pronoritidae, is represented in the American Triassic only by *Cordillerites* of the Lower Triassic, though *Pronorites* is found in the Carboniferous and *Medlicottia* in the Permian.

Family II. Thalassoceratidae, is represented in the American Triassic by *Ussuria* and *Sturia*, both in the Lower Triassic.

Family III. Haueritidae, is represented in the Lower Triassic of America by *Lanceolites* and in the Upper Triassic by *Fremontites*, *Hauerites*, and *Klamathites*. The Paleozoic ancestors of the group, *Gonioloboceras* and *Texites*, are found in the "Coal Measures" (Pennsylvanian series).

Family IV. Pinacoceratidae, is represented in the Lower Triassic of America by *Aspenites* and *Pseudosageceras;* in the Middle Triassic by *Sageceras;* in the Upper Triassic by *Pinacoceras*, *Dieneria*, and *Placites*. The Paleozoic ancestral type, *Prodromites*, occurs at several places in the Mississippian series ("Lower Carboniferous").

Family HAUERITIDAE Smith

Forms compressed, discoidal, involute, high-whorled; venters narrow, bicarinate, and channeled. Surface nearly smooth, with a few weak folds. Septa with lanceolate lobes, digitate in the more complex members, and in all with adventitious lobes more or less individualized. Body chamber short.

The family includes *Lanceolites* of the Lower Triassic, *Arthaberites* of the Middle Triassic, and *Hauerites*, *Fremontites*, and *Klamathites* of the Upper Triassic.

Some of these genera have been included by Arthaber in the family Carnitidae, but that group is heterogeneous and polyphyletic, and it is very unlikely that *Carnites* belongs to it; hence the name Haueritidae is substituted, based on the well-known genus *Hauerites*. The phylogeny of the group is discussed under the Pinacoceratoidea and under the genus *Klamathites*.

The family is represented in the Upper Triassic of America by *Klamathites*, *Hauerites*, and *Fremontites*.

Genus HAUERITES Mojsisovics

1893. *Hauerites*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 517.

1896. *Hauerites*. Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 645.

1905. *Hauerites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 104.

1911. *Pseudohauerites*. Arthaber, Die Trias von Albanien: Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, Band 24, p. 215.

Type.—Ammonites rarestriatus Hauer.[77]

Involute, discoidal, laterally compressed, deeply embracing, and deeply indented by the inner whorls. Umbilicus narrow, concealing the inner whorls. Sides flattened convex, curving without abdominal shoulders up to the narrow venter, which is deeply channeled and bounded by narrow keels. Sides ornamented with fine sigmoidal foldlike ribs and with striae parallel to these ribs. Body chamber short. Septa ammonitic, not deeply digitate, and very little above the ceratitic stage of development. They consist of a series of adventitious lobes, an external lobe, a first and second lateral, and an auxiliary series. The adventitious lobes are formed by secondary division of the siphonal and first lateral saddle.

This genus was first described by Mojsisovics as a subgenus of *Cyrtopleurites*, but he afterward gave it independent rank. It was classed by him with the Ceratitidae, but the character of the septa and the ontogeny of the group forbid such a classification. The young stages of this genus bear no resemblance to *Dinarites* or *Tirolites* but do resemble the genus *Ambites*, supposed by Waagen to be one of the stock forms of the Noritidae. The characters of the septa are such that this genus must be placed in Waagen's group of Pinacoceratidae.

Hauerites is known only from the Upper Triassic Karnic and Noric stages of the Alpine province; the Karnic stage of the Himalayas; and the same horizon in California, where it is represented by *Hauerites lawsoni* Smith.

Hauerites lawsoni Smith, n. sp.

Plate LXIII, Figures 22–29

Shell small, strongly compressed laterally, high-whorled, narrowly umbilicate, smooth. Venter narrow, bicarinate, and rather deeply channeled. Body chamber short. Septa deeply digitate, with principal, adventitious, and auxiliary lobes.

Hauerites lawsoni resembles *Hauerites aesculapii* Mojsisovics but differs from it in being more compressed and smoother and in lacking crenulations on

[77] Hauer, F. von, Ueber neue Cephalopoden aus den Marmorschichten von Hallstatt und Aussee: Haidinger's Naturwiss. Abh., Band 3, p. 11, pl. 5, fig. 10; pl. 6, figs. 4–5, 1849. Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 529, pl. 150, fig. 5, 1893.

the ventral keels. It also differs from *Fremontites ashleyi* in its greater compression, its lack of the lateral ribs, and the stronger development of the adventitious series of lobes.

Named in honor of Dr. A. C. Lawson.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, lower horizon (*Trachyceras* subzone), on Brock Mountain, 3 miles east of Madison's ranch, on the trail from the United States forestry station to Pit River, Shasta County, Calif.

Genus KLAMATHITES Smith, n. gen.

Type.—*Klamathites schucherti* Smith, n. sp.

Form involute, laterally compressed, with narrow venter, either channeled or slightly rounded; sides flattened. Whorls high, narrow, and deeply embracing. Surface nearly smooth or with weak lateral folds. Body chamber relatively short, not more than three-fourths of a revolution. Septa consist of three series, adventitious, principal, and auxiliary. The saddles are rounded and but slightly brachyphyllic, the lobes partly lanceolate, and partly ceratitic. The three adventitious lobes are long, narrow lanceolate; the first lateral lobe is unsymmetrically divided into several secondary lobes, all somewhat lanceolate; the second lateral lobe is serrated; the auxiliary series is long and slightly serrated. This type of septation resembles that of *Cordillerites* Hyatt and Smith and *Lanceolites* Hyatt and Smith, of the Lower Triassic of America, but is much more complex than that of either of those genera. In youth the septation of *Klamathites* is somewhat like that of *Hedenstroemia* Waagen, although there is probably no near relationship between them. The form of *Klamathites* shows considerable resemblance to *Metacarnites* Diener, but *Metacarnites* has thoroughly ammonitic lobes and saddles and is altogether much more highly specialized, the first lateral lobe retaining nothing of the lanceolate character. *Paratibetites* Mojsisovics, which may belong to the Pinacoceratoidea, has the same general plan of septation, but though the adventitious series is rather similar to that of *Klamathites* the first lateral lobe shows none of the division into lanceolate secondary lobes, being merely ceratitic. *Bambanagites* Mojsisovics is another genus with which *Klamathites* should be compared, but *Bambanagites* has the septa thoroughly ammonitic, of the *Pinacoceras* type, and lacks the lanceolate character and also has strong lateral ribs.

Arthaber [78] has named the family Carnitidae, under the Pinacoceratoidea, to include compressed discoidal forms, with narrow venters and complex adventitious lobes. He includes in that family the following genera: *Carnites* Mojsisovics, *Metacarnites* Diener, *Procarnites* Arthaber, *Arthaberites* Diener, *Ussuria* Diener, *Bambanagites* Mojsisovics, *Tibetites* and its subgenera *Anatibetites* and *Paratibetites* Mojsisovics, *Pseudosirenites* Arthaber (including the compressed discoidal forms with adventitious lobes, which Mojsisovics places in *Sirenites*), *Pseudohauerites* Arthaber, and *Lanceolites* Hyatt and Smith. To this list should be added *Klamathites* Smith and *Fremontites* Smith. *Ussuria* should be dropped from the number in spite of its adventitious lobes, for its young stages are wholly unlike the Beloceratidae. The writer has given above his reasons for substituting the name Haueritidae for Carnitidae. This group forms one of the most homogeneous and continuous phyla known among the ammonoids in the Mediterranean region, the Indian region, and in western America; it ranges from the Lower to the Upper Triassic.

Klamathites resembles *Hauerites* Mojsisovics, with which it is nearly related, but differs in its more strongly lanceolate and less digitate septa and in its more complex adventitious series. It also resembles *Tibetites* Mojsisovics, but that genus has strong sculpture and ceratitic rather than lanceolate lobes. *Paratibetites* Mojsisovics is more like *Klamathites* and is also nearly smooth, but the ground plan of its septa is the same as that of *Tibetites*. *Bambanagites* Mojsisovics is another similar group but has strong lateral ribs, and its septa are thoroughly ammonitic, of the *Pinacoceras* type. *Metacarnites* Diener agrees with *Klamathites* in form and in losing at maturity the biangular venter but differs from it in more complex dolichophyllic lobes.

Another kindred genus is *Fremontites* Smith, which differs only in its short and little-developed adventitious series.

Klamathites is related to the Carnitidae, as defined by Arthaber [79] but is not very closely allied to *Carnites* and certainly is not a descendant of *Procarnites* Arthaber. A possible ancestor is *Arthaberites* [80] Diener, in the Middle Triassic. A more distant ancestor may be found in *Lanceolites* [81] Hyatt and Smith, of the Lower Triassic, which has a very similar but much simpler ground plan of septa, purely lanceolate, without any secondary digitations, and a little-developed adventitious series of lobes. (See Pl. XXI, figs. 9a–c.)

The Paleozoic radicle of *Klamathites* and of the entire group of Haueritidae is probably *Texites* Smith, n. gen., type "*Dimorphoceras*" *texanum* Smith,[82] of the Cisco group (Pennsylvanian) of Texas. This species was wrongly assigned to *Dimorphoceras*, from which it differs in developing the rudiments of the adventitious lobes. It has the same compressed form, biangular channeled venter, and smooth shell, characteristic of *Lanceolites* and *Klamathites*, and its

[78] Arthaber, G. von, op. cit., p. 211.

[79] Arthaber, G. von, op. cit., p. 211.

[80] Idem, p. 217, fig. 9.

[81] Hyatt, Alpheus, and Smith, J. P., The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 113, 1905.

[82] Smith, J. P., The Carboniferous ammonoids of America: U. S. Geol. Survey Mon. 42, p. 126, pl. 20, figs. 12–15, 1903.

septa are still simply goniatitic. This species is refigured in Plate XX, Figures 4–7, for comparison with the young stages of more highly specialized members of the group.

A still more distant ancestor is probably *Gonioloboceras* Hyatt, of the Carboniferous, of which a species, *Gonioloboceras welleri* Smith, is figured in Plate XX, Figures 1–3, to show the derivation from the Gephyroceratidae.

Occurrence: *Klamathites* is known only in Upper Triassic rocks of Karnic age, zone of *Tropites subbullatus*, in western America, where it is represented by two species, *Klamathites schucherti* Smith and *Klamathites kellyi* Smith.

Klamathites schucherti Smith, n. sp.

Plate LXII, Figures 14–17

Form laterally compressed, discoidal, completely involute, umbilicus closed. Sides flattened, with very gentle convexity. Outer whorls completely embracing and indented by the inner to two-thirds of the height. Venter narrow, biangulate and channeled in youth and slightly convex at maturity. Surface of shell and cast shows low, weak, curved folds, which are much stronger in youth. Septa of the lanceolate type, slightly ammonitic, brachyphylloid, with numerous lobes and saddles, principal, adventitious, and auxiliary. The first lateral lobe is deeply divided into long fingerlike extensions, and the external saddle is broken up into a series of adventitious lobes and saddles. The auxiliary series of lobes is shorter and simpler. The body chamber is short, not more than three-fourths of a revolution.

Klamathites schucherti is closely related to *Klamathites kellyi* Smith but differs in the greater simplicity of the septa, which are less digitate. There is also a close similarity in form to *Fremontites ashleyi* Hyatt and Smith, but the sculpture is simpler and the septa are much more complex than those of *Fremontites.*

The ground plan of the septa is the same as that of *Lanceolites* Hyatt and Smith but differs in the greater division into numerous lobes and saddles and in the full development of the adventitious series.

Klamathites schucherti is chosen as the type of a new genus because of the striking differences between this group and all others of the Pinacoceratoidea.

Named in honor of Prof. Charles Schuchert.

Occurrence: Rare in the upper beds (*Juvavites* subzone) of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone, North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Klamathites kellyi Smith, n. sp.

Plate LXIII, Figures 1–5

Form involute, narrowly umbilicate, discoidal, strongly compressed laterally, deeply embracing, and deeply impressed by the inner whorls. Venter narrow and slightly convex at maturity. Surface nearly smooth, with weak lateral folds almost obsolete at maturity. Body chamber apparently short. Septa complex, thoroughly ammonitic, of the brachyphylloid type, with principal, auxiliary, and adventitious lobes, the latter formed by subdivision of the external saddle.

Klamathites kellyi is closely related to *Klamathites schucherti* Smith, from which it differs in slightly larger size and in much greater complexity of septa, which are less lanceolate and more digitate than those of *Klamathites schucherti* at the same size. It differs from *Fremontites ashleyi* Hyatt and Smith in weaker sculpture and greater complexity of septa.

Named for its occurrence near Kelly's ranch, which has been for many years the central point for all geologic work in that region.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the upper beds (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, and in the same beds at the north end and west side of Brock Mountain, Squaw Creek, 5 miles north of the forestry station, in Shasta County, Calif.

Genus FREMONTITES Smith, n. gen.

Type.—"*Hauerites*" *ashleyi* Hyatt and Smith.

Form involute, narrowly umbilicate, laterally compressed, high and narrow whorled, sides flattened, and venter narrow, biangulate, and channeled. Surface with low, curved folds. Body chamber short. Septa moderately complex, with short and little-divided adventitious series of lobes, which are formed by subdivision of the original external lobe.

Fremontites differs from *Klamathites* in the greater simplicity of septa, the weak subdivision of the principal lateral lobe, and the shorter adventitious series. The septa are much less lanceolate and more like those of typical Noritidae. The position of the genus is somewhat between *Klamathites* and *Hauerites*, but it has more resemblance to the parent *Lanceolites* than has either of those genera.

The type species, *Fremontites ashleyi*, was erroneously assigned to *Hauerites* by Hyatt and Smith,[83] but new material found later shows different generic characters and necessitates founding a new genus.

Named in memory of the "Pathfinder" of California, Gen. John C. Frémont.

Occurrence: In the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, *Trachyceras* subzone, Shasta County, Calif.

Fremontites ashleyi (Hyatt and Smith)

Plate XXVII, Figures 10–12; Plate LXIII, Figures 6–21

1905. *Hauerites ashleyi.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 104, pl. 38, figs. 10–12.

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[83] Hyatt, Alpheus, and Smith, J. P., The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 104, 1905.

Involute, discoidal, laterally compressed. Whorl high, with flattened convex sides and narrow venter, slightly concave, bounded by sharp marginal shoulder angles. Deeply embracing and deeply indented by the inner whorl. Umbilicus narrow, almost closed, not exposing any of the interior volutions. The height of the whorl is three-fifths of the total diameter, and the width is half the height. It is indented to slightly more than one-third of the height by the inner whorl. The width of the venter between the marginal angles is 2.5 millimeters on a specimen 40 millimeters in diameter. The surface is ornamented with rather strong sigmoidal ribs and parallel cross striae that bend sharply forward in the middle of the flanks and then backward toward the abdominal shoulders, where they again curve forward, slightly crenulating the shoulder angles. The septa are ammonitic but are very little above the ceratitic stage of development, the lobes being only slightly digitate and the saddles slightly serrated. The external lobe is divided by secondary saddles into a series of adventitious lobes, all short and acute; the first lateral is long and wide, somewhat digitate, the second lateral is much smaller and simpler. The auxiliary lobe is divided into several small lobes.

Fremontites ashleyi is most nearly related to *Hauerites aesculapii* Mojsisovics but differs in its flatter and broader venter, shallower ventral furrow, weaker crenulation of the marginal shoulder angles, and less complex septa. Also in *Hauerites aesculapii* the first lateral saddle is unsystematically divided, which is not its condition in *Fremontites ashleyi.*

This species is similar to *Klamathites schucherti* but differs in the less distinctly lanceolate lobes and in the much shorter adventitious series. It also resembles *Hauerites lawsoni,* with which it is associated, but is more robust and larger and has simpler digitation of the septa.

The species was erroneously assigned to *Hauerites* by Hyatt and Smith; further study and the finding of more material have shown the writer that it is not a typical *Hauerites* but that it differs sufficiently to serve as type of a new genus of the same family.

Occurrence: *Fremontites ashleyi* was found in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus, Trachyceras* subzone, 3 miles east of Madison's ranch, in the limestone beds on the divide between Squaw Creek and Pit River, half a mile north of the trail across the divide, in Shasta County, Calif.

Family PINACOCERATIDAE Mojsisovics

Genus PINACOCERAS Mojsisovics

1873. *Pinacoceras.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, p. 65.

1882. *Pinacoceras.* Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 195.

1902. *Pinacoceras.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 293.

1906. *Pinacoceras.* Diener, Fauna of the *Tropites* limestone of Byans: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 161.

Forms strongly compressed, involute, discoidal. Venter acutely carinate. Surface either smooth or with weak folds. · Body chamber short. Septa very deeply and finely digitate, with complex development of the adventitious and the auxiliary series of lobes.

This genus occurs in the Upper Triassic of the Alps and the Himalayas and in America is represented by a single species that is common to those two regions.

Pinacoceras rex Mojsisovics

Plate LXII, Figures 18-20; Plate CIII, Figures 13, 14

1873. *Pinacoceras rex.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, p. 65, pl. 23, figs. 8, 9.

1906. *Pinacoceras rex.* Diener, India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 164, pl. 14, fig. 4.

Involute, laterally compressed, thin, acute venter. Surface nearly smooth, with very weak, low, radial folds. Umbilicus moderately wide. Septa of the exceedingly complex pinacoceran type, with numerous adventitious and auxiliary lobes, all deeply digitate.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.; it is associated with *Tropites welleri, Juvavites subinterruptus, Homerites semiglobosus, Halobia superba,* and other species. It was also found at the same horizon in the Tyrolian Alps, near Hallstatt, Austria; also in the *Tropites* limestone of Byans, in the Himalayas, India. It was somewhat doubtfully identified from the *Juvavites* subzone of Admiralty Island, Alaska, at locality 8848, a point at the north entrance to Herring Bay, where it is associated with a fauna identical with that of the Hosselkus limestone of Shasta County, Calif.

Genus DIENERIA Hyatt and Smith

1905. *Dieneria.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 105.

Type.—Dieneria arthaberi Hyatt and Smith.

Involute, laterally compressed, discoidal, deeply embracing whorls deeply indented by the inner volutions. Sides flattened, venter narrow, with angular margins, and without furrow or keel. Umbilicus very narrow, exposing but little of the inner whorls. Surface smooth, ornamented only with flexuous lines of growth. Septa very simple, just in the transition from the goniatitic to the ceratitic stage. The external lobe is divided by a shallow siphonal notch; the first lateral lobe is broad, shallow, and slightly serrated; the second lateral is smaller and entire; following this the septum runs in a nearly straight line to the umbilical suture, with the auxiliary lobes indicated only by undulations.

This genus resembles greatly *Ambites* Waagen, from which it differs in the slightly serrated first lateral lobe, which in *Ambites* is entire. The young are exactly like *Ambites*.

Dieneria is known only from the Upper Triassic zone of *Tropites subbullatus*, of Shasta County, Calif., where it is represented by a single species.

Dieneria arthaberi Hyatt and Smith

Plate XXXVII, Figures 13–16; Plate LXXXI, Figures 10–25

1905. *Dieneria arthaberi*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 106, pl. 37, figs. 13–16; pl. 81, figs. 10–25.

Form involute, discoidal, laterally compressed. Whorl high and increasing rapidly in height; deeply embracing and deeply indented by the inner whorls. Umbilicus very narrow, almost closed, exposing only the umbilical shoulders of the inner whorls. Sides almost flat; venter narrow and flat, bounded by angular margins; without ventral furrow or keel. The height of the whorl is seven-twelfths of the total diameter, and the width is about one-third of the height. The indentation or involution is less than one-third of the height of the whorl. The surface is smooth and is ornamented only with fine flexuous cross striae of growth. Septa very simple; only the first lateral lobe is slightly serrated, and all the other lobes and the saddles are entire. The external lobe is divided by a shallow siphonal notch into two small branches; the first lateral is broader, deeper, and weakly serrated; the second lateral is small and entire; the auxiliary series is represented by a nearly straight line, with only slight undulations on the flank just above the umbilicus.

The young of this species is more robust than the mature shell and has rounded venters, without abdominal marginal angles. The septa are goniatitic, like those of *Ambites* Waagen, toward which it may be reversionary. *Dieneria arthaberi* has a strong external resemblance to *Fremontites ashleyi* Hyatt and Smith but differs in its less complex septa and in the absence of lateral ribs and abdominal furrow.

The abdominal angles appear at a diameter of 3.5 millimeters, and the first lateral lobe becomes serrated at a diameter of 8 millimeters.

The young stages of *Hauerites* are like the mature forms of *Dieneria*, and both genera in the young stages resemble also *Beneckeia tenuis* Seebach, but the mature form of *Dieneria arthaberi* differs from that species in lacking a ventral keel and in having the septa simpler. In *Beneckeia* both the first and the second lateral lobes are serrated, and the auxiliary series has distinct lobes.

The genus *Ambites*, to which the young stages of *Dieneria* are compared, is assigned by Waagen to the Noritidae, but the writer thinks this group should be assigned to the Pinacoceratidae.

Dimensions of a young specimen of Dieneria arthaberi in the Ambites stage

[See Plate LXXXI, figs. 15–18]

	Millimeters
Diameter	3. 60
Height of last whorl	1. 92
Height of last whorl from preceding	1. 48
Width of last whorl	1. 24
Involution	. 44
Width of umbilicus	. 72

Dimensions of the type specimen of Dieneria arthaberi

	Millimeters
Diameter	15
Height of last whorl	8. 5
Height of last whorl from preceding	6
Width of last whorl	2. 7
Involution	2. 5
Width of umbilicus	2

Occurrence: *Dieneria arthaberi* was found by the writer in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, *Trachyceras* subzone, 3 miles east of Madison's ranch, on the divide between Squaw Creek and Pit River, half a mile north of the trail from Madison's to Brock's ranch, in Shasta County, Calif. It was associated with a large number of typical species of the upper Karnic fauna.

Genus PLACITES Mojsisovics

1896. *Placites*. Mojsisovics, Ueber den chronologischen Umfang des Dachsteinkalkes: K. Akad. Wiss. Wien Sitzungsber., vol. 105, pt. 1, p. 18.

1896. *Placites*. Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Fauna des Himalaya: K. Akad. Wiss. Wien Denkschr., vol. 63, p. 663.

1905. *Placites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 107.

Type.—Group of *Pinacoceras platyphyllum* Mojsisovics.

Form involute, laterally compressed, discoidal, whorls deeply embracing and deeply indented by the inner volutions; sides flattened, venter narrow and rounded. Surface smooth, destitute of all ornamentation. Septa complex, digitate, with an external lobe, two principal lateral lobes, and a series of auxiliaries. At maturity the external lobe is secondarily divided into a short adventitious series.

This genus is characteristic of the Upper Triassic of the Mediterranean and Oriental regions. It began in the Karnic stage but became much more common in the Noric. In America it is represented by a single species, in beds of Noric age in Nevada.

Placites humboldtensis Hyatt and Smith

Plate LVI, Figures 10–25

1905. *Placites humboldtensis.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 107, pl. 56, figs. 10–25.

Involute, discoidal, laterally compressed; whorl high and narrow, increasing rapidly in height, deeply embracing, and deeply indented by the inner volutions; venter narrow and rounded. Surface smooth. Length of body chamber unknown. Septa complex, deeply digitate, showing an external lobe, two principal lobes, and a short auxiliary series. The external lobe is divided into small branches that might be termed an adventitious series, but the septa do not resemble those of the undoubted Pinacoceratoidea, and the species may have to be removed from that group.

Placites humboldtensis Hyatt and Smith is a very near ally of *Placites sakuntala* Mojsisovics,[84] of the Noric stage of India, but differs from that species in the greater complexity and deeper digitation of the lobes and saddles.

Dimensions of the type specimen of Placites humboldtensis

	Millimeters
Diameter	27
Height of last whorl	16
Height of last whorl from preceding	11
Width of last whorl	7.5
Involution	5
Width of umbilicus	0

Occurrence: Upper part (*Pseudomonotis* zone) of Star Peak formation, Muttleberry Canyon, West Humboldt Mountains, on road 8 miles southeast of Lovelocks, Nev., associated with *Pseudomonotis subcircularis* Gabb, *Arcestes andersoni, Rhabdoceras russelli* Hyatt, and *Halorites americanus* Hyatt.

Suborder CERATITOIDEA

Form evolute or involute, laterally compressed; body chamber usually short but long in some genera; surface in most specimens ornamented with ribs, in some specimens with knots or spines. Septa goniatitic in some primitive forms, ceratitic in most, and ammonitic in a few highly specialized genera.

As recognized in this paper the group of Ceratitoidea corresponds to the group as established by Hyatt and Smith[85] with the addition of the Phylloceratidae, as Arthaber[86] has shown that *Monophyllites* comes from the Xenodiscidae.

The Ceratitoidea must have been ultimately derived from the Gephyroceratidae of the Devonian, as shown by the writer[87] in several papers.

Under the Ceratitoidea are included the Ceratitidae, the Hungaritidae, the Meekoceratidae, the Gymnitidae, the Xenodiscidae, and the Phylloceratidae.

Only the Ceratitidae and the Phylloceratidae occur in the Upper Triassic of North America.

Family CERATITIDAE Mojsisovics

Represented in the Upper Triassic of North America by *Trachyceras, Sirenites, Arpadites, Clionites, Dawsonites, Sandlingites, Tirolites (Metatirolites), Polycyclus, Choristoceras, Thisbites*, and *Rhabdoceras*.

The phylogeny of the Ceratitidae has been treated fully by the writer[88] elsewhere, so there is no need of repetition here.

Arthaber[89] names but does not describe a family Trachyceratidae. As this group is not characterized, it is not possible to use it, for there is no idea as to what would be its limits. Eventually, of course, the Ceratitidae will be subdivided into families or subfamilies, but the material in the hands of the writer is not sufficient for such a critical revision as would be necessary.

Genus TRACHYCERAS Laube

1869. *Trachyceras.* Laube, Ueber *Ammonites aon* Münster und dessen Verwandte: K. Akad. Wiss. Wien Sitzungsber., Band 59, Abt. 1, p. 7.

1877. *Trachyceras.* Meek, U. S. Geol. and Geog. Expl. 40th Par. Rept., vol. 4, p. 116.

1879. *Trachyceras.* Mojsisovics, Vorläufige kurze Uebersicht der Ammoniten-Gattungen der Mediterranen und Juvavischen Trias: K.-k. geol. Reichsanstalt Wien Verh., p. 140.

1882. *Trachyceras* (part). Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 93.

1889. *Trachyceras.* Hyatt, in Whiteaves, Fossils of the Triassic rocks of British Columbia: Canada Geol. Survey, Contr. Canadian Palaeontology, vol. 1, pt. 2, p. 142. [=*Dawsonites* Boehm.]

1893. *Trachyceras.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 617.

1896. *Trachyceras.* Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 646.

1898. *Protrachyceras.* Tornquist, Neuere Beiträge zur Geologie und Paläontologie der Umgebung von Recoaro und Schio in Venetien: Deutsche geol. Gesell. Zeitschr., Band 50, Heft 4, p. 659.

1903. *Trachyceras.* Frech, Neue Cephalopoden aus den Buchensteiner, Wengener und Raibler Schichten des südlichen Bakony: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Theil 1, p. 21.

1904. *Trachyceras.* Smith, The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., vol. 1, p. 387.

1905. *Trachyceras.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 191.

[84] Mojsisovics, E. von, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 665, pl. 19, figs. 3–5, 1896.

[85] Hyatt, Alpheus, and Smith, J. P., The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 30, 1906.

[86] Arthaber, G. von, Die Trias von Albanien: Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, Band 24, p. 232, 1911.

[87] Smith, J. P., Acceleration of development in fossil Cephalopoda: Leland Stanford Junior Univ. Pub., univ. ser., p. 21, 1914; U. S. Geol. Survey Prof. Paper 83, pp. 65 et seq., 1914.

[88] Smith, J. P., The Middle Triassic marine invertebrate faunas of North America: U. S. Geol. Survey Prof. Paper 83, pp. 65 et seq., 1914.

[89] Arthaber, G. von, Die Trias von Albanien: Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, Band 24, p. 178, 1911.

1907. *Trachyceras.* Diener, The fauna of the Himalayan Muschelkalk: India Geol. Survey Mem., Palaeontologia Indica, 15th ser., vol. 5, No. 2, p. 94.

1913. *Trachyceras.* Simionescu, Fauna Amonitilor Triasici de la Hagighiol (Dobrogea): Academia Romana Pub. 34, p. 295.

1914. *Trachyceras.* Smith, The Middle Triassic marine invertebrate faunas of North America: U. S. Geol. Survey Prof. Paper 83, p. 127.

Subgenus PROTRACHYCERAS Mojsisovics

1893. *Protrachyceras.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 618.

1896. *Protrachyceras.* Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., vol. 63, p. 646.

1898. *Protrachyceras.* Tornquist, Neuere Beiträge zur Geologie und Paläontologie der Umgebung von Recoaro und Schio in Venetien: Deutsche geol. Gesell. Zeitschr., Band 50, p. 659.

1904. *Protrachyceras.* Smith, The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., vol. 1, p. 387.

1905. *Protrachyceras.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 193.

1914. *Protrachyceras.* Smith, The Middle Triassic marine invertebrate faunas of North America: U. S. Geol. Survey Prof. Paper 83, p. 121.

No type is expressly given by Mojsisovics for this subgenus, but the species first mentioned is *Trachyceras chiesense* Mojsisovics,[90] which is merely a fragment and could hardly have been the typical form in the mind of the author. The first form described under the new subgenus was *Protrachyceras rudolphi* Mojsisovics,[91] which is much more characteristic, but even this species is not well known.

Studies by the writer, Diener, Philippi, and others, show that *Trachyceras* is probably a polyphyletic genus, and that one set of species came from the *Tirolites* stock and the other probably from *Meekoceras.* The stock from which came *Trachyceras aon*, the type of the genus, is not known. The American species seem to have come from the *Meekoceras* branch as far as can be determined by their reversions toward primitive types, but the *Clionites* species associated with them are invariably reversionary toward *Tirolites.*

Trachyceras is represented in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, *Trachyceras* subzone, in Shasta County, Calif., by several very fine species, which form a series or "gross Art" and which suggest complete intergradation, although the extremes are as unlike each other as it is possible for species in the same genus to be.

The species of *Trachyceras* in the American Upper Triassic are arranged in a series that begins with the most compressed and discoidal form and ends with the most robust. They all occur together in the same bed and therefore do not represent an evolutionary series but forms that have departed in different degrees from the ancestral type or that have reverted in different degrees toward that type. Of these the compressed forms are most specialized and least primitive, although they are more strongly reversionary toward the ancient and primitive ancestor *Meekoceras.* The more robust and coarsely sculptured forms are more primitive and are closer to the immediate ancestors in the Ladinic stage, when *Trachyceras* was at its height of development. The series of species is arranged as follows:

Trachyceras lecontei Hyatt and Smith (compressed).
shastense Smith (compressed).
madisonense Smith (somewhat compressed).
lindgreni Smith (intermediate).
beckeri Smith (rugose and robust).
californicum Smith (very robust).

Trachyceras storrsi Smith, which is probably robust, occurs in lower beds and does not belong in the series.

The occurrence of typical species of *Trachyceras* in the zone of *Tropites subbullatus* is an anomaly, for in the Mediterranean region the two faunas never occur together. This anomaly may be explained by *Trachyceras* living later in the California province or by *Tropites* appearing earlier. As the writer has shown that *Tropites* was probably endemic in the California region, the latter explanation is probably correct. At any rate there can be no doubt about the occurrence together of *Tropites* and *Trachyceras*, for the writer has frequently collected them in the same hand specimen.

Trachyceras (Protrachyceras) lecontei Hyatt and Smith

Plate VI, Figure 1; Plate XLIV, Figures 1, 2; Plate XLV, Figures 1-9; Plate XLVI, Figures 1-15

1905. *Trachyceras (Protrachyceras) lecontei.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 194, pl. 44, figs. 1, 2; pl. 45, figs. 1-9; pl. 46, figs. 1-15.

Form discoidal, involute, laterally compressed. Whorls narrow, high, deeply embracing but not deeply indented by the inner volutions. Umbilical shoulders abruptly rounded, inner walls steep, umbilicus narrow, exposing very little of the inner whorls. Sides flattened, with the greatest width just above the shoulders, sloping with gentle convexity up to the margin. Venter very narrow, slightly flattened, and with shallow median furrow, bounded by a row of small tubercles. The height of the whorl is more than twice its width and nearly three-fifths of the total diameter. The whorl is indented to one-fourth of its height by the inner volution and conceals two-thirds of this volution. The width of the umbilicus of the adult is about one-eighth of the total diameter of the shell, whereas that of the adolescent stages is much narrower proportionally, being only about one-tenth.

[90] Mojsisovics, E. von, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 95, pl. 34, fig. 4, 1882.

[91] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 623, pl. 166, figs. 2, 3, 1893.

The surface is ornamented with very fine forward-curving radial ribs and coarser spiral ridges. These ridges number about twelve on the sides and form small tubercles where they cross the radial ribs. These spiral rows of tubercles are closer together near the ventral margin than on the flanks. On the umbilical shoulders there is a row of somewhat coarser knots.

The septa are ammonitic, the lobes and saddles deeply digitate. The external lobe is divided by a small siphonal saddle into two short and broad divisions; the first lateral is broad and deep; the second lateral is similar in shape to the first but much shorter and not so deeply digitate. The auxiliary is broad and shallow, with several divisions. The external saddle is somewhat narrower than the first lateral lobe and long; the second is somewhat longer but not so deeply divided. The auxiliary saddle is shorter and broader in proportion to its length. The antisiphonal lobe is long and narrow and is flanked by three internal laterals on each side.

The earlier larval stages are smooth, the radial ribs beginning as fine folds at a diameter of about 2.5 millimeters. The spiral rows of tubercles appear at a diameter of 4 millimeters, at first with only a few rows and the tubercles wide apart.

The septa begin to be ammonitic at a diameter of 4 millimeters, there being no ceratitic stage intervening between the goniatitic and the ammonitic stages of development.

Until the appearance of the spiral rows of tubercles the whorls are evolute, low, and broad, but at this stage they begin to be involute and laterally compressed.

Dimensions of some specimens of Trachyceras lecontei

	1	2	3	4	5	6
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
Diameter	3. 91	5	8. 3	12	26	40
Height of last whorl	2. 04	3. 3	4. 5	7	15	23. 5
Height of last whorl from preceding	1. 70	2. 5	3. 6	5	12. 5	18
Width of last whorl	2. 46	3	4. 5	5. 5	10	13
Involution	. 34	. 8	. 9	2	2. 5	5. 5
Width of umbilicus	. 76	1	1. 4	1. 7	2. 5	4

Dimensions and ratios of type specimens of Trachyceras lecontei

[See Pl. XLIV, figs. 1, 2]

	Dimensions (millimeters)	Ratios
Diameter	141	1
Height of last whorl	83	. 59
Height of last whorl from preceding	60	. 42
Width of last whorl	41	. 29
Involution	23	. 17
Width of umbilicus	14	. 10

Trachyceras lecontei resembles *Trachyceras attila* Mojsisovics [92] but differs from that species in its greater lateral compression, finer sculpture, more complex septa, and narrower umbilicus.

Occurrence: *Trachyceras lecontei* is not uncommon in the Upper Triassic Hosselkus limestone, in the *Tropites subbullatus* zone, *Trachyceras* subzone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, half a mile north of the trail from Madison's to Brock's ranch, Shasta County, Calif. It is associated with *Tropites subbullatus*, *Paratropites sellai*, *Discotropites sandlingensis*, *Halobia superba*, and many other species characteristic of this horizon. In the same bed were found several other species of *Trachyceras*, all apparently new but nearly related to Alpine forms.

Trachyceras (Protrachyceras) beckeri Smith, n. sp.

Plate IV, Figures 1–8

Form at maturity robust, thick set, with broadly rounded venter, involute, deeply embracing. Surface with coarse ribs and strong spiral rows of spines. Body chamber short. Septa deeply digitate.

In youth laterally compressed, with very fine rows of spiral lines that form weak knots on the low radial ribs. At maturity the form and sculpture are very like those of *Trachyceras californicum* and in youth like *Trachyceras shastense*. The change is sudden, and the growth of *Trachyceras beckeri* forms a sharp contrast to that of the other two species mentioned. *Trachyceras shastense* is uniformly rather compressed and finely sculptured from youth to old age, and *Trachyceras californicum* is equally uniformly robust and coarse through life. The suddenness of the change suggests reversion from the highly specialized type of *Trachyceras shastense* to the primitive type of *Trachyceras californicum*, although all three species were collected from the same bed. This species probably shows a prolongation of ontogeny.

Named in memory of Dr. G. F. Becker.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was associated with *Tropites subbullatus*, *Paratropites sellai*, *Discotropites sandlingensis*, *Trachyceras californicum*, *Proclydonautilus triadicus*, *Halobia superba*, and other forms.

Trachyceras (Protrachyceras) californicum Smith, n. sp.

Plate I, Figures 1, 2; Plate II, Figures 1–7

Large, robust, involute, with gently convex sides, rounded shoulders, arched venter with deep furrow. Surface with radial ribs branching in pairs on the umbilicus and a second time on the ventral shoulders; spiral rows of spines alternating in size from umbilicus to venter, three rows on the flanks and two rows on the ventral slope being finer than the others; the

[92] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 633, pl. 169, figs. 6–9; pl. 170, figs. 1, 2, 1893.

coarse spines lie in five rows, four on the sides, and one on the border of the ventral furrow. Rather fine spiral lines connect the spines and give a beautifully cancellate appearance to the outer shell. The ribs become strong and the spines weak at maturity. There are 14 umbilical knots and about twice as many shoulder knots to a revolution. The spiral rows or lines are about 10 in number, forming spines where they cross the ribs. Numerous intercalary ribs alternate with the primary series. Body chamber about two-thirds of a revolution in length. Septa deeply digitate, with long and wide external lobe, a larger first lateral, a somewhat smaller second lateral, and large well-developed auxiliary lobe, all lobes and saddles being rather deeply divided by many secondary branches.

In youth the spines are much stronger and the shell more rugose than at maturity, which gives some suggestion of *Nevadites* as the possible ancestor.

Dimensions of the type specimen of Trachyceras californicum

	Millimeters
Diameter	170
Height of last whorl	90
Width of last whorl	63
Involution	18
Width of umbilicus	26

The height of the whorl is more than half the total diameter, the width is two-thirds of the height, and the inner whorl is embraced to two-thirds of its height by the outer. The umbilicus is narrow for this group—less than one-sixth of the diameter of the shell.

Trachyceras californicum is nearest to *Trachyceras gredleri* Mojsisovics[93] but is distinguished by its greater involution, greater lateral compression, and stronger ribs and spines. It is distinguished from *Trachyceras ladinum* Mojsisovics[94] by its more robust whorl and coarser sculpture and is somewhat intermediate between the two Mediterranean species.

Trachyceras californicum is distinguished from *Trachyceras lindgreni* by its greater involution and coarser spines. These differences persist even in youth, for *Trachyceras californicum* is robust and rugose even at a very small size, but in the other American species of robust *Trachyceras* the young stages show much weaker sculpture.

Occurrence: This species was found by the writer in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, at the south end of Brock Mountain, about halfway between Squaw Creek and Pit River, Shasta County, Calif. It was in the same bed with *Tropites subbullatus, Paratropites sellai, Discotropites sandlingensis, Sagenites herbichi, Proclydonautilus triadicus, Clionites fairbanksi, Halobia superba,* and many other species characteristic of this horizon. Either *Trachyceras* lived longer in the California province, or else, as the writer believes, *Tropites* appeared there earlier than it did in the Mediterranean region. In Europe *Trachyceras* does not occur along with *Tropites*, but on Brock Mountain the writer repeatedly found them both in the same hand specimen, and at each place unmistakably in the same bed.

[93] Mojsisovics, E. von, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. Geol. Reichsanstalt Wien Abh., Band 10, p. 117, pls. 17, 18, 1882.

[94] Idem, p. 125.

Trachyceras (Protrachyceras) lindgreni Smith, n. sp.

Plate III, Figures 1–6

Form large, robust, involute, narrowly umbilicate, with flattened sides, rounded venter, and deep furrow. Whorls deeply embracing and rather deeply indented by the inner whorls. Surface shows rather fine radial ribs and fine rows of knots instead of spines on the shell, alternating irregularly, in some places with two intermediate finer rows instead of one. Also the ribs do not bend forward at the ventral shoulder knots. The body chamber is about two-thirds of a revolution in length. The septa are deeply digitate, as in all this group of *Trachyceras*, very like those of *Trachyceras californicum.*

Trachyceras lindgreni is intermediate between *Trachyceras madisonense* and *Trachyceras californicum*, with which it is associated; more robust and with coarser sculpture than *Trachyceras madisonense*; more compressed and with weaker spines and ribs than *Trachyceres californicum.* It is also somewhat similar to *Trachyceras ladinum* Mojsisovics, of the Mediterranean region but differs in the details of its surface sculpture, as will be seen from the figures.

Named in honor of Prof. Waldemar Lindgren.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was associated with *Tropites subbullatus, Paratropites sellai, Clionites fairbanksi, Proclydonautilus triadicus, Halobia superba,* and many other species characteristic of this horizon.

Trachyceras (Protrachyceras) madisonense Smith, n. sp.

Plate VI, Figures 2–14

Form moderately robust, somewhat compressed laterally, involute, narrowly umbilicate, with flattened sides and rather narrow arched venter. Surface with fine radial ribs and medium-sized knots arranged in spiral rows. Septa digitate but not deeply so. Body chamber short.

Trachyceras madisonense is intermediate between *Trachyceras shastense* and *Trachyceras lindgreni.* It is more robust and more coarsely sculptured than *Trachyceras madisonense* and is more compressed and less strongly ornamented with ribs and spines than *Trachyceras lindgreni*. It is also a smaller species than either of those.

Named for Madison's ranch, for many years the starting point for geologic work in this region.

Occurrence: Not uncommon in the Upper Triassic Hosselkus limestone, in the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was associated with *Tropites subbullatus*, *Paratropites sellai*, *Discotropites sandlingensis*, *Trachyceras californicum*, *Clionites fairbanksi*, *Proclydonautilus triadicus*, *Halobia superba*, and other species.

Trachyceras (Protrachyceras) shastense Smith

Plate V, Figures 1–19

1904. *Trachyceras* (*Protrachyceras*) *shastense*. Smith, The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., vol. 1, p. 391, pl. 46, figs. 9, 9a; pl. 48, figs. 3, 4.

Form involute, subrobust, laterally compressed, whorls deeply embracing and deeply indented by the inner volutions. Sides flattened, venter narrow and rounded, with shallow ventral furrow. Umbilicus narrow, exposing only the umbilical shoulders of the inner whorls. The height of the whorl is more than half the diameter, and the width is two-thirds of the height; the whorl is impressed to more than one-fourth of its height by the inner volution. The width of the umbilicus is slightly more than one-seventh of the total diameter of the shell. The surface is ornamented with fine dichotomous falcoid radial ribs and fine spiral rows of knots on the ribs. There are about eleven of the spiral rows of knots, which are rudimentary spines. As the shell grows older the number of rows is augmented by intercalating secondary rows, smaller than the primary. The row of spines bordering the ventral furrow is the coarsest, as in most of the Trachycerata.

Trachyceras shastense is most nearly related to *Trachyceras lecontei*, with which it is associated, but differs from it in the more robust whorl and coarser sculpture; the radial ribs are coarser and the spiral rows of knots are coarser and fewer. It differs from *Trachyceras attila* Mojsisovics in being less robust and in its finer sculpture and also in its more complex septa.

Occurrence: Rather common in the Upper Triassic Hosselkus limestone, in the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Trachyceras (Protrachyceras) storrsi Smith, n. sp.

Plate VII, Figures 1–4

Form large, robust, involute, deeply embracing. Surface with coarse curved bifurcating ribs and six to seven spiral rows of coarse knots on the ribs. In youth the ribs are much finer, with more numerous and smaller spines. Septa and length of body chamber unknown.

Trachyceras storrsi resembles *Trachyceras gredleri* Mojsisovics, but the state of preservation prevents nearer comparison, for *Trachyceras storrsi* is known only in compressed casts in slates.

Named in honor of James Storrs, who assisted J. S. Diller in his work in northern California.

Occurrence: Very common in the Upper Triassic *Halobia rugosa* zone of the Pit shale, about 200 feet below the Hosselkus limestone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus SIRENITES Mojsisovics

1893. *Sirenites*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 725.

1896. *Sirenites*. Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., vol. 63, p. 649.

1905. *Sirenites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 193.

Type.—Ammonites senticosus Dittmar.[95]

Involute, robust, laterally compressed, deeply embracing, and deeply indented by the inner whorls. Sides flattened convex; whorls high and increasing rapidly in height. Venter broad, with somewhat abrupt abdominal shoulders and distinct ventral furrow. Sculpture consists of strong ribs that start out from the umbilicus and run nearly straight or with sigmoidal bend to the abdominal shoulders, where they bifurcate on strong knots and then bend sharply forward. There are also spiral rows of knots or spines on the lateral ribs. The septa are ammonitic, like those of *Trachyceras*, from which *Sirenites* differs in the bifurcation of the ribs and the forward bending at the knots on the abdominal shoulders. The body chamber is short, and the other characters like those of *Trachyceras* or *Protrachyceras*, from which latter group Mojsisovics supposes *Sirenites* to have been derived. The various subgenera of this genus are not represented in the American region, so it is unnecessary to discuss them.

Sirenites is characteristic of the Upper Triassic and Noric stages. In America it is known only in the zone of *Tropites subbullatus*. The species described below is the only one known in the United States.

[95] Dittmar, A. von, Zur Fauna der Hallstätter Kalke, in Benecke, E. W., Geognostische-palaeontologische Beiträge, Band 1, p. 375, pl. 17, figs. 8, 9, 1866.

Sirenites lawsoni Hyatt and Smith

Plate XLVI, Figures 16, 17; Plate XLVII, Figures 1–9

1905. *Sirenites lawsoni.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 198, pl. 46, figs. 16, 17; pl. 47, figs. 1–9.

Involute, robust, somewhat compressed laterally. Whorls deeply embracing and deeply indented by the inner volutions. The height of the whorl is half the total diameter; the breadth is four-fifths of the height, and the indentation is about one-sixth of the height. The greatest breadth is at the umbilical shoulders; the flanks converge steeply to the abdominal shoulders, where the width is reduced to one-half. The venter is arched but low, rising but little above the shoulders. The umbilicus is deep and narrow; it is only one-sixth of the diameter but exposes nearly all the inner whorls. The umbilical shoulders are abrupt, with nearly vertical inner slope. Although the outer whorl is deeply embracing, covering two-thirds of the inner, the two whorls are scarcely in contact. The shell is uncoiling, for the young stages show much greater involution than is visible at maturity. The sculpture consists of radial ribs, provided with short spines or knots, fine spiral lines on the outer shell, and a shallow ventral furrow. The ribs bend slightly backward on the flanks until they reach the shoulders, where they develop large knots, bifurcate, and turn abruptly forward, ending in a single row of knots on the margins of the ventral furrow. The alternate ribs also usually bifurcate on the flanks, not far above the umbilicus. The knots or spines are obscure on the flanks but become very strong on the shoulders. There is a second smaller row above the shoulders, halfway between them and the row of knots on the margins of the furrow. The septa are ammonitic, like those of *Trachyceras*, both lobes and saddles being strongly digitate.

The young stages are involute and globose in shape, with coarse radial ribs and rows of knots arranged in spiral lines. They resemble exactly the *Brotheus* stage in the development of *Trachyceras* and do not retain any trace of *Tirolites*. At the diameter of 6 millimeters the alternate ribs become larger than the others, soon developing into prominent folds with two or three ribs between them. At a diameter of 25 millimeters the folds lose their prominence, the shoulders and the shoulder knots are developed, and the shell enters the *Sirenites* stage, which is characterized by the furrow and the bifurcating ribs. The form now becomes more compressed laterally, and from this stage onward little change takes place except increase in size and in relative height of the whorls.

Mojsisovics considered this genus as a descendant of *Protrachyceras*, and its development shows it to be nearly related to that subgenus. In fact, it is very doubtful whether such a minor character as the bundling of the ribs on the shoulders should be regarded as of generic importance. However, it does not agree exactly with any of the species of *Protrachyceras* known in America, and therefore the writer has retained the name as it is customarily used.

Occurrence: In the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, *Trachyceras* subzone, on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch, and half a mile north of the trail to Brock's ranch in Shasta County, Calif. The young of this species are not uncommon in the limestone at this locality, but only one adult specimen was found.

The specific name is given in honor of Dr. A. C. Lawson.

Sirenites hayesi Smith, n. sp.

Plate CIII, Figures 7, 8

Shell small, involute, with flattened, compressed sides, and narrow, high, deeply channeled venter. Surface ornamented with sigmoidal ribs that bifurcate at one-third of the distance up the flanks from the umbilicus and bend sharply forward on the ventral shoulders. There are also five rows of nodes or short spines—one on the umbilical shoulder, two on the flanks, one on the ventral shoulder, and one on the ridge bordering the ventral furrow. There are also faint suggestions of secondary rows of nodes on the flanks between the primaries. Septa and length of body chamber unknown.

Sirenites hayesi is most nearly related to *Sirenites senticosus* Dittmar, from the Karnic stage of the Tyrolian Alps, from which it differs chiefly in the somewhat coarser ribs and nodes; otherwise the two species show a remarkable resemblance.

Named in honor of Dr. C. W. Hayes.

Occurrence: Very rare in Upper Triassic rocks of Karnic age at locality 8479, United States Geological Survey, about 3 miles from foot of glacier on Middle Fork of White River, near Skolai Pass in the Alaskan Range; associated with *Halobia* cf. *H. superba*. This locality is referred by G. C. Martin[96] to the *Pseudomonotis* zone, which was based on a mistaken identification of the *Sirenites* and the *Halobia*.

Genus SANDLINGITES Mojsisovics

1893. *Sandlingites.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 70.

1896. *Sandlingites.* Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 648.

1905. *Sandlingites.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 200.

Type.—*Ammonites oribasus* Dittmar.[97]

[96] Martin, G. C., Triassic rocks of Alaska: Geol. Soc. America Bull., vol. 27, p. 696, 1916.

[97] Dittmar, A. von, Zur Fauna der Hallstätter Kalke, in Benecke, E. W., Geognostische-palaeontologische Beiträge, Band 1, p. 384, pl. 18, figs. 8-10, 1866. Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 706, pl. 167, figs. 5-7, 1893.

Evolute, little embracing, subquadratic whorls, increasing slowly in height. Umbilicus wide and rather shallow. Venter flattened, with shallow ventral furrow, not bounded by keels. Surface ornamented with smooth falcoid dichotomous ribs that cross the ventral furrow. In early youth the form is like *Tirolites*, and next it becomes like *Protrachyceras*, with spines on the ribs. Toward maturity the spines become obsolete, and the ventral furrow almost disappears. The septa are ceratitic on all the forms known and appear to be even goniatitic on some species.

This genus is made up wholly of dwarf forms, probably degenerates, and is confined largely to the Karnic stage of the Upper Triassic, but a very few species are found in the Noric stage.

In America this genus has been found only in beds of Karnic age, zone of *Tropites subbullatus*.

Sandlingites andersoni Hyatt and Smith

Plate XLVII, Figures 10–12

1905. *Sandlingites andersoni.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 200, pl. 47, figs. 10–12.

Form evolute, laterally compressed, with whorls little embracing, and little indented by the inner volutions. Cross section of whorl subquadratic, the height being equal to the breadth and somewhat more than one-third of the total diameter of the shell. The flanks are flattened and the umbilical and abdominal shoulders abruptly rounded; the venter is low. The umbilicus is shallow and broad, being more than one-third of the diameter of the shell. The surface is ornamented with radical ribs, which begin in blunt spines on the umbilical shoulders; the alternate ones generally bifurcate there, run straight up the flanks, branch a second time on the abdominal shoulder knots, and then cross the venter with a forward bend. On these ribs on each side there are four rows of knots, or blunt spines, one row on the abdominal shoulders, and a fourth row on the venter. The ventral pair of spine rows do not stand opposite each other, but alternate. The septa are ceratitic, only the lobes being weakly serrated; there is a small divided ventral, a large lateral lobe, small second lateral, and a smaller auxiliary at the umbilical suture. The body chamber seems to have been three-fourths of a revolution in length.

The young portion of the shell shows a decided resemblance to *Anolcites*, which is, doubtless, the ancestor of *Sandlingites*.

Occurrence: In the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, *Trachyceras* subzone, on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch, and half a mile north of the trail to Brock's ranch, in Shasta County, Calif.

Only a single specimen was found in five seasons of collecting at this locality, where ammonites are extremely abundant in the lower beds of the Hosselkus limestone.

The specific name is given in honor of Frank M. Anderson, who assisted in collecting the rich fauna obtained at this place.

Sandlingites oribasus (Dittmar)

Plate LVII, Figures 24–27

1866. *Ammonites oribasus.* Dittmar, Zur Fauna der Hallstätter Kalke, in Benecke, E. W., Geognostische-palaeontologische Beiträge, Band 1, p. 384, pl. 18, figs. 8–10.

1893. *Sandlingites oribasus.* Mojsisovics, Die Cephalopoden der HallstätterKalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 706, pl. 167, figs. 5–7.

Dwarf form, evolute, little embracing, widely umbilicate; whorls increase rather rapidly in height and give a discoidal appearance to the shell. Sides compressed, venter rounded, with a very low median depression, the remnant of the trachyceran furrow. Surface with very fine ribs, alternately dichotomous on the umbilicus, often forking a second time about two-thirds of the distance up the flanks and ending at the ventral depression without alternation on opposite sides. There are rudimentary knots at the second bifurcation. In youth the ribs cross the venter without interruption or furrow. The body chamber is less than two-thirds of a revolution in length. Septa goniatitic, with scarcely divided ventral lobe, one large lateral, and a small auxiliary.

Sandlingites oribasus is an arrested form, partly reversionary to the ancestors of the Trachyceratea but retaining the traces of trachyceran form and sculpture.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus CLIONITES Mojsisovics

1893. *Clionites.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 451.

1896. *Clionites.* Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 624.

1905. *Clionites.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 181.

Type.—Clionites angulosus Mojsisovics.[98]

Evolute, little embracing, whorl low, breadth usually equal to the height, increasing slowly in height. Umbilicus wide and shallow. Umbilical shoulders abrupt, sides flattened, venter somewhat flattened, with distinct abdominal shoulders. Surface

[98] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 465, pl. 122, fig. 10, 1893.

ornamented with strong ribs, generally dichotomous, which run nearly straight up the sides and commonly bifurcate just below the shoulders and then bend sharply forward. There is a ventral furrow, bounded by ridges made by the ends of the ribs. These ridges are rows of knots or spines, and the ribs are provided with similar knots arranged in spiral rows from the umbilical shoulders to the ridges bordering the furrow. Although these spines are present on most species of this group, they are lacking on the first species mentioned and described by Mojsisovics, *Clionites angulosus*, and therefore this form is only technically the type. The body chamber is short, as in most of the Ceratitidae. The septa are ceratitic; the external lobe is divided by a shallow siphonal saddle into two short narrow branches, which may be either entire or slightly serrated; the lateral lobe is larger and invariably serrated; and there is also an auxiliary lobe on the umbilical shoulder. The saddles are all rounded and entire.

Mojsisovics regarded this group as a subgenus of *Arpadites*, from which it differs in the greater evolution and in the strong spiny ribs and the ventral furrow bounded by rows of knots instead of continuous marginal keels, and also in having one lobe less on the sides. For these reasons, and because several distinct subgeneric groups may be distinguished under it, the writer regards *Clionites* as an independent genus. Although it probably had a common origin with *Arpadites*, it is neither ancestor nor descendant of that genus and therefore should have independent rank.

This group is abundantly represented in the Upper Triassic of the Mediterranean region, of India, and of California. All known species are evolute, widely umbilicate, with whorls low and increasing slowly in height; the umbilical and ventral shoulders are abrupt, the sides flattened, and the venter low, with a median furrow bounded by low ridges. The surface is always rugose, with radial ribs, either simple or bifurcating, and spiral rows of knots or spines. The body chamber is short, and the septa always ceratitic.

This group has been shown by the writer to be a reversionary degenerate genus, derived from *Trachyceras*. It is reverting in septa and form to *Tirolites*, though it retains the trachyceran furrow in all species and the sculpture of that genus in most of them. It is one of the best examples of arrested development and shows the usual variability of such forms. It is very difficult to draw specific lines in it, and even to distinguish the subgenera or groups of species.

Clionites is represented in the Upper Triassic of America by a large number of species, which for convenience are separated into groups or subgenera. These species are more closely related to the Indian species than to those of the Mediterranean region.

GROUPS OF CLIONITES IN THE AMERICAN TRIASSIC

1. Group of *Clionites fairbanksi* Hyatt and Smith (*Traskites* Hyatt and Smith): All American species of *Clionites* are retarded and arrested in different degrees. Of these the group of *Clionites fairbanksi* is least retarded and most nearly normal. It is retarded in septation to the stage of development of the primitive Trachyceratea of the Middle Triassic, but the forms have much of the shape and ornamentation of *Protrachyceras* of the Upper Triassic. Its changes in ontogeny are slow but regular, and the *Tirolites* stage occurs early in its history and is not unduly prolonged. It has dropped behind its immediate ancestors only a little and is only slightly reversionary.

The two species of this group, *Clionites fairbanksi* Hyatt and Smith and *Clionites americanus* Smith, were formerly considered by the writer as belonging to *Clionites* s. s., but later collecting and study show that it intergrades with *Traskites*.

2. Group of *Clionites robustus* Hyatt and Smith (*Traskites* Hyatt and Smith): This group at maturity is still very like *Trachyceras* in form and sculpture, with strong spines on well-developed ribs and the deep trachyceran furrow, but its septa are merely ceratitic. It also shows considerable retardation in the prolongation of ontogeny, in the persistence and exaggeration of the *Tirolites* stage, with low, square, broad whorl, with projecting shoulders and strong shoulder knots—the so-called "*Californites*" stage—until very late in life. But it does finally grow out of this stage before maturity. *Clionites tornquisti* Smith is transitional from group 1.

Represented in America by *Clionites robustus* Hyatt and Smith, *Clionites stantoni* Smith, *Clionites tornquisti* Smith, and *Clionites nanus* Smith.

3. Group of *Clionites compressus* Hyatt and Smith (*Shastites* Hyatt and Smith): These species are very like the group of *Clionites fairbanksi* in their slow and orderly development and also in the retention of ancestral trachyceran shape and sculpture and in the retarded septation. Degeneration is shown chiefly in loss of sculpture at maturity and reduction of the spines to rows of blunt nodes. The group is more reversionary and more distinctly arrested in development than the group of *Clionites fairbanksi,* from which it must have been derived.

Represented in America by *Clionites compressus* Hyatt and Smith, *Clionites compactus* Smith, and *Clionites whitneyi* Smith.

4. Group of *Clionites rugosus* Hyatt and Smith (*Stantonites* Hyatt and Smith): This group is arrested in the ceratitic stage of septation and also has the sculpture very much reduced, the trachyceran spines being reduced to rows of nodes. It has also become extremely evolute, thus showing degeneration in the

tendency to unroll. The *Tirolites* stage is very much prolonged, but the shell grows out of it completely and gradually before maturity.

Represented in America by *Clionites evolutus* Smith and *Clionites rugosus* Hyatt and Smith.

5. Group of *Clionites californicus* Hyatt and Smith (*Neanites* Hyatt and Smith): This group is still more retarded and prolongs the *Tirolites* stage with the additional characters of pronounced sculpture (the *Californites* stage) almost to maturity, in exaggerated development. Then suddenly at maturity it grows out of this stage, becomes high-whorled, and loses its strong sculpture.

This group is developed out of that of *Clionites robustus* by prolongation of the ontogeny, and though it is not exactly a persistent ancestral type it lingers persistently in some of the ancestral characters.

Represented in America by *Clionites californicus* Hyatt and Smith, *Clionites minutus* Smith, and *Clionites osmonti* Smith.

6. Group of *Clionites merriami* Hyatt and Smith (*Californites* Hyatt and Smith): This group is completely retarded in the stage with strong *Tirolites* characters, simple septa and exaggerated shoulder knots, but still has the trachyceran furrow and sculpture which *Tirolites* never had. It is a persistent adolescent stage, with nearly complete arrest of development, the final chapter in the downward progress of the race, unless perhaps *Metatirolites* should fill this place in the reverse phylogeny.

Represented in America by *Clionites careyi* Smith and *Clionites merriami* Hyatt and Smith.

Subgenus TRASKITES Hyatt and Smith

1905. *Traskites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 186.

Type.—Clionites robustus Hyatt and Smith.

Evolute, little embracing, whorls low and broad, with quadratic cross section. Venter broad and flattened, with distinct ventral furrow, bordered by rows of spines. Sides ornamented with strong, straight ribs, provided with short spines from the umbilicus to the square abdominal shoulders, where there is a row of strong spines. Rows of spines also occur on the ribs where they cross the venter between the abdominal shoulders and the ridges bordering the furrow.

The young persist in the *Californites* stage of growth until late in life and make the transition to the *Traskites* type of sculpture quite suddenly. Septa ceratitic. Body chamber short.

This group looks very like *Distichites* Mojsisovics but is distinguished by having ceratitic instead of ammonitic septa. It is known only in the Upper Triassic zone of *Tropites subbullatus* of Shasta County, Calif.

Clionites (Traskites) americanus Smith, n. sp.

Plate LXIV, Figures 1–15

Form evolute, little embracing, and little impressed by the inner volution, widely umbilicate. Whorls with angular ventral and umbilical shoulders, flat, vertical flanks, and low venter, with deep ventral furrow. Surface with stout lateral ribs alternating in size, the alternate coarser ribs bifurcating at the coarse shoulder knots and running obliquely forward to the ridge bordering the ventral furrow. There are six rows of spines, two of which are coarse—those on the umbilical shoulder and on the ventral shoulder. The two rows on the flanks and the row on the ventral ridge are somewhat finer, and the row in the middle of the slightly sloping ventral arc is very fine. The row of shoulder spines is alternately coarse and fine, which gives a very characteristic ornamentation to the shell. The body chamber is short, about three-fourths of a revolution. The septa are ceratitic, with entire saddles and serrated lobes.

Clionites americanus is distinguished from *Clionites fairbanksi* by its square shoulders, less compressed whorl, and the more pronounced alternation of the ribs and spines. It differs from *Clionites tornquisti* Smith in its less rectangular cross section and fine sculpture. It is a smaller species than either of those, and shows old-age characters at a much smaller size. *Clionites americanus* belongs in the series *Clionites fairbanksi* and *Clionites americanus*, both of which are very closely related and form rather a "gross Art" than two sharply defined species. They are both equally arrested and reversionary, having been retarded in the *Tirolites* stage in form but retaining the furrow and an equal amount of the trachyceran sculpture.

As in all arrested and reversionary groups the separation of species is exceedingly difficult and uncertain; there are no two individuals exactly alike, in either form or sculpture, so that it is much easier to multiply them unnecessarily than to limit them correctly.

Occurrence: Exceedingly abundant in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Clionites (Traskites) fairbanksi Hyatt and Smith

Plate XL, Figures 1–11; Plate XLI, Figures 1–14

1905. *Clionites fairbanksi*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 183, pl. 40, figs. 1–11; pl. 41, figs. 1–14.

Evolute, discoidal, widely umbilicate, laterally compressed. Whorl low and increasing slowly in height, little embracing, and little indented by the inner volutions. The umbilical shoulders are abrupt, with steep inward slope; the sides are flattened, and slope gently outward, so that the whorl is slightly broader at the abdominal than at the umbilical shoulders. The cross section is subrectangular, and the breadth of the whorl is five-sixths of the height. The abdominal shoulders occur at three-fourths of the height of the whorl and slope abruptly to the rather high venter. The height of the whorl is slightly more than one-third of the total diameter of the shell, and the indentation is about one-tenth of the height. The umbilicus is wide and shallow and is two-fifths of the total diameter. The surface is ornamented with coarse radial ribs, which begin in knots on the umbilical shoulder, run nearly straight up the flanks, bend abruptly forward at the abdominal shoulders, and end in knots on the sides of the ventral furrow. The alternate ribs bifurcate on the abdominal shoulder, so that the ventral ribs are finer than those on the flanks. On the ribs there are spiral rows of short spines, five rows on the flanks, and two between the abdominal shoulder knots and the ventral furrow.

The septa are ceratitic, the saddles all rounded and entire, the lobes all serrated. The ventral lobe is divided by a short siphonal notch into two narrow, slightly serrated branches, which fall upon the external row of knots. The first lateral, which falls on the abdominal shoulders, is broader and deeper, with fine serrations; the second lateral is about one-third the size of the first, generally trifid, and falls on the umbilical shoulder. On the umbilical slope, partly concealed by the involution, is a small auxiliary lobe, only slightly serrated.

The length of the body chamber is nearly three-fourths of a revolution.

In old age the ribs come much closer together, the spines become longer, and one or two additional rows of knots are intercalated on the flanks. The whorl becomes rounder, nearly as broad as high, and the abdominal shoulders cease to be angular. The species grew to a diameter of at least 80 millimeters, for several broken specimens of that size have been found. Senile degeneration usually begins at a diameter of about 60 millimeters, although on some specimens it begins prematurely at a diameter of 40 millimeters.

In the larval stage the whorl is broader than high, with trapezoidal cross section, narrow flanks, angular abdominal shoulders, and broad, flattened venter. The surface is ornamented only with umbilical ribs, forming nodes on the abdominal shoulders. There are no spines and no ventral furrow, and the abdomen is smooth. This stage corresponds to *Tirolites.*

At a diameter of about 5 millimeters the ribs begin to extend beyond the shoulders, ending in a row of knots on each side of the center, although as yet there is no ventral furrow. At about 6 millimeters the furrow begins to show, and the shell enters the *Californites* stage. The whorl now grows steadily higher in proportion to its width, the rows of incipient spines begin to be visible, and at a diameter of about 10 millimeters the shell enters the *Clionites* stage, although it does not attain the characters distinctive of this species until it reaches a diameter of 25 millimeters.

The nearest described species to *Clionites fairbanksi* is *Clionites woodwardi* Mojsisovics [99] from the Noric stage of the Upper Triassic of India, but the Indian species has fewer spiral rows of knots and a much wider ventral furrow. The dimensions and other characters of the two species appear to be identical.

Clionites spinosus Mojsisovics, from the same horizon in India, is more similar to the California species in its sculpture but differs in its lower and broader whorl.

Dimensions of the type specimen of Clionites fairbanksi

[See Pl. XL, figs. 1-4]

	Millimeters
Diameter	65
Height of last whorl	22. 5
Height of last whorl from preceding	20. 5
Width of last whorl	17. 5
Involution	2
Width of umbilicus	25. 5

Dimensions of specimens of Clionites fairbanksi in younger stages

	1	2	3	4	5	6	7
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
Diameter	5. 08	7. 50	10. 20	14	17. 5	32	47
Height of last whorl	1. 64	2. 60	3. 40	5	6. 3	11. 5	18
Height of last whorl from preceding	1. 40	2. 20	3. 10	4. 6	5. 3	10. 2	15. 5
Width of last whorl	2. 60	3. 80	4. 70	5. 2	7	10. 3	13. 5
Involution	. 24	. 40	. 30	. 40	1	1. 3	2. 5
Width of umbilicus	2. 24	3. 08	4. 20	5. 5	7	13	18

Clionites fairbanksi is the most typical member of the genus in the American fauna. It is an exceedingly variable species, and it was found very difficult to draw the line between this and kindred forms. The young stages especially are more and more alike the smaller they are taken, so that it becomes nearly impossible to distinguish the young of this species from those of several others in the larval and early adolescent stages, and it is even difficult to distinguish the young of *Clionites* s. s. from those of the subgenera *Traskites, Stantonites,* and *Shastites* until the adolescent stage has begun.

Occurrence: In the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus, Trachyceras* subzone, on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch and half a mile north of the trail to Brock's ranch, Shasta County, Calif.

The specific name is given in honor of Dr. H. W. Fairbanks, the discoverer of this fauna.

[99] Mojsisovics, E. von, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 624, pl. 18, figs. 4, 5, 1896.

Clionites (Traskites) robustus Hyatt and Smith

Plate XLII, Figures 1–19; Plate LXVI, Figures 30–32

1905. *Clionites* (*Traskites*) *robustus.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 186, pl. 42, figs. 1–19.

Form robust, thick set, evolute, discoidal. Whorl low, increasing slowly in height, little embracing, and little indented by the inner volution. Cross section subquadratic, with flattened sides, square abdominal shoulders, and low, little arched venter. Umbilical shoulders square, umbilical slope nearly vertical. The umbilicus is rather deep and wide and is two-fifths of the total diameter of the shell. The height of the whorl is one-third of the diameter of the shell, the width is somewhat greater than the height, and the indentation is one-seventh of the height.

The sculpture is very marked and is composed of strong radial ribs and spiral rows of spines. The ribs run straight across the flanks, the alternate ribs dividing into two or sometimes three smaller ones on the strong abdominal shoulder knots. The intermediate ribs are usually undivided but bend sharply forward on the shoulders, as do the others. There are three spiral rows of small spines on the flanks—a large row that forms knots on the shoulders, a small row on the ventral slope, and another larger row on the ridge that borders the ventral furrow. The first row lies on the umbilical shoulders, and some of the spines grow to considerable length, as do also those on the abdominal shoulders and the ventral ridge.

The septa are ceratitic, with entire saddles and serrated lobes; a divided ventral lobe, a large first lateral on the abdominal shoulder, a small second lateral on the flanks, a smaller auxiliary on the umbilical slope, a rather long undivided antisiphonal, and a pair of internal laterals.

In the larval stage the form and ornamentation are like those of *Tirolites;* the whorl is low, broad, with trapezoidal cross section and narrow flanks, provided with marginal spines, and a low, flattened venter without furrow or other ornamentation. At a diameter of 5 millimeters the ventral furrow appears, and the shell then corresponds to *Californites.* At this size, too, the flanks grow higher and the marginal knots are prolonged into lateral ribs, which cease on the abdominal shoulders. At a diameter of 8 millimeters the ribs begin to show on the venter and the row of spines appears on the ridge that borders the ventral furrow. This stage marks the beginning of the characters of *Traskites,* although those of *Californites* persist until the shell is nearly mature. In fact, the subgeneric character of *Traskites* is the preservation, at maturity, of most of the characters of *Californites*—the low, broad whorl, flattened venter, and strong marginal spines.

The young of *Clionites ares* Mojsisovics [1] resembles the adult stage of *Clionites* (*Traskites*) *robustus.* This resemblance suggests that the European species, which occurs in the higher Noric beds, may have been developed out of the group of *Traskites.* There is, however, no mature form known anywhere else that might be compared with the species from California.

Dimensions of the type specimen of Clionites robustus

[See Pl. XLII, figs. 1-3]

	Millimeters
Diameter	57
Height of last whorl	20
Height of last whorl from preceding	19
Width of last whorl	23. 5
Involution	1
Width of umbilicus	24

Dimensions of young stages of Clionites robustus, showing changes in development

	1	2	3	4	5
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*
Diameter	4. 88	7. 10	10. 5	16	26
Height of last whorl	1. 52	2. 52	3. 5	6	10. 5
Height of last whorl from preceding	1. 28	2. 04	3	5	9
Width of last whorl	3. 08	4. 24	5. 6	7. 8	11
Involution	. 34	. 48	. 5	1	1. 5
Width of umbilicus	2. 28	3. 18	4. 2	6. 5	10. 5

These figures show the relative increase in the height of the whorl as maturity is approached.

Occurrence: In the Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the zone of *Tropites subbullatus,* on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch and half a mile north of the trail to Brock's ranch in Shasta County, Calif. This species is rather common in these lower beds of the Hosselkus limestone but above the strata in which *Tropites subbullatus* is most common.

Clionites (Traskites) stantoni Smith, n. sp.

Plate LXIV, Figures 16–27

Form robust, moderately evolute, widely umbilicate, with subrectangular cross section, parallel sides, subangular shoulders, and somewhat sloping venter.

Surface with fine close-set ribs, alternately finer and coarser, bifurcating on the ventral shoulders and bending sharply forward. There are also seven rows of short blunt spines on the ribs—four on the flanks, one on the ventral shoulder, and two on the ventral slope. The aperture has a projecting hoodlike expansion, showing a decided change in sculpture. The ventral furrow is sharply incised. Body chamber nearly three-fourths of a revolution in length. Septa with serrated lobes and entire saddles.

[1] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 478, pl. 140, fig. 2, 1893.

Clionites stantoni is closely related to *Clionites robustus* but differs in its narrower and less robust whorl and finer, more closely set ribs and spines. It is more involute than *Clionites tornquisti*, has finer ribs and spines and somewhat broader whorl, and is much smaller.

In youth *Clionites stantoni* and *Clionites robustus* are almost exactly alike, but the difference in breadth of the whorls persists almost down to the larval stages. In very early youth nearly all the American species of *Clionites* are very similar.

Named in honor of Dr. T. W. Stanton.

Occurrence: Rather rare in the Upper Triassic Hosselkus limestone at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Clionites (Traskites) tornquisti Smith, n. sp.

Plate LXV, Figures 8–25

Rather robust, evolute, widely umbilicate, whorl rectangular in cross section, with angular shoulders, parallel sides and somewhat sloping venter. Surface with coarse and fine ribs alternating, the coarser ones bifurcating on the ventral shoulders. Seven rows of blunt spines on the ribs. Ventral furrow rather deep, bordered by low ridges. Body chamber two-thirds of a revolution in length. Septa with rounded entire saddles and serrated lobes.

The young stages are only moderately broad, with sharp sculpture and rather square shoulders, very like the young of all *Clionites*. The entire larval stages are exactly like *Tirolites*, toward which the species is reversionary.

Clionites tornquisti is intermediate between the group *of Clionites fairbanksi* and *Clionites robustus*, being more robust and strongly sculptured than the former, and more slender and finely ornamented than the latter. It is transitional from the group of *Clionites* s. s. to the subgenus *Traskites*.

Named for Dr. Alexander Tornquist.

Occurrence: Very abundant in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Clionites (Traskites) nanus Smith, n. sp.

Plate LXV, Figures 1–7

Dwarf form, robust, thick set, moderately evolute, with square cross section, flattened venter, and distinct ventral furrow. Surface has fine ribs and spines, which form knots on the ventral shoulders.

Clionites nanus resembles a dwarf form of *Clionites robustus* but differs in its very small size, reaching maturity at a dimeter of 20 millimeters. It has more resemblance to *Clionites stantoni* but differs likewise in its much smaller size and finer sculpture.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Subgenus SHASTITES Hyatt and Smith

1905. *Shastites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 188.

Type.—*Clionites compressus* Hyatt and Smith.

Whorls somewhat evolute, laterally compressed, higher than wide, rather deeply embracing, sides flattened, venter narrow. Umbilicus rather narrow. Sigmoidal ribs ending in knots, forming almost continuous ridges bordering the central furrow. Spines nearly obsolete, represented only by tubercles on the ribs. The young retain the spines but lose them early. Septa ceratitic, as in *Clionites* s. s.

Shastites is known at present only in the zone of *Tropites subbullatus*, in the Upper Triassic of Shasta County, Calif.

Clionites (Shastites) compressus Hyatt and Smith

Plate XLIII, Figures 1–15

1905. *Clionites (Shastites) compressus*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 188, pl. 43, figs. 1–15.

Moderately evolute, discoidal, very much compressed laterally. Whorl increasing rather rapidly in height, embracing nearly half of the inner volution but not deeply indented by it. The height of the whorl is three-eighths of the total diameter, and the width is three-fourths of the height. It is indented to one-ninth of the height by the inner volution. The width of the umbilicus is three-eighths of the total diameter of the shell.

The surface is ornamented with slender sigmoidal radial ribs, which bend gently forward high up on the flanks, ending at the margins of the deep ventral furrow. There are on each side seven rows of small knots or rudimentary spines, four on the flanks, one on the indistinct abdominal shoulders, one on the arched sides of the venter, and one on the ridge that borders the ventral furrow. These spines become weaker as the shell grows larger and are almost obsolete at maturity. They occur only on the ribs, never on the intervening depressions. The septa are ceratitic, of the type that is common in *Clionites*, consisting of a divided ventral, a large first lateral lobe, a small second lateral, a small auxiliary on the umbilical slope, and a narrow internal antisiphonal lobe with a single lateral on each side.

In the young stage the shell is evolute and has a trapezoidal cross section, with no flanks and a broad, flattened venter, corresponding to *Tirolites*. At a diameter of 5 millimeters the ventral furrow begins, and the marginal nodes extend obliquely across the venter to the furrow. This stage corresponds to *Californites*. The flanks become gradually higher and the venter more rounded until the *Clionites* stage is reached, which happens at a diameter of about 10 millimeters. The lateral compression characteristic of this species does not become marked until the shell has attained a diameter of about 20 millimeters; but even in the adolescent stages the fine sigmoidal ribs, almost wholly destitute of spines, would distinguish *Clionites compressus* from all other species.

Dimensions of the type specimen of Clionites compressus

	Millimeters
Diameter	48
Height of last whorl	18
Height of last whorl from preceding	16
Width of last whorl	14. 5
Involution	2
Width of umbilicus	18

Clionites compressus differs from all other species of *Clionites* in the late larval and adolescent stages, in the fine sculpture and narrowness of the whorl, especially in contrast to similar stages of growth in *Traskites*, *Stantonites*, and *Neanites*. The subgenus *Shastites* has departed farther from the *Californites* stock than any of the others, and though it retains the *Tirolites* stage to an equal degree, it has almost lost that corresponding to *Californites*. It further shows its acceleration of development in the early stage at which it takes on characters of *Clionites*.

Occurrence: Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, *Trachyceras* subzone, on divide between Squaw Creek and Pit River, about 3 miles east of Madison's ranch and half a mile north of the trail from Madison's to Brock's ranch, Shasta County, Calif. This species is much less common than most other species of *Clionites* which occur in this bed. It is associated with the usual fossils of the zone of *Tropites subbullatus*.

Clionites (Shastites) compactus Smith, n. sp.

Plate LXVII, Figures 12–23

Form moderately involute, robust, laterally compressed, shoulders slightly developed, venter sloping gently. Ventral furrow deep. Surface bears radial ribs which bifurcate on the shoulders and extend forward across the ventral slope. Six spiral rows of rather coarse knots, those on the umbilicus and on the ventral shoulder being coarser.

Clionites compactus is the most involute of the American species of this genus. It is somewhat like *Sirenites* but differs in its ornamentation and septation. It differs from *Clionites compressus* in its greater involution, much more robust whorls, and coarser ribs and knots. It differs from *Clionites fairbanksi* in the narrower umbilicus, greater compression, and finer ribs. This robust shape persists even in the very young stages, which may easily be distinguished by this character. The larval stages are as broad as those of *Clionites robustus* or *Clionites stantoni* but have fine curving ribs and no knots or spines.

Occurrence: Rather rare in the Upper Triassic Hosselkus limestone at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Clionites (Shastites) whitneyi Smith, n. sp.

Plate LXVI, Figures 21–29

Form laterally compressed, widely umbilicate, with flattened sides and narrow venter. Ventral furrow sharply incised. Surface with fine, somewhat curved ribs and spiral rows of fine knots. Body chamber short. Septa with serrated lobes.

Clionites whitneyi is somewhat intermediate between *Clionites fairbanksi* and *Clionites compressus*. It is more compressed and has finer ribs and spines than *Clionites fairbanksi* and is less compressed and has greater development of the rows of knots than *Clionites compressus* and its ribs are coarser.

Named in memory of Prof. J. D. Whitney, whose work on the geology of California is a lasting source of pride to the State.

Occurrence: Not uncommon in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Subgenus STANTONITES Hyatt and Smith

1905. *Stantonites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 185.

Type.—*Clionites rugosus* Hyatt and Smith.

Evolute, little embracing, whorls low, and not increasing rapidly in height, cross section subquadratic. Inner whorls not concealed by the outer and scarcely indenting them. Umbilicus wide and shallow. Surface ornamented with coarse ribs, which are broken up into knots that are the modifications of the spines of *Clionites* s. s. The ventral furrow is distinct, bordered by rows of knots, and there is a second row on the abdominal shoulder. Septa ceratitic. This is probably a phylogerontic modification of the group, for in old age the whorls scarcely touch. The rugose modification of the sculpture begins in early youth.

This subgenus is known only in the Upper Triassic zone of *Tropites subbullatus*, Shasta County, Calif.

Clionites (Stantonites) rugosus Hyatt and Smith

Plate XLI, Figures 15–26

1905. *Clionites* (*Stantonites*) *rugosus*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 185, pl. 41, figs. 15–26.

Evolute, discoidal, widely umbilicate, laterally compressed. Whorl low and increasing very slowly in height, little embracing, and scarcely indented by the inner volution. The cross section is subquadrati . The height of the whorl is slightly less than one-third of the total diameter of the shell, and the breadth is four-fifths of the height. The umbilicus is wide and shallow, being three-sevenths of the total diameter. The umbilical shoulders are abruptly rounded, with a steep inner slope. The sides are flattened and nearly parallel. The abdominal shoulders are square. The venter is low, the center being but little higher than the shoulders. The surface is ornamented with radial ribs, spiral rows of knots, and a ventral furrow. The ribs run straight up the sides to the shoulders and then bifurcate and are continued obliquely forward by smaller ribs. Between the principal lateral ribs there is usually a smaller one that does not bifurcate. On each side there are six rows of knots—four small ones on the flanks, a large one on the abdominal shoulders, and another smaller one on each side of the ventral furrow. The unusual development of the abdominal shoulder knots is the chief characteristic of this subgenus. The form is extremely evolute. This character begins at a very early age and is a mark of degeneration, which also shows itself in the reduction of the spines to knots.

The septa are ceratitic, saddles rounded and entire, lobes serrated—all of the type that is common in *Clionites*; a small divided ventral lobe, large first lateral, small second lateral, and still smaller auxiliary on the umbilical slope.

The adolescent stages are so like the mature forms that no description of them is necessary. The larval stage is like that of *Clionites fairbanksi* and corresponds to *Tirolites*. It also passes through the *Californites* stage in early adolescence.

Occurrence: In the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, *Trachyceras* subzone, about 3 miles east of Madison's ranch, on the divide between Squaw Creek and Pit River, about 6 miles northeast of Bully Hill mine, in Shasta County, Calif.

Clionites (Stantonites) evolutus Smith, n. sp.

Plate LXVI, Figures 13–20

Form very evolute, widely umbilicate, whorls barely touching, not embracing; laterally compressed, slender, with narrow venter. Ventral furrow deep. Body chamber short. Septa with serrated lobes. Surface bears fine ribs that run nearly straight to the ventral shoulders, continued on the ventral slope by the knots. Five or six rows of blunt spines, which form coarse knots on the shoulders. Both ribs and spines alternate in size and give a delicate and beautiful ornamentation to the shell.

Clionites evolutus is the most evolute and slender of the American species. It differs from *Clionites rugosus* in its greater evolution and much finer sculpture. It has also some resemblance to *Clionites whitneyi* but is easily distinguished by its slender whorl and straighter ribs.

Occurrence: Rare in the Upper Triassic Hosselkus limestone at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Subgenus NEANITES Hyatt and Smith

1905. *Neanites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 189.

Type.—*Clionites californicus* Hyatt and Smith, n. sp.

Evolute, little embracing, low-whorled, involute. Wide umbilicus, abrupt umbilical shoulders. Cross section subquadratic. Ventral furrow much reduced. Ribs run nearly straight from umbilicus to border of the ventral furrow; spines obsolete, represented only by small knots. Septa ceratitic. The chief characteristic of this group is the persistence of the *Californites* stage until the end of the adolescent period and then the sudden change to the characters of *Clionites*. In the adolescent stage the whorls are low and broad, with square abdominal shoulders provided with long spines and flattened venter. At maturity the venter is highly arched.

Neanites is known only from the Upper Triassic zone of *Tropites subbullatus*, of Shasta County, Calif.

Clionites (Neanites) californicus Hyatt and Smith

Plate LXXXIII, Figures 14–27

1905. *Clionites (Neanites) californicus*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 190, pl. 83, figs. 14–27.

Evolute, robust, widely umbilicate. Whorl subquadratic in cross section, height and breadth equal and about two-fifths of the total diameter of the shell. The whorl increases slowly in height and is little embracing and little indented by the inner volution. The umbilical shoulders are abrupt, with steep inner slope. The sides are flat and nearly parallel. The abdominal shoulder occurs at three-fourths of the height of the whorl, is gently rounded, and slopes gradually up to the broad, low venter. The umbilicus is wide and deep, the width being slightly more than one-third of the total diameter of the shell. The surface is ornamented with a shallow ventral furrow, fine radial ribs bending forward on the abdominal shoulders, and spiral rows of knots, becoming almost obsolete at maturity. The ribs are close together and sigmoidal. There are five rows of knots—one on the umbilical shoulder, one, sometimes double, on the flanks a short distance above the shoulder, one on the abdominal shoulder, one halfway up the ventral slope, and one on the ridge that borders the ventral furrow. Both ribs and knots grow finer at maturity, the knots becoming nearly obsolete. The septa are ceratitic, like those of all other *Clionites*. The most salient character of this species is the sudden change from the adolescent to the mature stage, when the whorl becomes subquadratic instead of trapezoidal in cross section, the venter becomes arched instead of flattened, and the strong row of marginal spines becomes obsolete.

In the larval stage the shell is evolute, with deep, wide umbilicus and broad trapezoidal whorl. The flanks consist merely of a narrow angular umbilical ridge, and the venter is broad and nearly flat. The only ornamentation consists of rather strong marginal spines, which are prolonged in very faint ribs on the venter. This stage corresponds exactly with *Tirolites* in shape, ornamentation, and septa. At a diameter of slightly less than 5 millimeters the ventral furrow appears, the ribs begin to show more decidedly above the shoulders, and the flanks increase in height. This stage resembles and corresponds to *Californites* in all its characters, the septa now being ceratitic, as in that genus. The *Californites* stage lasts until a diameter of about 25 millimeters is reached. Then suddenly the marginal spines disappear, the flanks become higher, the venter arches, and the radial sculpture grows weak. The form is then mature, and the characters of *Neanites* have been assumed.

Occurrence: In the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, *Trachyceras* subzone, on the divide between Squaw Creek and Pit River, about 3 miles east of Madison's ranch and half a mile north of the trail leading to Brock's ranch, in Shasta County, Calif.

Clionites (Neanites) minutus Smith, n. sp.

Plate LXIV, Figures 28–38

Dwarf form, with slender, little-embracing whorls, rectangular cross section, and wide umbilicus. Surface with ventral furrow and lateral ribs, which bifurcate on the square shoulders and run across the flattened venter; spines very small. Septa ceratitic. Body chamber short.

Clionites minutus has some resemblance to *Clionites merriami*, especially in youth, but at maturity its characters change abruptly to those of *Neanites*, and it then resembles *Clionites californicus* but is much more slender and is like *Tirolites*, from which it is distinguished only by the furrow and the ventral sculpture.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Clionites (Neanites) osmonti Smith, n. sp.

Plate LXVII, Figures 1–11

Form robust, evolute, widely umbilicate, with angular ventral shoulders, flat sides and highly arched venter. Ventral furrow deep, bordered by ridges. Surface with strong lateral ribs, which bifurcate on the ventral shoulders and continue strong on the venter. Spiral rows of knots or blunt spines, especially strong on the shoulders. Until near maturity the whorl is low, broad, and square, and the shell resembles *Tirolites* in everything but sculpture. It persists unusually long in the *Californites* stage but changes suddenly at maturity to *Clionites* in shape and ornamentation.

Clionites osmonti is most nearly related to *Clionites californicus* but differs in its coarser ribs and spines and in arched venter.

Named in honor of V. C. Osmont, who assisted in collecting this fauna.

Occurrence: Rather rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Subgenus CALIFORNITES Hyatt and Smith

1905. *Californites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 179.

Type.—*Californites merriami* Hyatt and Smith.

Evolute, low whorled, little embracing, scarcely impressed by the inner volutions. Umbilicus wide, umbilical shoulders abrupt, cross section trapezoidal, with flattened sides that slope outwardly to the angular abdominal shoulders. Venter low arched, nearly smooth, and with distinct ventral furrow. Sides ornamented with straight ribs that have short knots on them and end in strong spines on the abdominal shoulders. The venter is nearly smooth. The septa are ceratitic and consist of a divided external lobe, a principal lateral, and a small auxiliary on the umbilicus. The body chamber is short.

This group is almost completely reversionary to *Tirolites* and differs from it chiefly in the ventral furrow. It is of especial importance in the phylogenetic history of the group of *Clionites*, for all spinose members of that group go through a distinct *Californites* stage and some persist in it almost until maturity.

Californites is known only from the Upper Triassic zone of *Tropites subbullatus*, of Shasta County, Calif., where the species described below have been found.

Clionites (Californites) merriami Hyatt and Smith

Plate LXXXII, Figures 11–23

1905. *Californites merriami.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 180, pl. 82, figs. 11–23.

Form evolute, robust, low whorled. Whorl little embracing and little indented by the inner volution; low and increasing slowly in height. Cross section trapezoidal, wider at top. Sides flattened, sloping outward. Abdominal shoulders abrupt and square, venter flattened and broad. The height of the whorl is less than one-third of the total diameter of the shell; the width is slightly greater than the height, and the indentation is only one-ninth of the height. The width of the umbilicus is three-sevenths of the total diameter of the shell. The surface is ornamented with coarse ribs that start from a row of knots on the umbilical shoulders and run straight up the sides, ending in strong spines on the abdominal shoulders. From these marginal spines finer ribs extend obliquely forward on the venter. There is a strong median furrow on the venter, bounded by low, rounded ridges, at which the fine ventral ribs become obsolete. The septa are ceratitic, all the saddles being entire. The external lobe is divided by a small siphonal notch into two narrow, short, simple lobes, which fall upon the ridges bounding the median furrow. The lateral is larger and serrated and falls upon the abdominal shoulder. On the flank, just above the umbilical shoulder, is the small, simple auxiliary lobe. The first and second saddles are large and broadly rounded.

The young stages of this species are exactly like *Tirolites*, and the mature form differs from that genus only in the second lobe on the flank and the median furrow. The median furrow appears at a diameter of about 6 millimeters.

The specific name is given in honor of Dr. John C. Merriam.

Occurrence: *Californites merriami* Hyatt and Smith was found by the writer in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, *Trachyceras* subzone, in the limestone belt on the divide between Squaw Creek and Pit River, about 3 miles east of Madison's ranch and half a mile north of the trail from Madison's ranch to Brock's ranch on Pit River, Shasta County, Calif. This locality is 6 miles northeast of the Bully Hill mine.

Clionites (Californites) careyi Smith, n. sp.

Plate LXVI, Figures 1–12

Form thick set, square shouldered, widely umbilicate; whorls little embracing and little indented by the inner volutions, with rectangular cross section. Surface with lateral ribs, becoming almost obsolete on the flattened venter; spines on the ribs strong, especially on the angular ventral shoulders. Ventral furrow deeply incised. Septa ceratitic.

Clionites careyi belongs to the group of *Clionites merriami*, of the subgenus *Californites* Hyatt and Smith; in both these species the *Tirolites* stage is prolonged almost to maturity, but both have the trachyceran furrow and some remnants of trachyceran sculpture.

Clionites careyi is arrested in development and more strongly retarded than any other known species of Trachyceratea. It differs from *Clionites merriami* in its much broader and more robust whorl. Its form is very like that of *Thetidites* Mojsisovics, but it differs in possession of the ventral furrow and certainly does not belong to the Sibiritidae. It differs from the adolescent stages of *Clionites* (*Neanites*) *osmonti* in being more depressed, broader, and more rugose.

Named in honor of E. P. Carey, who assisted in collecting this fauna.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Subgenus DAWSONITES Boehm

1903. *Dawsonites.* Boehm, Ueber die obertriadische Fauna der Bäreninsel: K. svenska Vet.-Akad. Handl., Band 37, No. 3, p. 56.

Type.—Trachyceras canadense Whiteaves.

Form laterally compressed, moderately evolute, with open umbilicus, flattened sides, and rounded venter, with deep ventral furrow. Surface ornamented with sharp dichotomous ribs that bifurcate on the middle of the flanks and bend sharply forward on the shoulders. There are spiral rows of blunt nodes on the ribs. Septa with rounded entire saddles and serrated lobes.

Dawsonites is quite possibly identical with *Shastites*, but the few fragmentary specimens thus far found are hardly sufficient to justify this reference.

Occurrence: In the Upper Triassic of Canada, Alaska, and Bear Island, presumably in beds of Karnic age.

Clionites (Dawsonites) canadensis (Whiteaves)

Plate CVII, Figures 8–10

1889. *Trachyceras canadense.* Whiteaves, The fossils of the Triassic rocks of British Columbia: Contr. Canadian Paleontology, vol. 1, pt. 2, p. 142, pl. 18, figs. 4a, 4b.

1903. *Dawsonites canadensis.* Boehm, Ueber die obertriadische Fauna der Bäreninsel: K. svenska Vet.-Akad. Handl., Band 37, No. 3, p. 56, pl. 6, figs. 25–30.

Shell laterally compressed, with somewhat flattened sides, broadly rounded venter, open but not broad umbilicus, distinct ventral furrow. Involute, but not deeply embraced, the whorl increasing rather rapidly in height. Height of the whorl a little greater than the breadth. Surface with transverse ribs and spiral rows of small close-set tubercles. The ribs often bifurcate on nodes or tubercles and sometimes again on the flanks. They run nearly straight up the sides and turn sharply forward on the ventral shoulder. Septa with rounded entire saddles and serrated lobes.

Occurrence: In the Upper Triassic, presumably in beds of lower Karnic age, on Liard River, about 25 miles below Devils Portage, British Columbia; also on Bear Island, in the Arctic Ocean.

Genus ARPADITES Mojsisovics

1879. *Arpadites.* Mojsisovics, Vorläufige kurze Uebersicht der Ammoniten-Gattungen der Mediterranen und Juvavischen Trias: K.-k. geol. Reichsanstalt Wien Verh., p. 140.

1882. *Arpadites.* Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 52.

1893. *Arpadites* (part). Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 450.

1898. *Arpadites.* Tornquist, Neuere Beiträge zur Geologie und Paläontologie der Umgebung von Recoaro und Schio in Venetien: Deutsche geol. Gesell. Zeitschr., Band 50, Heft 4, p. 647.

1905. *Arpadites.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 174.

Type.—Ammonites arpadis Mojsisovics.[2]

As originally defined, *Arpadites* embraced rather evolute, discoidal, laterally compressed forms, with wide, shallow umbilicus, flattened sides, and narrow venters. The whorls are not deeply embracing but are higher than wide. The venter has a furrow bounded by ridges or keels and may be either smooth or crenulated. There are umbilical knots from which ribs extend toward the shoulder keels, commonly becoming fainter on the sides, on which a few tubercles may be developed. The septa are ceratitic, with rounded narrow entire saddles, and serrated lobes, of which there are four, the divided external, the two laterals, and a small auxiliary on the umbilical shoulder.

Arpadites is clearly a descendant of *Ceratites*, from which it differs in the greater lateral compression, the narrow venter, the ventral furrow bounded by shoulder keels, and the absence of the elongated auxiliary series of lobes.

This genus is known at present from the upper Muschelkalk (Middle Triassic) of the Alps and in the lower part of the Upper Triassic of the Alps, India, and California, where it is represented by *Arpadites gabbi* and by *A. kingi.*

Arpadites gabbi Hyatt and Smith

Plate XXXIX, Figures 1–17; Plate LXXXIII, Figures 1–13

1905. *Arpadites gabbi* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 175, pl. 39, figs. 1–17; pl. 83, figs. 1–13.

[2] Mojsisovics, E. von, Beiträge zur Kenntniss der Cephalopoden-Fauna der Oenischen Gruppe: K.-k. geol. Reichsanstalt Jahrb., Wien 1870, p. 109, pl. 5, fig. 6; Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 54, pl. 25, fig. 29, 1882.

Laterally compressed, involute, discoidal, deeply embracing, and deeply indented by the inner volutions. Whorls high and narrow, increasing rapidly in height. Umbilical shoulders abruptly rounded, sides flattened convex. Venter narrow, channeled, bounded by marginal ridges slightly beaded. The height of the whorl is a little more than half the total diameter; the breadth of the whorl is three-sevenths of the height. The outer whorl covers seven-eighths of the inner and is indented to two-sevenths of the height by it. The umbilicus is narrow but open, exposing the umbilical shoulders of the inner whorls in steps; its width is one-eighth of the diameter of the shell. The surface of the shell is ornamented with umbilical knots, which are extended up the sides in low folds, made up of bundles of sigmoidal striae. These folds are faint on the sides but become strong again at the abdominal marginal ridges, giving to them a beaded appearance. This sculpture shows on the cast as well as on the shell. The septa are ceratitic, saddles all rounded and entire, lobes all serrated. The ventral lobe is divided by a shallow siphonal notch into two short narrow branches with three serrations. The first lateral lobe is broad and deep, terminating in fine serrations. The second lateral is smaller, less than half the size of the first, and trifid. The auxiliary series is composed of two small lobes, hardly more than notches, on the umbilical shoulder. The antisiphonal lobe is rather long and narrow and is flanked by a shorter lateral.

The foregoing description applies only to the mature shell, for the young stages are absolutely unlike the adults. The inner coils, up to a diameter of 2.5 millimeters, are evolute, broad, low whorled, with wide umbilicus, genuine *Tirolites* in shape, with depressed volutions, somewhat flattened venter, and strong marginal tubercles but no furrow. The ventral lobe is undivided and narrow, and there is but a single lateral, with a very small auxiliary on the umbilical shoulder. The antisiphonal lobe is flanked by a small lateral, hardly larger than the external auxiliary.

Dimensions of larval stage of Arpadites gabbi just before appearance of furrow

	Millimeters
Diameter	2. 19
Height of last whorl	. 80
Height of last whorl from preceding	. 68
Width of last whorl	1. 32
Involution	. 12
Width of umbilicus	. 80

At the diameter of 2.5 millimeters the ventral furrow begins, but the *Tirolites* shape persists for half of a revolution farther, to the diameter of 4 millimeters. At this size the whorl becomes higher and the sides developed. The tubercles are no longer lateral but umbilical, and the stage corresponds to *Dinarites* with the exception of the ventral furrow.

Dimensions of two specimens of Arpadites gabbi at Dinarites stage

	1	2
	Mm.	*Mm.*
Diameter	4. 60	12
Height of last whorl	1. 70	5
Height of last whorl from preceding	1. 26	4
Width of last whorl	2. 12	4. 5
Involution	. 44	1
Width of umbilicus	1. 85	3. 5

These dimensions show the whorl to be proportionally higher and the umbilicus narrower than in the *Tirolites* stage; the marginal knots have become umbilical ribs, which are extended up the sides but do not reach the abdominal shoulders. This stage lasts to the diameter of 11 millimeters. At this size the whorl increases rapidly in height and becomes laterally compressed. The shell is now analogous to *Ceratites*, in which stage it remains to the diameter of about 20 millimeters.

Dimensions of specimen of Arpadites gabbi at Ceratites stage

	Millimeters
Diameter	17
Height of last whorl	7
Height of last whorl from preceding	5. 5
Width of last whorl	6. 5
Involution	1. 5
Width of umbilicus	5. 5

The shell then gradually makes the transition to the *Arpadites* stage, becoming more involute, the lateral ribs less pronounced, and the ridges bordering the ventral furrow are beaded by the ends of the lateral ribs.

Arpadites gabbi is more involute than any other described species of this genus. Its nearest relative is *Arpadites cinensis* Mojsisovics,[3] but *Arpadites gabbi* differs from the Alpine species in its greater involution, narrower umbilicus, higher whorl, crenulated abdominal ridges, and in its more complex septa. The late adolescent stages of *Arpadites gabbi* are very like the mature form of *Arpadites cinensis*, which is in keeping with the later age of the American species.

Occurrence: *Arpadites gabbi* was found by the writer in the Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus*, *Trachyceras* subzone, on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch and half a mile north of the trail from Madison's ranch to Brock's ranch, on Pit River, Shasta County, Calif. This locality is about 6 miles northeast of Winthrop. It was associated with *Tropites subbullatus* Hauer, *Tropites torquillus* Mojsisovics, *Paratropites sellai* Mojsisovics, *Sagenites herbichi* Mojsisovics, *Discotropites sandlingensis* Hauer, *Halobia superba* Mojsisovics, and many other forms characteristic of the upper Karnic horizon.

[3] Mojsisovics, E. von, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 56, pl. 26, figs. 3-15, 1882.

Arpadites kingi Smith, n. sp.

Plate LVII, Figures 31–34

Form robust, laterally compressed, with umbilicus narrow but open, venter narrow, with ventral furrow bordered by beaded keels. Ribs on the flanks rather strong, persisting at maturity. Body chamber short.

Arpadites kingi resembles *Arpadites gabbi* but differs in its coarse lateral ribs, umbilical knots, and strongly beaded keels. These characters are all present on *Arpadites gabbi* but disappear at maturity, whereas on *Arpadites kingi* they are present through life.

Named in memory of Clarence King.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the zone of *Tropites subbullatus*, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus TIROLITES Mojsisovics

1878. *Tirolites*. Mojsisovics, Die Dolomitriffe von Südtirol und Venetien, p. 43.

1879. *Tirolites*. Mojsisovics, Vorläufige kurze Uebersicht der Ammoniten-Gattungen der Mediterranen und Juvavischen Trias: K.-k. geol. Reichsanstalt Wien Verh., p. 138.

1882. *Tirolites*. Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 64.

1893. *Tirolites*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 588.

1902. *Tirolites*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 324.

1903. *Tirolites*. Kittl, Die Cephalopoden der oberen Werfener Schichten von Muć in Dalmatien: K.-k. geol. Reichsanstalt Wien Abh., Band 20, p. 29.

1905. *Tirolites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 158.

1914. *Tirolites*. Smith, The Middle Triassic marine invertebrate faunas of North America: U. S. Geol. Survey Prof. Paper 83, p. 68.

Type.—"*Ceratites*" *idrianus* Hauer.[4]

Subgenus METATIROLITES Mojsisovics

1893. *Metatirolites*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 588.

1905. *Metatirolites*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 160.

Type.—*Ammonites foliaceus* Dittmar.[5]

Evolute, little-embracing, robust whorls, with wide umbilicus. Cross section quadratic, sides flattened, abdominal shoulders square, venter flattened and

[4] Hauer, F. von, Cephalopoden aus der unteren Trias der Alpen: K. Akad. Wiss. Wien Sitzungsber., Band 52, p. 610, pl. 1, figs. 4, 5, 1865. Mojsisovics, E. von, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 67, pl. 1, fig. 1, 1882.

[5] Dittmar, A. von, Zur Fauna der Hallstätter Kalke, in Benecke, E. W., Geognostische-palaeontologische Beiträge, Band 1, p. 358, pl. 15, figs. 10-12, 1866; Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 590, pl. 140, figs. 1-5, 1893.

broad, without any ventral furrow. A row of spines is seen on the abdominal shoulders as in *Tirolites* s. s. The septa consist of a divided external lobe, serrated first lateral, and a distinct auxiliary lobe on the umbilical shoulder. This latter character is the only mark of distinction from *Tirolites*, from which this subgenus undoubtedly descends.

Metatirolites is found in the Upper Triassic, Karnic stage, zone of *Tropites subbullatus*, in the Mediterranean region, to which it has been supposed, up to the present, to be confined. The writer found *Metatirolites foliaceus* Dittmar in the Upper Triassic of Shasta County, Calif., associated with *Halobia superba* Mojsisovics, *Discotropites sandlingensis* Hauer, *Sagenites herbichi* Mojsisovics, *Tropites subbullatus* Hauer, and many other species characteristic of the upper Karnic.

Tirolites (Metatirolites) foliaceus (Dittmar)

Plate LXXXII, Figures 1–10

1866. *Ammonites foliaceus*. Dittmar, Zur Fauna der Hallstätter Kalke, in Benecke, E. W., Geognostische-palaeontologische Beiträge, Band 1, p. 358, pl. 15, figs. 10–12.

1893. *Metatirolites foliaceus*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 590, pl. 140, figs. 1–5.

1905. *Tirolites* (*Metatirolites*) *foliaceus*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 160, pl. 82, figs. 1–10.

Form evolute, robust, little embracing, and little indented by the inner volutions. Whorls low and increasing slowly in height, trapezoidal in shape; sides flattened and sloping outward, with square, angular abdominal shoulders and flattened, broad venter. Umbilical shoulders rounded, umbilicus wide and deep, exposing the inner volutions. The height of the whorl is about equal to the width and is half of the total diameter. The width of the umbilicus is about one-third of the diameter of the shell.

On the abdominal shoulders is a row of strong but blunt knots, which are the remnants of the *Tirolites* spines. In addition to these, the surface is ornamented with fine radial striae, which run nearly straight up the sides and bend sharply forward at the marginal knots, forming a broad and deep sinus on the venter. On the venter are seen also fine spiral lines, which give a somewhat reticulated appearance to this portion of the shell. On the sides are low folds which become stronger on the venter, bending forward, parallel to the cross striae. The septa are ceratitic; the external lobe is narrow and divided by a small siphonal notch; the lateral lobe is larger, distinctly serrated, and falls on the abdominal shoulder angle; on the umbilical slope there is a small but distinct second lateral or auxiliary lobe. The antisiphonal lobe is narrow and is flanked by a single short internal lateral on each side.

There is no other species with which *Tirolites foliaceus* may be compared, but the California specimens agree exactly with the figures and descriptions of those from the Alps, and there can be doubt of the identity of those from the two regions, in spite of their geographic separation, for the horizon and faunal association are the same in both places.

Occurrence: *Tirolites* (*Metatirolites*) *foliaceus* was first found in the Upper Triassic zone of *Tropites subbullatus* of the Alps. In California it was found in the same zone, in the Hosselkus limestone, *Trachyceras* subzone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif.; it is associated with *Tropites subbullatus*, *Paratropites sellai*, *Sagenites herbichi*, *Discotropites sandlingensis*, *Halobia superba*, and many other species characteristic of this zone.

Tirolites (Metatirolites) subpygmaeus (Mojsisovics)

Plate LIX, Figures 4–8

1893. *Ceratites subpygmaeus*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 402, pl. 140, figs. 6–7.

A dwarf, arrested, degenerate form, with quadrangular whorls, square ventral shoulders, rather involute, with broad, flattened venter, and sides sloping inward toward the umbilicus. Rather strong ventral shoulder knots, with ribs running up to them from the umbilicus and becoming nearly obsolete on the venter. Septa goniatitic, with undivided ventral lobe, one lateral, and an auxiliary.

This species was described by Mojsisovics as *Ceratites*, but he thought it might belong to *Heraclites*. It certainly has no kinship with either genus. It resembles *Tirolites quadrangulus* Hauer, with which it is associated, but differs in its more robust whorl and stronger sculpture.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif. It is associated with *Tropites welleri*, *Homerites subglobosus*, *Juvavites subinterruptus*, *Halobia superba*, and other species. It was described from the same horizon, near Hallstatt in the Tyrolian Alps, Austria.

Tirolites (Metatirolites) quadrangulus (Hauer)

Plate LIX, Figures 9–11

1860. *Clydonites quadrangulus*. Hauer, Nachtrag zur Kenntniss der Cephalopoden-Faunen der Hallstätter Schichten: K. Akad. Wiss. Wien Sitzungsber., Band 41, p. 131, pl. 5, figs. 3–6.

1893. *Ceratites* (*Dinarites*) *quadrangulus*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 401, pl. 140, fig. 8.

Dwarf form, shell very small, subrectangular, subangular shoulders, and flat, rather broad venter. Somewhat involute, with narrow umbilicus. Sculpture very weak, with fine lines of growth, weak nodes on the ventral shoulders, and almost obsolete ribs. Septa goniatitic, with undivided ventral lobe and a broad lateral; the auxiliary concealed by the umbilicus. There is no siphonal saddle. This is an arrested degenerate form, neither *Ceratites*, *Dinarites*, nor true *Tirolites*, but a reversion toward the ancestral type.

It resembles *Tirolites subpygmaeus* but is less robust, with much weaker sculpture.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.; it is associated with *Tropites welleri*, *Juvavites subinterruptus*, and many other species. It was first found in the Upper Triassic of the Hallstatt limestone of the Austrian Alps, in approximately the same horizon and association.

Genus POLYCYCLUS Mojsisovics

1889. *Polycyclus*. Mojsisovics, Nachweis der Zone des *Tropites subbullatus* in den Hallstätter Kalken bei Hallein: K.-k. geol. Reichsanstalt Wien Verh., p. 281.

1893. *Polycyclus*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 534.

1905. *Polycyclus*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 201.

Type.—Ammonites nasturtium Dittmar.[6]

Evolute, little-embracing, low whorls, laterally compressed, and increasing very slowly in height. Cross section oval, height greater than the breadth. Umbilicus wide and very shallow. Venter highly arched. Surface ornamented with simple, undivided strong ribs that run from the umbilical shoulders nearly straight across the venter without interruption. Spines and constrictions are unknown in this genus. The septa are usually goniatitic, but traces of serration are sometimes visible on the lateral lobe. The ventral lobe is divided by a small siphonal notch; there are two laterals, of which the second may be considered as the auxiliary. Internal antisiphonal lobe long.

Polycyclus appears in the Upper Triassic of the Alps and in the Upper Triassic (Hosselkus limestone) in California, in the zone of *Tropites subbullatus*. In the Alps it occurs also sparingly in the Noric stage. In California three species have been found, *Polycyclus henseli* Oppel, *Polycyclus nodifer* Hyatt and Smith, and *Polycyclus major* Smith.

[6] Dittmar, A. von, Zur Fauna der Hallstätter Kalke, in Benecke, E. W., Geognostische-palaeontologische Beiträge, Band 1, p. 358, pl. 14, figs. 24–37, 1866. Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 535, pl. 132, figs. 27–36, 1893.

Polycyclus nodifer Hyatt and Smith

Plate XXXVIII, Figures 1–18

1905. *Polycyclus nodifer*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 201, pl. 88, figs. 1–18.

Evolute, discoidal, laterally compressed, widely umbilicate. Whorls low and increasing very slowly in height, little embracing, and scarcely indented by the inner volution. The height of the whorl is one-third of the total diameter of the shell, and the width is three-fourths of the height. The umbilical shoulders are abruptly rounded, the flanks somewhat flattened, the venter low, rising but little above the abrupt abdominal shoulders. The umbilicus is wide and shallow, being about three-sevenths of the diameter of the shell. The surface is ornamented with strong radial ribs which run from the umbilicus up the flanks and across the venter and are considerably broader than the intervening spaces. On the cast there is seen on the venter a slight furrow, which does not interrupt the ribs but depresses them. On each side of this furrow the ribs are raised into low knots. This sculpture is not visible on the shell. The septa are goniatitic except the first lateral lobe, which is very slightly ceratitic. The ventral lobe is divided by a small siphonal notch into two short narrow branches; the first lateral lobe is proportionally much larger; the second lateral and the auxiliary are exceedingly small; the internal or dorsal lobe is narrow and rather long, flanked on each side by a small internal lateral.

This species is most nearly related to *Polycyclus henseli* Oppel, and especially to the variety *directa*, figured by Mojsisovics,[7] but *Polycyclus nodifer* is more evolute than the Tyrolian species, and the nodes on its ribs serve as distinguishing characters. All the other marks and the faunal association are the same. In the same beds with *Polycyclus nodifer* there is a species that is almost undoubtedly identical with *Polycyclus henseli*, and it is not unlikely that a transition between the two species may be traced.

In the young stages the shell is subglobose, but the umbilicus speedily widens and the whorl becomes relatively lower. The lateral ribs begin at the diameter of 1.6 millimeters, at first as umbilical knots. The ventral knots and furrow begin at a diameter of 3.2 millimeters. The serration of the first lateral lobe begins at a diameter of about 8 millimeters. The largest specimens found had a diameter of about 25 millimeters.

Occurrence: Upper Triassic Hosselkus limestone, in the zone of *Tropites subbullatus, Trachyceras* subzone, on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch and half a mile north of the trail to Brock's ranch in Shasta County, Calif.

[7] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, pl. 132, figs. 7–11, 1893.

Polycyclus henseli (Oppel)

Plate LVII, Figures 28–30

1865. *Ammonites henseli.* Oppel, Palaeontologische Mittheilungen, Band 1, p. 132, pl. 41, fig. 3.
1866. *Ammonites henseli.* Dittmar, Zur Fauna der Hallstätter Kalke: Geognostische-palaeontologische Beiträge, Band 1, p. 357, pl. 14, figs. 16–20.
1893. *Polycyclus henseli.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 536, pl. 132, figs. 7–23.
1906. *Polycyclus henseli.* Diener, Fauna of the *Tropites* limestone of Byans: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, No. 1, p. 74, pl. 7, fig. 12.

Dwarf, arrested, degenerate form, evolute, laterally compressed, widely umbilicate. Surface with strong ribs running from the umbilicus across the venter without interruption. Septa with simple lobes, except the first lateral, which is slightly serrated. Body chamber short.

Polycyclus henseli is closely related to *Polycyclus nodifer*, differing in lacking the ventral furrow and the nodes at the ends of the ribs.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Polycyclus major Smith, n. sp.

Plate LVIII, Figures 30–32

Form evolute, discoidal, laterally compressed, widely umbilicate, with flattened sides, and narrow flattened venter, with abrupt ventral shoulders. There is a very shallow ventral furrow. Surface with fine nearly straight ribs that run from the umbilicus across the venter without interruption but with a median depression or shallow furrow made by the knots on the ribs at the ventral shoulder. The outer whorl embraces nearly half of the inner but is only slightly indented by it. Body chamber short. Septa with rounded saddles and serrated lobes; there are a divided ventral lobe, a large lateral, and a very small second lateral; the auxiliary is indicated only by a notch on the umbilical suture.

Polycyclus major resembles *Polycyclus nodifer* but is distinguished by its much greater size, more numerous and finer ribs, and greater lateral compression. It differs from *Choristoceras kellyi* in its greater lateral compression, flattened instead of subrectangular whorl, deeper ventral furrow, more distinct knots at ends of the ribs, and greater involution. It is probably intermediate between *Polycyclus* and *Choristoceras*.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of *Tropites subbullatus* zone, on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Genus CHORISTOCERAS Hauer

1865. *Choristoceras.* Hauer, Eine neue Cephalopodensippe aus den Kössener Schichten: K. Akad. Wiss. Wien Sitzungsber., Band 52, p. 654.
1893. *Choristoceras.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 543.

Type.—*Choristoceras marshi* Hauer.[8]

Form with open spiral, uncoiling in age, but close-coiled in youth. Simple, undivided, usually ending in spines at the ventral furrow. Lobes commonly ceratitic but in some specimens merely indented. Body chamber short.

This is a degenerate, arrested genus, probably descended from *Polycyclus*. It is confined wherever known to the upper beds of the Upper Triassic.

Choristoceras is represented in the California province by two species, *Choristoceras kellyi* and *Choristoceras klamathense*, which are described below.

Choristoceras kellyi Smith, n. sp.

Plate LIX, Figures 1–3

Form slender, evolute, widely umbilicate; whorls barely touching but not uncoiling. Surface with strong ribs crossing the venter, with shallow ventral furrow, bordered by rows of weak tubercles. Septa bear serrated lobes and rounded saddles. Ventral lobe divided and short, first lateral lobe larger, second lateral lobe very small, auxiliary barely indicated at the ventral suture; internal lateral lobe obsolete.

This form is intermediate between *Choristoceras* and *Polycyclus*, differing from the latter in the degeneration of the lobes and the beginning of uncoiling.

Choristoceras kellyi differs from *Choristoceras klamathense* in its shallower ventral furrow and weaker knots at the ventral ends of the ribs.

Named in honor of Kelly's ranch.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif. It is associated with *Tropites welleri*, *Juvavites subinterruptus*, *Homerites semiglobosus*, *Halobia superba*, and other species.

Choristoceras klamathense Smith, n. sp.

Plate LIX, Figures 12, 13

Evolute, slender, loosely coiled, but not uncoiling; whorls increasing very slowly in size; umbilicus widening very rapidly in the young stages. Whorls subquadratic in cross section, higher than wide, with rounded umbilical and abrupt ventral shoulders. Venter moderately broad, with ventral furrow. Numerous close-set slender ribs running from the umbilicus and ending in spines or knots at the ridge

[8] Hauer, F. von, Eine neue Cephalopodensippe aus den Kössener Schichten: K. Akad. Wiss. Wien Sitzungsber., Band 52, p. 654, pl. 1, figs. 1–8.

bordering the ventral furrow; there is also a second row of much smaller knots just below the shoulder. Septa not seen.

Choristoceras klamathense differs from *Polycyclus nodifer* in its stronger furrow and sharper spines; it is distinguished from *Choristoceras kellyi* by its stronger ventral furrow and rows of knots and slenderer whorl.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, of Bear Cove, at the north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It is associated with *Tropites welleri*, *Metasibirites frechi*, *Discotropites lineatus*, *Juvavites subinterruptus*, *Proclydonautilus triadicus*, *Halobia superba*, and other species.

Choristoceras suttonense Clapp and Shimer

Plate CV, Figures 5, 6

1911. *Choristoceras suttonense.* Clapp and Shimer, The Sutton Jurassic of the Vancouver group, Vancouver Island, B. C.: Boston Soc. Nat. Hist. Proc., vol. 34, No. 12, p. 434, pl. 40, figs. 4, 6.

Clapp and Shimer describe this species as follows:

Whorls laterally compressed, but little or not at all embracing, as evidenced by the absence of any impressed zone, and increasing very slowly in size. Cross section oval with breadth about four-fifths of the height; sides broadly rounded; venter slightly flattened. Surface ornamented with strong simple ribs that cross the umbilical region, though there much weaker, increase in strength up the sides to the ventral shoulders, and run straight across the venter. On the venter the ribs are depressed by a slight furrow; this depression of the ribs accentuates their height on the ventral shoulders into the appearance of low knobs bordering the furrow. Lobes and saddles entire, except that the ventral lobe is divided by a small siphonal notch. There are two narrow lateral lobes, the second lateral being about two-thirds the depth of the first. The three saddles are much broader than the lobes, the first saddle being very deep. Internal antisiphonal lobe not as deep as the second lateral.

Clapp and Shimer assign this species to the Lias (Lower Jurassic), but *Choristoceras* is exclusively Upper Triassic in its occurrence, and the other forms in the Sutton formation appear to be more probably Triassic than Jurassic; the writer agrees with Martin [9] in assigning this species and the accompanying fauna to the lower Noric zone of the Upper Triassic.

Occurrence: Sutton formation, Cowichan Lake, Vancouver Island, British Columbia.

Genus THISBITES Mojsisovics

1893. *Thisbites.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 399.

Type.—Thisbites agricolae Mojsisovics.[10]

Dwarf forms, arrested, reversionary, evolute, rather widely umbilicate. Falciform ribs, commonly forming bundles on the umbilical shoulders; ventral keel, commonly with bordering furrows. Septa goniatitic very much reduced. Body chamber short.

Thisbites is rather common in the Upper Triassic of the Mediterranean region and is represented in America by a single species.

Thisbites uhligi Mojsisovics

Plate LVIII, Figures 6, 7

1893. *Thisbites uhligi.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 435, pl. 142, fig. 38.

Form somewhat compressed laterally, with subangular shoulders, strong ventral keel, and curved lateral ribs. It has some resemblance to the young of *Discotropites mojsvarensis* Smith but lacks the nodes. This species is probably reversionary to the keeled *Ceratites* of the Middle Triassic and resembles them in form but is still more primitive or reversionary in the simplicity of its septa, which have been arrested in the goniatitic stage that corresponds to *Gephyroceras* of the Devonian or some other kindred form.

Thisbites, like all other arrested forms, is never entirely reversionary to any one genus in all its characters but retains some characters from all along its line of ancestors. This is now known to have been the rule with degenerate arrested genera and species.

Thisbites uhligi is very rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif. It was first found at the same horizon in the Hallstatt limestone of the Tyrolian Alps.

Genus BADIOTITES Mojsisovics

1879. *Badiotites.* Mojsisovics, Vorläufige kurze Uebersicht der Ammoniten-Gattungen der Mediterranen und Juvavischen Trias: K.-k. geol. Reichsanstalt Wien Verh., p. 142.

Moderately evolute, umbilicate, with compressed sides, and somewhat acute venter; sickle-shaped ribs; goniatitic septa, with entire lobes and saddles; body chamber short. Mojsisovics lists *Badiotites eryx* Muenster and *Badiotites glaucus* Muenster as the two characteristic species. Both occur in the St. Cassian beds, in the lower part of the Upper Triassic of the Alps. The American species assigned to *Badiotites* has probably no near kinship with that genus.

Badiotites? carlottensis Whiteaves

Plate CVIII, Figure 5

1889. *Badiotites carlottensis.* Whiteaves, The fossils of the Triassic rocks of British Columbia: Contr. Canadian Palaeontology, vol. 1, pt. 2, p. 148, pl. 19, fig. 5.

Whiteaves describes this species as follows:

Shell small, strongly compressed at the side, periphery sharp but not distinctly keeled; whorls increasing rapidly in breadth

[9] Martin, G. C., Triassic rocks of Alaska: Geol. Soc. America Bull., vol 27, p 09, 1916.

[10] Mojsisovics, E. von, op. cit., p. 438, pl. 142, figs. 16–20.

in the dorsoventral direction. Surface of the outer volution marked by crowded, regularly disposed, and nearly equidistant minute and falcate riblike folds, which curve concavely forward on each of the sides and which are apparently not interrupted on the periphery. Sutural line unknown.

Just why this obscure fragment should have been assigned to *Badiotites*, the writer is unable to see. This genus is one of the least known in all the Upper Triassic fauna and one of the most improbable.

Occurrence: Very rare in the Upper Triassic, probably *Pseudomonotis* zone, of Houston Stewart Channel, Queen Charlotte Islands, British Columbia.

Genus RHABDOCERAS Hauer

1860. *Rhabdoceras*. Hauer, Beiträge zur Kenntniss der Cephalopoden-Fauna der Hallstätter Kalke: K. Akad. Wiss. Wien Sitzungsber., Band 41, p. 124.
1893. *Rhabdoceras*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 570.
1905. *Rhabdoceras*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 202.

Type.—*Rhabdoceras suessi* Hauer.[11]

Shell consists of a straight shaft, with marginal siphuncle, forward-pointing siphonal collars, and septa divided into lobes and saddles. The ventral lobe is divided, and there are two laterals and an undivided antisiphonal lobe. In Hauer's generic diagnosis it is stated that the lobes are clydonitic, unserrated, and the California species has similar septa. The form had a larval coil at the beginning, but this coil has not yet been found on the American species.

This genus is distinguished from *Bactrites* by its forward-pointing siphonal collars and more complex septa; from *Baculites* it is distinguished by its simpler goniatitic septa.

Rhabdoceras is known only from the Upper Triassic. In the Alpine province it occurs only in the Noric stage, and the beds of Plumas County, Calif., where it has been found, belong at this stage also.

Rhabdoceras suessi Hauer is the only European species of this genus, and *Rhabdoceras russelli* Hyatt is the only other representative known.

Rhabdoceras russelli Hyatt

Plate XLVII, Figures 13–15; Plate LVI, Figure 26

1892. *Rhabdoceras russelli*. Hyatt, Jura and Trias at Taylorsville, Calif.: Geol. Soc. America Bull., vol. 3, p. 398.
1905. *Rhabdoceras russelli*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 203, pl. 47, figs. 13–15; pl. 56, fig. 26.

Shell straight, slender, increasing very slowly in size; cross section oval; the venter more sharply rounded than the dorsum. Surface ornamented with cross ribs that run entirely around the shell, with gentle backward bend on the dorsum and the venter. The ribs are not prominent and are narrower than the interspaces. Septa goniatitic, with long, rounded saddles and linguaeform lobes. The ventral lobe is divided by a long saddle into two slender branches; there are two tongue-shaped laterals and a smaller undivided dorsal lobe.

This species resembles *Rhabdoceras suessi* Hauer as described by Mojsisovics,[12] but differs from that Alpine species in having the cross section more oval, the ribs not so strong, and the lobes and saddles longer at the same size.

Occurrence: In the Upper Triassic Brock shale (of Noric age and overlying the Hosselkus limestone), in the calcareous beds in the upper part of the *Pseudomonotis* zone, in Shasta County, Calif. It was associated with *Pseudomonotis subcircularis* Gabb, *Halorites americanus* Hyatt, and *Atractites* sp. indet., along with many pelecypods.

The writer also found it in the *Pseudomonotis* zone of Muttleberry Canyon, West Humboldt Range, 8 miles southeast of Lovelocks, Nev. It is associated with *Pseudomonotis subcircularis* Gabb, *Arcestes andersoni* Hyatt and Smith, *Placites humboldtensis* Hyatt and Smith, *Halorites* cf. *H. americanus* Hyatt, *Myophoria humboldtensis*, and other species not identified.

Family PHYLLOCERATIDAE Mojsisovics

Genus RHACOPHYLLITES Zittel

1885. *Rhacophyllites*. Zittel, Handbuch der Palaeontologie, Band 2, p. 439.
1902. *Rhacophyllites*. Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 317.

Type.—*Ammonites neojurensis* Quenstedt.

Evolute, discoidal, widely umbilicate, laterally compressed. Surface with striae of growth. Septa with phylloid saddle and monophyllic lobes.

Rhacophyllites is represented in the American Triassic only by the subgenus *Discophyllites* Hyatt, of which there is a single species.

Subgenus DISCOPHYLLITES Hyatt

1900. *Discophyllites*. Hyatt, Cephalopoda, in Zittel, K. A., Textbook of Palaeontology (translation by Eastman), vol. 1, p. 566.
1906. *Discophyllites*. Diener, Fauna of the *Tropites* limestone of Byans: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, pt. 1, p. 173.
1918. *Discophyllites*. Trechmann, The Trias of New Zealand: Geol. Soc. London Quart. Jour., vol. 73, pt. 3, p. 184.
1919. *Discophyllites*. Diener, Neue *Ammonoidea leiostraca* aus den Hallstätter Kalken des Salzkammergutes: Akad. Wiss. Wien Denkschr., Band 97, p. 381.

Type.—*Rhacophyllites patens* Mojsisovics.

Form rather evolute, discoidal, laterally compressed. Surface with only striae of growth. Body chamber short. Septa only moderately phylloid, with leaflike expansions of the saddles and digitate lobes. This

[11] Hauer, F. von, Beiträge zur Kenntniss der Cephalopoden-Fauna der Hallstätter Kalke: K. Akad. Wiss. Wien Sitzungsber., Band 41, p. 125, pl. 2, figs. 9–16.

[12] Mojsisovics E. von, Die Cephalopoden der Hallstätter Kalke; K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 2, p. 571, pl. 133, figs. 10–17, 1893.

genus is transitional from *Monophyllites* to *Phylloceras*. It is represented in the Karnic stage of the Upper Triassic by *Discophyllites ebneri* Mojsisovics, and *Discophyllites insignis* Gemmellaro; in the transitional beds between Karnic and Noric by *Discophyllites patens* Mojsisovics; and in the true Noric by *Discophyllites floweri* Diener.

Of these species only *Discophyllites patens* occurs in America.

Rhacophyllites (Discophyllites) patens (Mojsisovics)

Plate LXII, Figures 1–13; Plate CIII, Figures 4–6

1874. *Lytoceras patens.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, p. 34, pl. 16, fig. 13; pl. 19, fig. 17.

1902. *Rhacophyllites* (*Discophyllites*) *patens.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement Heft, p. 321.

1914. *Discophyllites* cf. *D. ebneri.* Welter, Obertriadische Ammoniten und Nautiloiden von Timor: Paläontologie von Timor, Lief. 1, p. 202, pl. 30, figs. 10 and 11; text figs. 74–76.

1919. *Discophyllites patens.* Diener, Neue *Ammonoidea leiostraca* aus den Hallstätter Kalken des Salzkammergutes: Akad. Wiss. Wien Denkschr., Band 97, p. 381, text figs. on p. 382.

Form robust, moderately evolute, rather widely umbilicate, little embracing, and little indented by the inner volutions. Flanks sloping gently up to the narrow venter, giving an oval rather than a cordiform cross section. Body chamber short. Surface with only striae of growth. Septa with phylloid saddles and deeply digitate lobes. In youth the saddles are entire and rounded, whereas the lobes are trifid as in primitive species of *Monophyllites*.

Rhacophyllites patens resembles *Rhacophyllites ebneri* Mojsisovics,[13] differing in its shorter siphonal lobe, and somewhat more distinctly phylloid lateral saddles.

Rhacophyllites patens also greatly resembles *Rhacophyllites insignis* Gemmellaro, from the Karnic beds of Sicily, from which it differs chiefly in its oval instead of cordiform cross section; otherwise the two species are exactly alike. The writer is of the opinion that *Rhacophyllites patens*, *Rhacophyllites ebneri*, and *Rhacophyllites insignis* are all specifically identical but can not decide the question for lack of material from Sicily and India.

The collection at Stanford University, however, contains perfect material of this species from the Austrian Alps and from Timor, and the writer can see no differences between forms from Timor and Austria, nor between these and specimens from California. Diener also is of the opinion that *Discophyllites ebneri* is a synonym of *D. patens*.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at several places on Brock Mountain, between Squaw Creek and Pit River, and on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.; also on Herring Bay, Admiralty Island, Alaska. It is associated with *Tropites welleri*, *Discotropites lineatus*, *Homerites semiglobosus*, *Juvavites subinterruptus*, *Sagenites herbichi*, *Arcestes pacificus*, *Proclydonautilus triadicus*, *Halobia superba*, and other species.

Rhacophyllites patens was first described as coming from the Noric beds of the Tyrolian Alps, but later studies in that region have shown that the beds are transitional from Karnic to Noric, just as are the beds in Shasta County, Calif.

[13] Mojsisovics, E. von, Beiträge zur Kenntniss der obertriadischen Cephalopoden-Faunen des Himalaya: K. Akad. Wiss. Wien Denkschr., Band 63, p. 668, pl. 19, fig. 6, 1893.

Order BELEMNOIDEA

Family BELEMNITIDAE

Genus ATRACTITES Gümbel

1861. *Atractites.* Gümbel, Geognostische Beschreibung des bayerischen Alpengebirges, p. 475.

1871. *Aulacoceras* (part). Mojsisovics, Ueber das Belemnitiden-Geschlecht *Aulacoceras:* K.-k. geol. Reichsanstalt Wien Jahrb., p. 41.

1880. *Aulacoceras* (part). Branco, Beobachtungen an *Aulacoceras:* Deutsche geol. Gesell. Zeitschr., p. 401.

1882. *Atractites.* Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 299.

1887. *Atractites.* Hauer, Cephalopoden des Bosnischen Muschelkalkes von Han Bulog bei Sarajevo: K. Akad. Wiss. Wien Denkschr., Band 54, p. 3.

1896. *Atractites.* Toula, Eine Muschelkalkfauna am Golfe von Ismid in Kleinasien: Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, Band 10, p. 185.

1902. *Atractites.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 192.

1904. *Atractites.* Martelli, Cefalopodi triasici di Boljevici presso Vir nel Montenegro: Palaeontographia Italica, vol. 10, p. 137.

1905. *Atractites.* Hyatt and Smith, The Triassic cephalopod genera of America, p. 204.

1907. *Atractites.* Diener, The fauna of the Himalayan Muschelkalk: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, Mem. No. 2, p. 21.

1914. *Atractites.* Smith, The Middle Triassic marine invertebrate faunas of North America: U. S. Geol. Survey Prof. Paper 83, p. 138.

The genus *Atractites*, as restricted by Mojsisovics, comprises belemnoid forms with long phragmocone and short guard. The phragmocone is chambered, long and slender, has simple concave septa, marginal siphuncle, backward-pointing siphonal collars, and a calcareous protoconch. The guard is the calcareous sheath.

Atractites drakei Smith, n. sp.

Plate LXXXIX, Figures 15, 16

Small, slender, laterally compressed, with flattened guard and slender phragmocone. Much smaller and slenderer than *A. philippii* and differing also in the compression. Named in honor of Dr. N. F. Drake.

Occurrence: Rather common in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Atractites philippii Hyatt and Smith

Plate XLVIII, Figures 1–3

1905. *Atractites philippii.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 204, pl. 48, figs. 1–3.

Form long, slender, conical, with cylindrical cross section. Angle of increase very small. Phragmocone long and slender, with chamber walls set close together, marginal siphuncle, backward-pointing siphonal collars, short siphonal lobe, and calcareous protoconch. Guard thick and massive, not extending far beyond the small end of the chambered internal shell, and not enlarged below the end, as is common in *Atractites.*

The guard was not developed until the chambered shell was several centimeters long, for specimens of this size were found without any trace of the ostracum.

Occurrence: Common in the upper part (*Juvavites* subzone) of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch, in Shasta County, Calif.; also at the same horizon on Bear Mountain, about 20 miles northeast of Redding, in the same county.

The specific name is given in honor of Dr. E. Philippi.

Genus AULACOCERAS Hauer

Aulacoceras carlottense Whiteaves

Plate CVIII, Figure 6

1889. *Aulacoceras carlottense.* Whiteaves, The fossils of the Triassic rocks of British Columbia: Canada Geol. Survey Contr. Canadian Paleontology, vol. 1, p. 2, p. 149, pl. 19, fig. 6.

Whiteaves describes this species as follows:

> Guard elongated, in the more perfect though smaller of the only two specimens collected, which may therefore be regarded as the type of the species, narrowly conical and increasing very slowly in thickness from the acutely pointed posterior end, whose apex is slightly excentric; in the larger but less perfect example comparatively thick, somewhat fusiform and bluntly pointed posteriorly, with apex distinctly excentric. Alveolus and phragmocone unknown. Outer surface marked by close-set, rounded longitudinal ribs, which are separated from each other by narrow but deep linear furrows.

Occurrence: Upper Triassic, presumably *Pseudomonotis* zone, at Houston Stewart Channel, Queen Charlotte Islands, British Columbia.

Genus DICTYOCONITES Mojsisoviçs

1902. *Dictyoconites.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 182.

1904. *Dictyoconites.* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, p. 304.

Type.—Aulacoceras reticulatum Hauer.

Belemnoid forms, with great development of the phragmocone and the rostrum on the guard still rudimentary; long chambered cones with simple septa, forward-pointing siphonal collars, and marginal siphuncle. Rostrum usually not preserved and consisting only of a rudimentary development at the lower end of the shell.

The species assigned to this genus were formerly assigned to *Orthoceras* and later to *Aulacoceras.* They differ from *Aulacoceras* chiefly in the ventral position of the siphuncle and the rudimentary nature of the rostrum.

Occurrence: Not uncommon in the Upper Triassic of the Alps, Sicily, and California.

Dictyoconites americanus Smith, n. sp.

Plate LXXXIX, Figures 10–14

Shell large, conical, consisting chiefly of the chambered phragmocone, with obscure traces of the radially striate rostrum. Siphuncle marginal. Cross section nearly circular. Angle of the shell, 13°; length, 250 millimeters; breadth, about 40 millimeters; distance between the chambers, about 7 millimeters. Surface ornamented with striae of growth that make a broad sinus on the dorsal side of the shell.

Dictyoconites americanus has some resemblance to *D. haugi* Mojsisovics [14] but differs in the greater angle of growth of the shell, which is only about 7 degrees on the European species.

Occurrence: Not uncommon in the Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the zone of *Tropites subbullatus*, of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Order NAUTILOIDEA

Genus ORTHOCERAS Breyn

Shell straight or nearly so, tapering; siphuncle median or submedian, never marginal. Septa convex toward the apex, straight in cross section. This form is the simplest and commonest member of the Orthoceratidae; as thus defined the genus ranges from the Ordovician to the Upper Triassic, with very little change. Species are distinguished by the angle of growth, the surface ornamentation, the distance apart of the septa, and the position and size of the siphuncle. But these differences are so slight that it is extremely unsatisfactory to attempt to separate most species of this group, and it is still more unsatisfactory to try

[14] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 188, pl. 15, figs. 3, 4, 1902.

to identify or compare species which are supposed to be identical but which occur at different localities and in different association.

In America it has been found sparingly in the Lower Triassic, but it is very common in the Middle Triassic of Nevada and occurs at a few places in the Upper Triassic of California.

Orthoceras shastense Hyatt and Smith

Plate XLVIII, Figures 4, 5

1905. *Orthoceras shastense.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 210, pl. 48, figs. 4, 5.

Shell small, slender, angle of increase about 6°. Cross section circular, siphuncle median. Surface smooth. Septa close together, distant about half the diameter of the shell.

This species resembles *Orthoceras blakei* Gabb, from the Middle Triassic of the Humboldt Range, Nev., but differs from that species in its smaller angle of increase and in its rather more distant septa.

Occurrence: A few specimens were found by J. P. Smith in the Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the zone of *Tropites subbullatus*, on the divide between Squaw Creek and Pit River, about 3 miles east of Madison's ranch and half a mile north of the trail to Brock's ranch, in Shasta County, Calif. They were associated with *Tropites subbullatus*, *Discotropites sandlingensis*, *Sagenites herbichi*, *Halobia superba*, and many other species characteristic of this zone.

Genus PARANAUTILUS Mojsisovics

1902. *Paranautilus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 205.

1914. *Paranautilus.* Smith, The Middle Triassic marine invertebrate faunas of North America: U. S. Geol. Survey Prof. Paper 83, p. 142.

Paranautilus liardensis (Whiteaves)

Plate CVII, Figures 1, 2

1889. *Nautilus liardensis.* Whiteaves, The fossils of the Triassic rocks of British Columbia: Contr. Canadian Paleontology, vol. 1, pt. 2, p. 137, pl. 18, figs. 1, 1a.

Form robust, subspherical; venter broadly depressed, umbilicus deep and narrow. Cross section elliptical. Septa nearly straight, without lobes or saddles. Surface sculpture consists of transverse striae of growth.

Occurrence: In the Upper Triassic on Liard River, 25 miles below Devils Portage, British Columbia, at the horizon of *Dawsonites canadensis*, presumably of lower Karnic age.

Genus PROCLYDONAUTILUS Mojsisovics

1902. *Proclydonautilus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 207.

1905. *Proclydonautilus.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 205.

Type.—Nautilus griesbachi Mojsisovics.

Form involute, with high, rounded whorls, nearly smooth shell, narrow umbilicus, and nearly central siphuncle. The septa are divided into numerous lobes and saddles. The broad ventral saddle is divided by a shallow funnel-shaped lobe; there is also a broad and deep lateral lobe. The internal part of the septum shows no lobes nor saddles. The young stages are like the Carboniferous genus *Coloceras* (*Nautilus globatus* Meek and Worthen), and the transition from the Paleozoic to the Triassic type of septa is very gradual. Mojsisovics [15] formerly assigned *Nautilus triadicus* to his genus *Clydonautilus*, from which, however, it may be distinguished by having one less lateral lobe, a rounded instead of angular whorl, and the shape of the inner volutions. The writer is very doubtful if *Proclydonautilus triadicus* belongs to the same group with *Clydonautilus*.

Proclydonautilus triadicus Mojsisovics

Plate XLIX, Figures 1–3; Plate L, Figures 1–17

1873. *Nautilus triadicus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, p. 27, pl. 14, figs. 1–4.

1882. *Clydonautilus triadicus.* Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 27.

1902. *Proclydonautilus triadicus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 209.

1905. *Proclydonautilus triadicus.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 206, pl. 49, figs. 1–3; pl. 50, figs. 1–10.

Involute, somewhat compressed laterally, high-whorled, with broadly rounded flanks and venter without any angle on either. Umbilicus completely closed; broadly rounded umbilical shoulders. The whorl is slightly broader than it is high, and the greatest breadth is even with the projection of the top of the inner whorl. The height of the whorl is two-thirds of the total diameter. The siphuncle lies a little below the center. The surface is smooth and has no ornamentation except the exceedingly fine radial striae of growth, which bend backward on the venter, forming a broad hyponomic sinus.

[15] Mojsisovics, E. von, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10 ,p. 281 ,1882.

The septa are sinuous, showing both lobes and saddles; the broad and deep ventral saddle is divided by a narrow and shallow abdominal lobe; the lateral lobe is long and rather broad; on the umbilicus there is a second lateral lobe, shallow and broad. There is no internal lobe.

Relative dimensions of the adult shell

	Millimeters
Diameter	1
Height of last whorl	.66
Height of last whorl from preceding	.46
Width of last whorl	.70
Involution	.20
Width of umbilicus	.00

The largest specimen found had a diameter of 97 millimeters; the average size of mature specimens was about 70 millimeters. In the youngest stages there is no lobe nor saddle, the septum is straight, and the shape is globose; at this stage the shell corresponds to the Carboniferous genus *Coloceras* Hyatt (*Nautilus globatus* Meek and Worthen). At a diameter of 7 millimeters the ventral lobe begins to develop and at a diameter of 10 millimeters the lateral lobes and saddles are visible; at this stage the whorl ceases to be globose and becomes higher. At a diameter of 25 millimeters the shell has all the characters of maturity, and the only later changes are those in size. On the ontogeny of this species we are able to connect a highly specialized Mesozoic group with the Paleozoic radicle.

Occurrence: Upper Triassic Hosselkus limestone, in both subzones of the zone of *Tropites subbullatus*, on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch and half a mile north of the trail to Brock's ranch, in Shasta County, Calif. This form is one of the commonest cephalopods in these beds.

Proclydonautilus spirolobus (Dittmar)

Plate LXXXVIII, Figures 6–14

1866. *Nautilus spirolobus.* Dittmar, Zur Fauna der Hallstätter Kalke, in Benecke, E. W., Geognostische-palaeontologische Beiträge, Band 1, p. 352, pl. 13, figs. 1, 2.

1902. *Proclydonautilus spirolobus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 211, pl. 10, fig. 3; pl. 11, fig. 1.

Subspherical, involute, with flanks and venter rounded, without shoulders. Aperture flaring and lunate. Surface with strong growth lines, almost amounting to ribs, parallel to the aperture. Septa with short, little-developed ventral lobe, and large lateral; the ventral lobe is developed only toward maturity, and thus the species differs from *Proclydonautilus triadicus*, in which the lobe is well developed in youth. Also *Proclydonautilus spirolobus* is broader. It differs from *Proclydonautilus goniatites* chiefly in its less spherical form.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the *Tropites subbullatus* zone, *Juvavites* subzone, at the north end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It is associated with *Tropites welleri*, *Discotropites lineatus*, *Juvavites subinterruptus*, *Sagenites herbichi*, *Proclydonautilus triadicus*, *Halobia superba*, and other species.

It was first described from the lower Noric beds of the Hallstatt limestone, of the Tyrolian Alps, Austria.

Proclydonautilus stantoni Smith, n. sp.

Plate LXXXV, Figures 6–11

Robust, involute, subspherical, with rounded flanks, subangular shoulders, and narrow flattened band on the venter. Surface with sinuous growth lines, making a broad, shallow backward-curving sinus on the venter. Septa with short narrow ventral lobe and deep lateral.

Proclydonautilus stantoni resembles *Proclydonautilus triadicus* but is much smaller and differs in the flattened band and the more robust form.

Named in honor of Dr. T. W. Stanton.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Proclydonautilus ursensis Smith, n. sp.

Plate LXXXIV, Figures 1–3; Plate LXXXV, Figures 1–5

Form large, subspherical, completely involute, deeply embracing but not deeply indented by the inner whorls. Umbilicus closed. Surface smooth. Septa with small V-shaped ventral lobe and deep broad lateral.

P. ursensis resembles *Proclydonautilus triadicus* but is more globose and much larger; it also has the ventral lobe undeveloped in youth, being thus retarded in development but not arrested. It is closer to *Proclydonautilus goniatites* Hauer[16] but is much larger and does not have the flanks so greatly expanded.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at Bear Cove, at the north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

[16] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 210, pl. 11, figs. 2, 3, 1902.

Genus COSMONAUTILUS Hyatt and Smith

1905. *Cosmonautilus*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 207.

Type.—Cosmonautilus dilleri Hyatt and Smith.

Form involute, high whorled, laterally compressed, with narrow flattened venter and distinct abdominal shoulders. Surface at maturity smooth, with only the striae of growth. Septa very sinuous, with broad rounded ventral lobe, long principal lateral, and a shallow small lobe outside of the umbilicus. The internal septum has no lobe. Siphuncle above the center.

In the adolescent stage this genus resembles *Metacoceras* (*M. cavatiforme* Hyatt).[17] In these stages the whorl is broad, much lower than at maturity, with simple septa, and there is a strong row of tubercles on the angular abdominal shoulders. The phylogeny of this group seems to be *Temnocheilus*→ *Metacoceras*→ *Cosmonautilus*. *Clydonautilus* Mojsisovics is evidently a descendant of this genus, for *C. quenstedti* Mojsisovics [18] in its youth goes through a stage exactly like *Cosmonautilus*. This genus is distinguished from its descendant in lacking one pair of lateral lobes and in the primitive character of its young, the simplicity of the septa, and the strong marginal tubercles.

Cosmonautilus is known only in the Triassic and is represented in California by several new species. *Clydonautilus biangularis* Mojsisovics, of the Upper Triassic of the Himalayas in India, appears to belong to this genus, as may also some of the European species assigned by Mojsisovics to *Clydonautilus*.

Cosmonautilus dilleri Hyatt and Smith

Plate LI, Figure 1; Plate LII, Figure 1; Plate LIII, Figures 1–2; Plate LIV, Figures 1–4; Plate LV, Figures 1–11; Plate XC, Figure 1; Plate XCI, Figures 1, 2; Plate XCII, Figures 1, 2

1905. *Cosmonautilus dilleri*. Hyatt and Smith, The Triassic cephalopod genera of America, p. 207, pl. 51, fig. 1; pl. 52, fig. 1; pl. 53, figs. 1, 2; pl. 54, figs. 1–4; pl. 55, figs. 1–11.

Form involute, high-whorled, somewhat compressed laterally, deeply embracing, and deeply indented by the inner volutions. Greatest breadth of the whorl at a point even with the projection of the inner volution. The height of the whorl is two-thirds of the total diameter of the shell, the width is six-sevenths of the height, and the indentation by the inner volution is less than one-third of the height. The whorl is broadly convex and slopes up from the widest point to the abruptly rounded abdominal shoulders; the venter is flattened, and its width between the shoulders is less than one-third of the greatest breadth of the whorl. The siphuncle is above the center of the chamber.

The septa are sinuous, divided externally into complex lobes and saddles. The long ventral saddle is divided by a broad U-shaped ventral lobe, forming two very narrow tongue-shaped saddles on the abdominal shoulders; there is a deep and broad principal lobe, with rounded extremity, and a small shallow lateral on the umbilical slope. The internal septum has no lobe nor saddles. The surface of the shell is smooth at maturity and shows only fine cross striae of growth.

In youth, until the shell attains a diameter of 8 millimeters, the whorl is subglobose and perfectly smooth, with simple straight septa. At this size the abdominal shoulders begin to develop, and very soon faint tubercles begin to appear on the shoulders; this sculpture rapidly grows strong, until the shape, sculpture, and septa are very like those of *Metacoceras* Hyatt. When the shell has attained a diameter of 12 millimeters, however, the septa already show the sinuous lobes and saddles characteristic of the mature form, except that they are not so complex. Thus the characters of *Metacoceras* and those of *Cosmonautilus* occur simultaneously in the same individual, which may indicate either that the Paleozoic characters are retarded in the development or that the Mesozoic characters are unduly accelerated in their appearance.

When the shell attains a diameter of 35 millimeters, the tubercles become obsolete and the shoulders lose their angularity. The shell is then entering on maturity, and from this time onward it does not change in any essential characters; the whorls become proportionally higher and more compressed laterally, but retain their general characters, except that the flattened band on the venter becomes more pronounced.

Occurrence: Upper Triassic Hosselkus limestone, in the *Juvavites* subzone of the zone of *Tropites subbullatus*, on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch and half a mile north of the trail to Brock's ranch, in Shasta County, Calif. This species is not so common as *Proclydonautilus triadicus* but is not uncommon. J. P. Smith also found it in the same horizon at Terrup Chetta (Cottonwood Flat), near Squaw Creek, about 6 miles north of the locality just mentioned. The specific name is given in honor of J. S. Diller.

Cosmonautilus hersheyi Smith, n. sp.

Plate LXXXIX, Figures 1–9

Laterally compressed, involute, with flattened sides, subangular shoulders, and rather narrow venter. Surface with fine sinuous growth lines. Septa with broad U-shaped ventral lobe and deep lateral.

C. hersheyi is more compressed than *C. dilleri*, with angular shoulders and distinct lateral furrow under them. It resembles the genus *Styrionautilus* but differs in the septa, which are of the true *Cosmonautilus* type.

[17] Hyatt, Alpheus, Carboniferous cephalopods: Texas Geol. Survey Second Ann. Rept., p. 334, figs. 30–33, 1891.

[18] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, p. 22, pl. 9, figs. 1, 3, 1873.

Named in honor of Oscar H. Hershey.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Cosmonautilus pacificus Smith, n. sp.

Plate LXXXVI, Figures 1–15

Form high-whorled, robust, rather involute, with flattened sides, subangular ventral shoulders and moderately broad, flattened venter. Surface ornamented with very fine close-set ribs, with strong backward curve. There are small tubercles on the ventral shoulder angles, distinct in youth and nearly obsolete in age. Body chamber short, as in all nautiloids. Septa with broad, shallow U-shaped ventral lobe, deep and broad lateral, with a second lateral indicated on the ventral suture.

In early youth the shell is rounded but soon becomes angular and develops the shoulder knots, corresponding to *Metacoceras;* then the whorl becomes more round-shouldered and the shell resembles *Cosmonautilus dilleri;* toward maturity the shoulders again become angular and the resemblance to *Metacoceras* again becomes pronounced, except in the septa, which retain the character of *Cosmonautilus*. The fine sharp curved ribs persist through life, making this the handsomest species of *Nautilus* in the American Triassic.

Occurrence: Rather rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Cosmonautilus shastensis Smith, n. sp.

Plate LXXXVII, Figures 1–11

Form involute, laterally compressed, thick set, with somewhat flattened sides, angular shoulders and broad flattened venter. Surface with strong blunt nodes on the shoulders. Body chamber short. Septa with broad, shallow U-shaped ventral lobe and broad deep lateral.

C. shastensis in form is a typical *Metacoceras* but differs in the strongly sinuous septa; it is either partly reversionary to that genus or retarded in that stage. It resembles *C. pacificus* but differs in the more robust whorl, the persistence of the ventral nodes, and the absence of the fine sinuous ribs. At maturity it bears some resemblance to the young of *C. dilleri*, but it has little similarity to that species at the same size. Both evidently come from *Metacoceras*, but *C. shastensis* retains many characters of that genus until maturity, whereas *C. dilleri* loses them entirely. *C. shastensis* is thus the most primitive or else the most reversionary species of the genus *Cosmonautilus*.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at Bear Cove, at the north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus GERMANONAUTILUS Mojsisovics

Germanonautilus brooksi Smith, n. sp.

Plate CII, Figures 7–10

Shell moderately evolute, with open umbilicus, whorls broader than high, deeply embracing. Cross section low, crescentic, with broadly arched venter, more sharply curving flanks, and steep umbilical walls. There is only a faint suggestion of the ventral shoulders usually characteristic of the group and no remnant of the nodes. Surface shows fine striae of growth and spiral lines. The striae of growth bend backward on the venter, forming a deep broad sinus. The septa show a broad, shallow ventral lobe, and a short funnel-shaped ventral or annular lobe. Siphuncle central.

Named in honor of Dr. A. H. Brooks.

Occurrence: Very rare in the Upper Triassic beds of Karnic age in Alaska, Yukon Valley, locality 9384, United States Geological Survey, opposite mouth of Nation River; collected by E. Blackwelder.

Genus MOJSVAROCERAS Hyatt

1883. *Mojsvaroceras*. Hyatt, Genera of fossil cephalopods: Boston Soc. Nat. Hist. Proc., vol. 22, p. 269.

1882. *Temnocheilus*. Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 226.

1905. *Mojsvaroceras*. Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 208.

(Not 1844. *Temnocheilus*. McCoy, Synopsis of the characters of the Carboniferous limestone fossils of Ireland, p. 20.)

Type.—Temnocheilus neumayri Mojsisovics.[19]

Form evolute, with low, broad quadrangular, little-embracing whorls; wide, deep umbilicus; and two rows of lateral tubercles, one on the umbilical and one on the abdominal shoulders. The septa show broad, shallow ventral and lateral lobes and a funnel-shaped dorsal or annular lobe.

The primitive shape and septa strongly resemble those of the Paleozoic and early Mesozoic *Foordiceras* Hyatt, through which group *Mojsvaroceras* has probably descended from *Temnocheilus*. Most of the species assigned by Hyatt to *Mojsvaroceras* have been described under the name of *Temnocheilus*, but this genus will have to be restricted to the less-specialized Paleozoic members of the group.

As thus defined *Mojsvaroceras* is known only in the Triassic. In America the species described below is the only certain representative, but there are some forms in the Middle Triassic that may belong here.

[19] Mojsisovics, E. von, Die Cephalopoden der Mediterranen Triasprovinz: K.-k. geol. Reichsanstalt Wien Abh., Band 10, p. 267, pl. 88, figs. 1, 2, 1882.

Mojsvaroceras turneri Hyatt and Smith

Plate XLVIII, Figures 6–11

1905. *Mojsvaroceras turneri.* Hyatt and Smith, The Triassic cephalopod genera of America: U. S. Geol. Survey Prof. Paper 40, p. 209, pl. 48, figs. 6–11.

Evolute, whorls subquadratic, low and broad, with flanks narrowing slightly to the abruptly rounded abdominal shoulders. Whorls rather deeply indented by the inner volutions. Surface nearly smooth but ornamented with weak tubercles on the flanks and on the abdominal shoulders. The umbilicus is deep and wide, and the inner walls are very steep.

Dimensions of type specimen of Mojsvaroceras turneri

	Millimeters
Diameter	90
Height of last whorl	40
Height of last whorl from preceding	30
Width of last whorl	60
Involution	10
Width of umbilicus	25

The septa are slightly sinuous, with a broad, shallow ventral lobe, a similar lateral lobe, and a funnel-shaped dorsal or annular lobe. The siphuncle is below the center of the whorl.

Occurrence: Two specimens were found by J. P. Smith in the Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the zone of *Tropites subbullatus*, on the divide between Squaw Creek and Pit River, about 3 miles east of Madison's ranch and half a mile north of the trail to Brock's ranch, Shasta County, Calif.

Genus SYRINGOCERAS Hyatt

1894. *Syringoceras.* Hyatt, Phylogeny of an acquired characteristic: Am. Philos. Soc. Proc., vol. 32, p. 546.
1900. *Syringoceras.* Hyatt, Cephalopoda, in Zittel, K. A., Textbook of Palaeontology (Eastman's translation), p. 521.
1902. *Syringoceras.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 214.

Type.—Nautilus barrandei Hauer.

Form evolute, with rounded little-embracing whorls, wide umbilicus, slightly compressed sides, and flattened venter. Umbilicus invariably perforated. Sculpture consists of fine growth lines and spirals. Septa very simple, nearly straight, but with well-developed annular lobe.

Occurrence: Common from Middle Triassic through the Upper Triassic. In America it is represented by a single species in the *Pseudomonotis subcircularis* zone, of upper Noric age.

Syringoceras spurri Smith, n. sp.

Plate CIV, Figures 8, 9

Form moderately robust, somewhat compress laterally, with open though not very wide um ilicus and rounded venter. Surface shows fine, sharp backward-curving growth lines. Septa have only gentle curves; no real lobes nor saddles on the outside. Annular lobe not observed.

S. spurri resembles *S. altius* Mojsisovics [20] but differs in being more compressed and less widely umbilicate.

Named in honor of J. E. Spurr.

Occurrence: Very rare in the Upper Triassic *Pseudomonotis subcircularis* zone of the Star Peak formation, in Muttleberry Canyon, in the West Humboldt Range, about 8 miles southeast of Lovelocks, Nev.; it is associated with *Rhabdoceras russelli*, *Halorites americanus*, *Arcestes andersoni*, *Placites humboldtensis*, and other species.

Genus JUVAVIONAUTILUS Mojsisovics

1902. *Juvavionautilus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 222.

Type.—Nautilus heterophyllus Hauer.

Form evolute, little-embracing, with somewhat rounded young and subtrapezoidal adult cross section. Surface smooth, with only fine sinuous lines of growth. Septa simple, with broad shallow ventral saddle, a similar lateral lobe, and a small annular lobe.

This genus appears to have been derived from *Syringonautilus* and is essentially characteristic of the Noric stage.

Subgenus OXYNAUTILUS Mojsisovics

1902. *Oxynautilus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 223.

Whorls somewhat more involute than those on *Juvavionautilus*, laterally compressed, and sharpened into a high, massive keel. Surface with fine sinuous growth lines and no other ornamentation. Septa with narrow ventral saddle, and broad lateral lobe.

Occurrence: Confined to the Noric stage of the Upper Triassic, and represented by a single species, *Juvavionautilus (Oxynautilus) acutus* Hauer.

Juvavionautilus (Oxynautilus) acutus (Hauer)

1846. *Nautilus acutus.* Hauer, Die Cephalopoden des Salzkammergutes aus der Sammlung des Fürsten Metternich, p. 38, pl. 11, figs. 1, 2.
1902. *Juvavionautilus (Oxynautilus) acutus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 226, pl. 2, fig. 1; pl. 3, fig. 1.

Form somewhat evolute, widely umbilicate, strongly compressed laterally, with narrow venter, surmounted by a strong keel. Surface smooth. Septa with narrow ventral saddle and broad lateral lobe.

Occurrence: Only a single specimen was found in the Upper Triassic Hosselkus limestone, above the coral zone at the base of the beds of Noric age at the

[20] Mojsisovics, E. von, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 219, pl. 6, fig. 2, 1902.

east side of the north end of Brock Mountain, between Pit River and Squaw Creek, Shasta County, Calif. This specimen was completely shattered in the attempt to get it out of the splintery rock matrix and could not be illustrated.

Genus GRYPOCERAS Hyatt

1883. *Grypoceras.* Hyatt, Genera of fossil Cephalopoda, p. 269.
1900. *Grypoceras.* Hyatt, Cephalopoda, in Zittel, K. A., Text-book of Palaeontology (translated by Eastman), p. 521.
1902. *Grypoceras.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 227.

Subgenus GRYPONAUTILUS Mojsisovics

1902. *Gryponautilus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 227.

Type.—Grypoceras galeatum Mojsisovics.

Involute, robust, square-shouldered, with flattened venter, and strong shoulder knots. Septa very simple, with no lobes nor saddles.

Gryponautilus is either a very primitive group, which retains until maturity the essential characters of *Metacoceras*, or else it is a reversion, by arrest of development, toward that genus. It is intermediate between *Metacoceras* and *Cosmonautilus*, is primitive in character, and resembles the early adolescent stages of *Cosmonautilus*.

Occurrence: Rare in the Upper Triassic Karnic stage of the Tyrolian Alps and India and corresponding beds in California.

Grypoceras (Gryponautilus) cooperi Smith, n. sp.

Plate LXXXVIII, Figures 1–5

Form very robust, with subrectangular cross section, moderately wide umbilicus, flattened sides, angular ventral shoulders, and broad, very slightly convex venter. The ventral shoulders are armed with strong nodes. The septa are nearly straight; they form only a slight angle at the shoulders and give a broad and shallow backward-curving sinus on the venter. This genus retains at maturity most of the characters of *Metacoceras*, and *Grypoceras cooperi* is unusually primitive; it is a genuine anachronism, either an arrested or a reversionary form.

Grypoceras cooperi is very closely related to *Grypoceras suessi* Mojsisovics but differs in its more robust form, wider and convex instead of concave venter, wider umbilicus, and coarser nodes. It also resembles *Grypoceras suessiforme* Diener,[21] but differs from that species in being more compressed and in having a narrower umbilicus. It lies between *Grypoceras suessi* and *Grypoceras suessiforme*, and more material would probably show an intergradation between the three species.

Named in memory of Dr. J. G. Cooper.

[21] Diener, Carl, Upper Triassic and Liassic faunae of the exotic blocks of Malla Johar in the Bhot Mahals of Kumaon: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 1, pt. 1, p. 54, pl. 10, fig. 1, 1908

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, in Bear Cove, at the north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus STYRIONAUTILUS Mojsisovics

1902. *Styrionautilus.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, Supplement-Heft, p. 206.

Type.—Nautilus styriacus Mojsisovics.

Involute, globose forms, with rounded venter. Septa with lateral lobes but without distinct ventral lobe. This genus is supposed to have developed out of *Paranautilus*, but transitional forms are lacking.

Styrionautilus is doubtfully represented in America by *S. sauperi*, in Upper Triassic beds of Karnic age.

Styrionautilus sauperi (Hauer)

Plate LXXXV, Figures 12–18

1846. *Nautilus sauperi.* Hauer, Cephalopoden des Muschelmarmors von Bleiberg in Kärnten: Haidinger's Naturw. Abh., Band 1, p. 26, pl. 1, figs. 1–4.
1847. *Nautilus sauperi.* Hauer, Cephalopoden des Muschelmarmors von Bleiberg in Kärnten: Haidinger's Naturw. Abh., Band 1, p. 261, pl. 8, figs. 4, 5.
1873. *Nautilus sauperi.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, p. 28, pl. 14, figs. 5, 6; pl. 15, fig. 1.
1902. *Styrionautilus sauperi.* Mojsisovics, Die Cephalopoden der Hallstätter Kalke: K.-k. geol. Reichsanstalt Wien Abh., Band 6, Hälfte 1, p. 209, text fig. 6.

Robust, involute, with flattened sides, subangular shoulders, and flat, narrow venter. Surface with fine sinuous growth lines. Septa with very small narrow ventral lobe and broad lateral lobe. Mojsisovics classed this species as intermediate between *Clydonautilus* and *Styrionautilus*, but it has great resemblance in form to *Cosmonautilus* in spite of the difference in its septa.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at Bear Cove, at the north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was first described from the same horizon in the Hallstatt limestone of the Tyrolian Alps, Austria.

Genus CLYDONAUTILUS Mojsisovics

Clydonautilus hessi Smith, n. sp.

Plate LXXXVIII, Figures 15–19

Form robust, rather involute, with subrectangular cross section, subangular shoulders and broad, flattened venter. Surface with sinuous growth lines bending backward in a broad, shallow sinus on the venter and with weak folds parallel to the lines. Septa with short narrow ventral lobe and wide, deep lateral lobe.

Clydonautilus hessi is more robust and thick set than *Proclydonautilus triadicus;* its form suggests that of *Cosmonautilus*, but it has no marginal nodes at any stage of growth. Its shape and septation do not agree with those of *Proclydonautilus* but suggest relationship to the more primitive *Mojsvaroceras*.

Named in honor of Frank L. Hess, who assisted in collecting this fauna.

Occurrence: Not uncommon in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Class GASTROPODA

Genus CAPULUS Montfort

Capulus silverthorni Smith, n. sp.

Plate XCIV, Figure 15

Shell of medium size, highly arched, with flaring aperture, and prominent incurved slender apex. Surface with only weak concentric wrinkles.

Named for the Silverthorn family, to whom the writer is indebted for many kindnesses.

Occurrence: Rather common in the Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the zone of *Tropites subbullatus*, of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus PATELLA Linné

Patella stuarti Smith, n. sp.

Plate XCIV, Figure 18

Form elliptic-oval, with apex slightly excentric, about two-fifths of the distance from the end. Shell subconical, with very low apical angle. Surface ornamented with extremely fine radial lines from apex to periphery.

Named in honor of W. E. Stuart, who assisted in collecting this fauna.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Patella sheehani Smith, n. sp.

Plate XCVI, Figures 28, 29

Form conical, with apex nearly central, and high apical angle, about 90°. The specimen is a cast and the external shell is unknown, but it seems to show traces of concentric lines only.

Named in honor of J. F. Sheehan, who assisted in collecting this fauna.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Genus COLLONIA Gray

Collonia occidentalis Smith, n. sp.

Plate XCIV, Figures 16, 17

Shell small, turbinate, with low apical angle, rounded whorls increasing rapidly in size; sutures deeply impressed. Surface with very fine spiral lines.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus OMPHALOPTYCHA Ammon

Omphaloptycha obesa Smith, n. sp.

Plate XCVI, Figure 4

Form turreted, with low spire, blunt apical angle, lower whorls becoming tumid. Suture deeply impressed. Surface with weak radial folds.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Omphaloptycha shastensis Smith, n. sp.

Plate XCVI, Figure 5

Form high-spired, increasing slowly in breadth, whorls about half as high as wide; suture deeply impressed. Surface smooth. Neither aperture nor apex seen. This species belongs to the group of *Chemnitzia*-like gastropods that is very common in the Triassic. There is much doubt whether it ought to be separated from *Chemnitzia*.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Genus WORTHENIA De Koninck

Worthenia klamathensis Smith, n. sp.

Plate XCVI, Figure 3

Form turbinate, with high spire, apical angle about 40°. Body whorl broad, with somewhat flattened base. About seven whorls with deeply impressed sutures. Surface with three or four obscure spiral ridges. The generic characters of *Worthenia* can not be made out on the poorly preserved specimen; it is assigned to that genus because of its resemblance to other species of *Pleurotomaria*-like forms of Triassic age.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Genus PROTORCULA Kittl

1899. *Protorcula.* Kittl, Die Gastropoden der Esinokalke, nebst einer Revision der Gastropoden der Marmolatakalke: K.-k. naturhist. Hofmus. Ann., Band 14, Nos. 1, 2, p. 184.
1913. *Protorcula.* Krumbeck, Obere Trias von Buru und Misól: Palaeontographica, Suppl. 4, Abt. 2, Lief. 1, Abschnitt 1, p. 85.

Turreted forms with high slender spire, angular whorls, and short canal. The genus was established to include the *Cerithium*-like forms of Triassic age.

Protorcula alaskana Smith, n. sp.

Plate CIII, Figures 9, 10

Form slender, with high spire; apical angle about 12°. About eight whorls, with shallow sinus and prominent shoulder near bottom of whorl. Surface ornamented with very fine backward-curving striae of growth, crossed by somewhat coarser spiral lines and with rather coarse nodes, about 24 to a whorl, on the shoulder angle.

This species is very similar to *Protorcula parvula* Krumbeck, from the Upper Triassic of eastern India, but differs in its smaller apical angle, shallower sinus, less pronounced shoulder, and coarser sculpture.

Occurrence: Very rare in the Upper Triassic, in beds probably of Karnic age, in Alaska, at locality 10093, United States Geological Survey. "Copeland Creek at Camp July 14. S. R. C., July 15, 1917." Associated with *Lima blackburnei.*

Protorcula bassetti Smith, n. sp.

Plate CI, Figure 7

Form slender, with high spire, angle of spire about 12°: nine whorls, with a sharp angle below the middle. Surface nearly smooth but with faint nodes on the shoulder angle. This species differs from *Protorcula alaskana* in having the shoulder angle near the middle of the whorl instead of near the base, also in the weakness of its sculpture.

Named in honor of T. E. Bassett, of the Stanford University geologic expedition, who assisted in collecting this fauna.

Occurrence: Very rare in the Upper Triassic coral zone of lower Noric age, at locality 8834, United States Geological Survey, north arm of Threemile Cove, near Dall Head, Gravina Island, Alaska.

Genus PURPURINA D'Orbigny

Purpurina gravinaensis Smith, n. sp.

Plate CI, Figure 6

Shell of medium size, whorls fine, thick set, somewhat tabulate at the suture. Body whorl more than half the total height. On each whorl there is a deep spiral furrow just below the tabulate shoulder. Surface ornamented with strong longitudinal ribs or folds, about 40 to a whorl.

This species is not closely related to any other known form, but its shell characters are sufficiently definite to make its reference to *Purpurina* reasonably certain.

Occurrence: Rare in the Upper Triassic coral zone of lower Noric age, on Gravina Island, Alaska, locality 9536, Fivemile Cove.

Genus MARGARITA Leach

Margarita triassica Whiteaves

Plate CVI, Figures 14, 15

1889. *Margarita triassica.* Whiteaves, The fossils of the Triassic rocks of British Columbia: Canada Geol. Survey, Contr. Canadian Paleontology, vol. 1, pt. 2, p. 136, pl. 17, figs. 8, 8a.

Shell small, turbinate, about as broad as high; four whorls, increasing rapidly in size; deeply and narrowly umbilicate; aperture nearly circular; outer lip thin and simple. Surface ornamented with four raised spiral lines on the upper half of the whorl.

Occurrence: In the Upper Triassic, presumably in the *Pseudomonotis* zone, about 30 miles below Devil's Portage on Liard River, British Columbia.

Class PELECYPODA

Genus MYOPHORIA Bronn

Myophoria alta Gabb

Plate CIV, Figure 16

1864. *Myophoria alta.* Gabb, Description of the Triassic fossils of California and the adjacent territories: California Geol. Survey, Paleontology, vol. 1, p. 33, pl. 6, fig. 33.

Gabb describes this species as follows:

> Shell small, inequilateral, higher than wide, abruptly truncated posteriorly; anterior end and base broadly rounded; beaks central, approximate, curved anteriorly; umbonal ridge acute, with a slight depression immediately in advance; surface posterior to this ridge abruptly descending to the posterior margin, and with a few radiating lines; anterior to it the surface is marked only by faint concentric lines.

Occurrence: In the Upper Triassic *Pseudomonotis* zone, of lower Noric age, in the Swearinger slate of Genesee Valley, Plumas County, Calif.; and also in the same zone at Dun Glen, East Range, Humboldt County, Nev.

Myophoria beringiana Smith, n. sp.

Plate CI, Figure 3

Shell large, with high backward-curving beak; muscle impressions large, pallial line entire. Surface of inner cast ornamented with eight coarse radial ribs impressed on the cast. Hinge and surface ornamentation of outer shell unknown.

Myophoria beringiana does not resemble any described species of this genus and superficially appears to be more like *Trigonia*, but its association is with Triassic fossils, and the occurrence of a *Trigonia* at that horizon is improbable.

Occurrence: Rare in the Upper Triassic beds of lower Noric age, locality 8836, United States Geological Survey, Bostwick Inlet, Gravina Island, Alaska, associated with *Arcestes* sp.

Myophoria brockensis Smith, n. sp.

Plate XCVI, Figures 25, 26

Shell rather large, trigonal; beaks prominent and only slightly curved. Surface smooth, except the fine concentric growth lines. Posterior area sharply defined by an obtuse angle running from the beak diagonally backward. Hinge not seen, but the shape makes the generic reference reasonably certain.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end and east side of Brock Mountain, about 6 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif.

Myophoria humboldtensis Smith, n. sp.

Plate XCVI, Figure 27

Shell medium in size, trigonal in shape, with slightly curved anterior beak. Surface with five coarse radial ribs. The finer sculpture has all disappeared. There is no known American species with which to compare this one, nor would the obscure details allow such a comparison.

Occurrence: Very rare in the Upper Triassic *Pseudomonotis subcircularis* zone of Noric age, in the Star Peak formation in Muttleberry Canyon, about 12 miles east of Lovelocks, Nev., associated with *Arcestes andersoni*, *Rhabdoceras russelli*, *Placites humboldtensis*, and *Pseudomonotis subcircularis*.

Myophoria suttonensis Clapp and Shimer

Plate CV, Figure 2

1911. *Myophoria suttonensis*. Clapp and Shimer, The Sutton Jurassic of the Vancouver group, Vancouver Island, B. C.: Boston Soc. Nat. Hist. Proc., vol. 34, No. 12, p. 433, pl. 41, figs. 12–14.

Clapp and Shimer describe this species as follows:

Shell trigonal, inequilateral, with rounded anterior and produced and angular posterior margin. Breadth and height about equal. Beaks situated slightly anterior to middle. Surface marked with a radial ridge extending from the umbos to the posterior border, separating from the rest of the shell the posterior dorsal area, which bears a different ornamentation. Main body of shell ornamented with from 17 to 19 radiating ribs; these ribs are much broader than the interspaces and are broadly rounded on top; they are strongly but minutely crenulated by crowded concentric striae. In the sinus bounding the radial ridge anteriorly there are two smaller radial ribs; from there, however, the ribs at once become strong and prominent and thence slowly decrease in strength toward the anterior portion of the shell, where they become very weak or are wholly absent. Numerous concentric striae are prominent upon the ribs but become especially strong at the anterior margin. The radial ribs are much smaller on the umbonal area, where they are crossed by three or four *Trigonia*-like strong transverse ridges. Posterior dorsal area nearly smooth. The ornamentation consists of concentric growth lines, most prominent over a broad, low medial rib. Cardinal teeth typical of other Myophorias—that is, two in the right valve, with vertical striations upon their outer and inner edges. These fit into corresponding socket-like teeth on the left valve that are striated only upon their inner edges.

This species is nearly related to *Myophoria goldfussi* Münster, differing in the stronger and broader posterior ridge, with two radial ribs instead of one rib on the sinus, and in the absence of prominent radial ribs from the flattened area behind the radial ridge, where *Myophoria goldfussi* has about three strong radial ribs.

Occurrence: Rare in the Sutton formation of Cowichan Lake, Vancouver Island, British Columbia. This formation was assigned by Clapp and Shimer to the Lower Jurassic, but the fauna points rather to the lower Noric horizon of the Upper Triassic series.

Genus ANOPLOPHORA Sandberger

Anoplophora? shastensis Smith, n. sp.

Plate XCIV, Figure 14

Form oblong, with blunt anterior and rounded posterior margin; umbo near the front, not prominent. Surface with fine radial lines running from the beak to the margin. Hinge not seen; consequently the generic reference is uncertain.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Genus TRIGONODUS Sandberger

Trigonodus? productus Whiteaves

1889. *Trigonodus? productus*. Whiteaves, The fossils of the Triassic rocks of British Columbia: Canada Geol. Survey, Contr. Canadian Paleontology, vol. 1, pt. 2, p. 135, pl. 17, figs. 7a, 7b.

Shell small, trigonal, slightly compressed, very inequilateral, longer than high, with beaks far to the front, and hardly projecting above the cardinal border. Surface marked by numerous fine concentric growth lines.

Occurrence: Upper Triassic, presumably in the *Pseudomonotis* zone, of lower Noric age, about 30 miles below Devil's Portage on Liard River, British Columbia.

Genus CARDINIA Agassiz

Cardinia gleimi Smith, n. sp.

Plate XCVI, Figures 7, 8

Shell subtrigonal, highly arched, with high, incurved, anterior beak. Surface of shell with fine concentric growth lines. Surface of cast with rather coarse concentric wrinkles.

Named in honor of E. M. Gleim, who assisted in collecting this fauna.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Cardinia? ponderosa Gabb

1869. *Cardinia ponderosa.* Gabb, Descriptions of some secondary fossils from the Pacific States: Am. Jour. Conchology, vol. 5, p. 13, pl. 6, figs. 11, 11a.

Gabb describes this species as follows:

Shell large, elongate, suboval, very thick; beaks a little more than a fourth of the length from the anterior end, very small, placed close together; ends broadly and nearly equally rounded, anterior a little the narrowest, cardinal margin slightly arched; base very broadly convex, nearly straight; immediately under the beaks the outline is very slightly emarginate; lunule none; ligament moderate in size, narrow, not prominent. Surface marked by rough, irregular lines of growth closely placed. Internal margin entire; pallial line strongly marked; muscular scars shallow.

Occurrence: Upper Triassic, presumably in the *Pseudomonotis* zone of lower Noric age, at New Pass, Desatoya Mountains, Nev.

Genus CARDIOMORPHA De Koninck

Cardiomorpha? digglesi Smith, n. sp.

Plate XCIV, Figure 8

Shell subcircular, highly arched, with rather short hinge line, and prominent, slender, incurving beaks, inclining forward, with slight obliquity. Surface with fine concentric wrinkles parallel with the growth lines. Hinge not seen; hence the generic reference is in doubt.

Named in memory of J. A. Diggles, who assisted in collecting this fauna.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, *Juvavites* and *Trachyceras* subzones of the *Tropites subbullatus* zone, on Brock Mountain, about 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif.

Genus CARDITA Bruguière

Cardita jenkinsi Smith, n. sp.

Plate XCVI, Figure 2

Shell small, trigonal, beak anterior. Surface with about 21 fine rounded radial ribs about one-third the width of the interspaces; also with low concentric wrinkles parallel with the growth lines. Hinge not seen, but the form makes the generic reference probable.

Named in honor of Hubert Jenkins, who assisted in collecting this fauna.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Genus PLEUROPHORUS King

Pleurophorus overbecki Smith, n. sp.

Plate CI, Figure 15

Shell small, elongate, with gibbous beak at the anterior end. Muscle impressions large, pallial line entire. Surface with only concentric ridges parallel with the growth lines.

Pleurophorus overbecki is closely related to *P. anderssoni* Boehm, from the *Nathorstites* zone of Bear Island but differs from the Arctic species in its more compact form and weaker sculpture.

Named in honor of Dr. R. M. Overbeck.

Occurrence: Rare in the Upper Triassic at locality No. 9384, Yukon Valley, opposite mouth of Nation River, below the *Halobia superba* zone and in a fauna that resembles the Arctic *Dawsonites* fauna.

Genus MYOCONCHA Sowerby

Myoconcha nana Smith, n. sp.

Plate XCIV, Figures 10, 11

Shell small, oblique, with short hinge line and beak far to the front. Surface with only weak lines of growth. Very like *Modiolus* but differs in the shortness of the hinge line and the obliquity of the shell.

Occurrence: Not uncommon in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch; also at the same horizon at the north end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus MYTILUS Linné

Mytilus ursensis Smith, n. sp.

Plate XCIV, Figure 9

Shell small, spatulate, with rounded posterior and acute anterior. Hinge line short. Surface with weak concentric lines of growth. Length, 54 millimeters; breadth, 16 millimeters.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at Bear Cove, at the north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus AVICULA Bruguière

Avicula mucronata Gabb

Plate CIV, Figure 1

1864. *Avicula mucronata.* Gabb, Description of the Triassic fossils of California and the adjacent territories: California Geol. Survey, Paleontology, vol. 1, p. 30, pl. 5, fig. 27.

Gabb describes this species as follows:

Shell small, compressed, oblique; beaks central; anterior basal margin rounded, obliquely truncated; posterior prominent; anterior ear unknown; posterior broad at the base, emarginate below, and produced at the extremity in the form of a slender spinelike process. Surface marked by fine, irregular, linear, radiating ribs, crossed by a few lines of growth.

Occurrence: Rare in the Upper Triassic *Pseudomonotis* zone, of lower Noric age, in the Swearinger slate near Robinson's (Gifford's) ranch, Genesee Valley, Plumas County, Calif.

Avicula soperi Smith, n. sp.

Plate XCVI, Figure 9; Plate CIII, Figure 12

Form small, oblique, with short anterior and long posterior wing. Beak of the left valve prominent. Surface smooth. Very like *A. pannonica* Bittner, as figured and described by Waagen [22] but lacks the concentric sculpture. It also greatly resembles *A. caudata* Bittner, as figured by Diener,[23] but the material is hardly good enough for identification, in view of the wide separation of the two forms.

Named in honor of E. F. Soper.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif. Also present in limestone of lower Noric age at locality 8946 on Rock Creek, near Strelna Creek, Alaska.

Genus CASSIANELLA Beyrich

Cassianella shastensis Smith, n. sp.

Plate XCVI, Figure 6

Form small, with left valve highly arched, beak incurving and hooklike. Rounded angular ridge at the rear. Wings rather short.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Cassianella gravinaensis Smith, n. sp.

Plate CI, Figures 4, 5

Shell small, with moderately long straight hinge line, short anterior and posterior wings, and with both valves highly arched. Surface ornamentation unknown, all specimens being inner casts.

C. gravinaensis has some resemblance to *C. tectiformis* Boehm, from the Upper Triassic of Bear Island, but differs from the Arctic species in the greater convexity of the valves and in the less pronounced angle from the beaks to the margin.

Occurrence: Rare in beds of lower Noric? age at locality 8836, Bostwick Inlet, Gravina Island, Alaska.

[22] Waagen, L., Die Lamellibranchiaten der Pachycardientuffe der Seiser Alm: K.-k. geol. Reichsanstalt Wien Abh., Band 18, Heft 2, p. 89, pl. 34, fig. 2, 1907.

[23] Diener, Carl, Fauna of the *Tropites* limestone of Byans: India Geol. Survey Mem., Palaeontologia, Indica ser. 15, vol. 5, No. 1, p. 10, pl. 17, fig. 8, 1906.

Genus POSIDONIA Bronn

Posidonia blatchleyi (Gabb)

Plate CIV, Figure 4

1869. *Posidonomya blatchleyi.* Gabb, Descriptions of some secondary fossils from the Pacific States: Am. Jour. Conchology, vol. 5, p. 13, pl. 6, fig. 12.

Gabb describes this species as follows:

> Shell large, flattened, obliquely semicircular; beaks small, nearly central, cardinal margin not so long as the width of the shell, straight for a short distance on both sides of the beaks, then bending down with a regular curve posteriorly, subangulated anteriorly; base narrowly rounded, most prominent directly opposite the posterior end of the cardinal line; anterior end, with a portion of the base, forming about a third of a circle; posterior end less convex. Surface marked by irregular and not very prominent concentric lines and undulations.

Occurrence: In the Upper Triassic, presumably in the *Pseudomonotis* zone, of lower Noric age, at New Pass, Desatoya Mountains, Nev.

Posidonia daytonensis (Gabb)

Plate CIV, Figure 2

1864. *Posidonomya daytonensis.* Gabb, Description of the Triassic fossils of California and the adjacent territories: California Geol. Survey, Paleontology, vol. 1, p. 32, pl. 6, fig. 32.

Gabb describes this species as follows:

> Shell flattened, oblique, beaks small, not prominent. Cardinal line straight, shorter than the greatest length of the shell. Buccal margin excavated below the hinge line, convex below, merging insensibly into the base. Anal margin convex below, nearly straight above, and inclined inward to meet the hinge line. Surface depressed, marked on the cast by a few faint concentric undulations.

Occurrence: Presumably in the Upper Triassic, exact horizon unknown, in El Dorado Canyon, near Dayton, Nev.

Posidonia jacksoni Smith, n. sp.

Plate XCIV, Figure 13

Shell small, oblique elongate-oval, with low, straight hinge line, and rather coarse concentric growth lines, almost amounting to ribs or wrinkles. Smaller and more coarsely sculptured than *Posidonia madisonensis*.

Named for B. N. Jackson, who assisted in collecting this fauna.

Occurrence: Common in the Upper Triassic Hosselkus limestone, lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Posidonia madisonensis Smith, n. sp.

Plate XCIV, Figure 12

Shell small, oblique, elongate, wider than high, with unusually long hinge line. Surface with fine concentric growth lines. Larger than *Posidonia jacksoni* and with finer sculpture.

Named in honor of Madison's ranch.

Occurrence: Very common in the Upper Triassic Hosselkus limestone, at the upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end and west side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Posidonia stella (Gabb)

Plate CIV, Figure 10

1864. *Posidonomya stella.* Gabb, Description of the Triassic fossils of California and the adjacent territories: California Geol. Survey, Paleontology, vol. 1, p. 32, pl. 6, fig. 31.

Gabb describes this species as follows:

Shell subcircular, convex, inequilateral; beaks prominent, anterior. Cardinal margin rounded in advance, straight and slightly sloping posteriorly and uniting with the anal margin by a curve. Surface smooth or marked by a few regular concentric, rounded ribs.

Occurrence: Presumably in the Upper Triassic, definite horizon unknown, of Star Canyon, West Humboldt Range, Nev.

Genus HALOBIA Bronn

1830. *Halobia.* Bronn, Neues Jahrb., Jahrg. 1, p. 284.
1874. *Halobia.* Mojsisovics, Ueber die triadischen Pelecypoden-Gattungen *Daonella* und *Halobia:* K.-k. geol. Reichsanstalt Wien Abh., Band 7, Heft 2, pp. 1–38.
1882. *Halobia.* Gemmellaro, Sul Trias della regione occidentale della Sicilia: R. accad. Lincei Mem., 3d ser., vol. 12, p. 279.
1899. *Halobia.* Bittner, Trias Brachiopoda and Lamellibranchiata: Geol. Survey India Mem., Paleontologia Indica, ser. 15, vol. 3, pt. 2.
1903. *Halobia.* Böhm, Ueber die obertriadische Fauna der Bäreninsel: K. svenska Vet.-Akad. Handl., vol. 37, No. 3, p. 30.
1904. *Halobia.* Smith, California Acad. Sci. Proc., 3d ser., Geology, vol. 1, p. 403.
1907. *Halobia.* Kittl, Die Triasfossilien vom Heureka Sund: Rept. Second Norwegian Arctic Expedition in the *Fram*, 1898–1902, No. 7, p. 14.
1912. *Halobia.* Kittl, Materialien zu einen Monographie der Halobiidae und Monotidae der Trias; Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, Paleontologie, Band 2, p. 85.
1918. *Halobia.* Trechmann, The Trias of New Zealand: Geol. Soc. London Quart. Jour., vol. 73, pt. 3, p. 197.

Type.—*Halobia salinarum* Bronn.

Aviculoid shells, thin, compressed, inequilateral, with the umbo in advance of the center. Hinge line long and straight, edentulous; equivalve, rounded in front and rear; without byssal notch; anterior ear somewhat differentiated from the rest of the shell, separated by a groove; surface of shell ornamented by sharp radial ribs, generally bundled, and increasing in number by bifurcation and intercalation.

Halobia is distinguished from *Daonella* Mojsisovics by the differentiation of the anterior ear and doubtless intergrades with that genus. In its development stages it begins life as a *Posidonia*, then becomes like *Daonella*, and at the end of the larval stage takes on the characters of *Halobia.*

Halobia is nearly world-wide in distribution in the Karnic and Noric stages of the Upper Triassic and is the most important and characteristic pelecypod genus in those horizons. It is represented by a large number of species, many of which have interregional distribution and are useful in correlation; the best known of these is *Halobia superba* Mojsisovics, which is a diagnostic zone fossil in the Mediterranean region, in western America, and in India. The genus is represented in America by a large number of species, described below.

Halobia alaskana Smith, n. sp.

Plate C, Figures 5–7

Form large, symmetrical, with relatively short hinge line and beak near the middle. Anterior ear not sharply differentiated, being indicated only by a shallow furrow and change in ornamentation. Surface ornamented with fine, sharp radial ribs, with narrow interspaces. The ribs are often dichotomous but do not bundle and are rather evenly distributed, except that, as is usual in *Halobia,* the posterior part of the shell is less strongly ribbed than the anterior.

Halobia alaskana has some resemblance to *Halobia occidentalis* but differs in its great size. It also resembles *Halobia insignis* Gemmellaro, from which it is distinguished by its greater height in proportion to its length and by its finer, less distinctly dichotomous ribs. Its sculpture greatly resembles that of *Halobia dilatata,* with which it is associated, but that species is much longer than high.

Occurrence: Rare at locality 9533, United States Geological Survey, Thompson Cove, Gravina Island, Alaska, in shales interbedded in the coral zone of lower Noric age.

Halobia austriaca Mojsisovics

Plate XCIX, Figures 10–13

1874. *Halobia austriaca.* Mojsisovics, Ueber die triadischen Pelecypoden-Gattungen *Daonella* und *Halobia:* K.-k. geol. Reichsanstalt Wien Abh., Band 7, Heft 2, p. 26, pl. 4, figs. 1–3, pl. 5, fig. 14.
1906. *Halobia austriaca.* Arthaber, Lethaea Geognostica, Band 2, Teil 1, pl. 45, fig. 2.
1912. *Halobia austriaca.* Kittl, Materialien zu einer Monographie der Halobiidae und Monotidae der Trias: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, Paleontologie, Band 2, p. 101, pl. 6, figs. 11–14.

Form nearly symmetric, somewhat longer than high, with the beak only slightly anterior to the middle of the straight hinge line and projecting somewhat above it. Anterior ear arched and sharply divided from the body of the shell by a distinct furrow. Posterior portion not developed as an ear but different from the rest of the shell in its weak sculpture. Surface of the young stage ornamented with strong concentric wrinkles parallel to the growth lines, extending about 10 millimeters from the beak. Entire surface with strong radial broad and flattish ribs, with narrower interspaces; these ribs are stronger on the anterior part of the shell, as in all this group, and lack the zigzag change of direction of the group of *Halobia superba*. *Halobia austriaca* differs from *Halobia charlyana* Mojsisovics in its greater symmetry and fewer, flatter ribs. It is also closely related to *Halobia halorica* Mojsisovics of the beds of Noric age in Europe and America but differs from that species in the stronger wrinkles on the beak and in the fewer, broader ribs.

Kittl, in his monograph cited above, has named a large number of species under this group, several of which probably belong to *Halobia austriaca*, for the differences which he uses as specific characters can hardly be more than individual variation. As these varieties are not known to occur in America, the writer can not enter into a critical discussion of them.

Occurrence: Rather common in the Upper Triassic beds of Karnic age in Alaska, in the upper division (*Juvavites* subzone) of the zone of *Tropites subbullatus*, locality 9935, United States Geological Survey, between forks of Rock Creek, region of Kuskulana River, Alaska, associated with *Halobia ornatissima;* also rare in the same subzone on Admiralty Island, locality 8847, United States Geological Survey point at north entrance of Herring Bay, along with *Halobia ornatissima;* also rare in the same subzone on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif. This species appears to be a good marker for the *Juvavites* subzone throughout the Cordilleran sea of western America.

Halobia brooksi Smith, n. sp.

Plate XCIX, Figures 7–9

Form rather symmetric, longer than high, only slightly oblique; with high beaks, somewhat in advance of the middle of the hinge line. Anterior ear strongly developed and separated from the body of the shell by a deep furrow; posterior ear not developed as such but distinguished by lack of ribs. Surface of the beaks and young stage with rather strong concentric wrinkles parallel with the growth lines. Surface of the shell with strong radial ribs, generally divided, bundled in twos and threes, beginning near the beaks, and at a distance of about 26 millimeters from the beak, forming an indistinct zigzag in direction.

Halobia brooksi is very closely related to *H. austriaca* but differs in the somewhat coarser ribs and in the zigzag of their direction. It is also very similar to *Halobia ocevjana* Kittl,[24] from the Karnic beds of Bosnia, but differs from the Balkan species in its somewhat finer ribs.

Named in honor of Dr. A. H. Brooks.

[24] Kittl, E., Materialien zu einen Monographie der Halobiidae und Monotidae der Trias: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, Paleontologie, Band 2, p. 158, text fig. 36, 1912.

Occurrence: Rare in the *Halobia*-bearing beds of upper Karnic or lower Noric age at locality 8153, ridge on west bank of Roadhouse Creek, 2 miles from Kuskulana River, Chitina region, Alaska.

Halobia cordillerana Smith, n. sp.

Plate XCIII, Figure 8; Plate XCVIII, Figure 9; Plate XCIX, Figures 1–6

1916. *Halobia* cf. *H. superba*. Martin, Triassic rocks of Alaska: Geol. Soc. America Bull., vol. 27, p. 708, pl. 29, fig. 2.

Form large, oval, symmetric, with prominent beak nearly in the middle of the long straight hinge line. Anterior portion of the shell broadly rounded, posterior more narrowly rounded, and slightly prolonged. Beak and young stages of shell prominent, highly arched. Anterior ear sharply defined from rest of the shell by a distinct furrow and ornamented with concentric lines and two strong radial ridges. Posterior ear less sharply though still distinctly defined. Beaks strongly wrinkled to height of about 12 millimeters. Surface with fine radial dichotomous ribs, making a sharp zigzag in their course at height of about 10 millimeters, then running nearly straight but becoming somewhat wavy. The ribbing on the anterior part of the shell is much coarser than on the posterior, upon which the sculpture is so fine that it looks almost smooth. *Halobia cordillerana* is most closely allied to *Halobia superba*, from which it differs in its more symmetric shape and finer ribbing. It differs from *Halobia fallax* in its greater size, more symmetric shape, and slightly coarser sculpture. It is distinguished from *Halobia oregonensis* by its greater size, more symmetric shape, less obliquity of the beak, and finer concentric wrinkles on the young stages. It also resembles *Halobia zitteli*, from which it is distinguished by its greater symmetry, finer sculpture, and more strongly defined anterior ear. *Halobia cordillerana* is more likely to be confused with *Halobia superbescens* Kittl but differs in its much greater size and coarser sculpture.

Occurrence: Rather common in the *Juvavites* subzone of the zone of *Tropites subbullatus*, of upper Karnic age, at locality 8897, Yukon Valley, 1 mile above the mouth of Nation River; also at locality 10267, United States Geological Survey, Yukon Valley, on Trout Creek about 3 miles above the mouth. At the former locality its horizon was about 10 feet above beds with *Halobia superba*. It was also found at locality 10197, United States Geological Survey, Keku Islet No. 1, Herring Bay, Admiralty Island, Alaska.

The writer has also collected this species in the *Juvavites* subzone of the *Tropites subbullatus* zone of the Hosselkus limestone on Brock Mountain, Shasta County, Calif.

Halobia dalliana Smith, n. sp.

Plate XCVIII, Figures 5, 6

Shell of medium size, somewhat longer than high, oblique, with projecting beak two-thirds of the distance from rear to front. Surface ornamented with extremely fine radial ribs and strong concentric wrinkles. The ribs do not change in direction as the shell grows larger, thus distinguishing this species from *Halobia septentrionalis*. The ear is very small but definitely developed, thus determining the genus as *Halobia* and not *Posidonomya*.

Halobia dalliana resembles *Halobia symmetrica*, with which it is associated, but differs in the fineness of its ribs and greater length of the hinge line.

Named in honor of Dr. W. H. Dall.

Occurrence: Rare in the Upper Triassic, at locality 10196, Keku Islet No. 1, Herring Bay, Admiralty Island, Alaska, in beds that seem to be of upper Karnic age.

Halobia dilatata Kittl

Plate XCV, Figure 5; Plate C, Figures 1–4

1912. *Halobia dilatata*. Kittl, Materialien zu einer Monographie der Halobiidae und Monotidae der Trias: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, Paleontologie, Band 2, p. 115, pl. 8, fig. 9.

Shell large, oval, wider than high, the largest specimens 8 centimeters in width and 6 centimeters in height. Hinge line long and straight, nearly the full width of the shell. Beak little prominent, situated at about one-third of the distance from the front to the rear.

Surface ornamented with strong radial ribs and weaker concentric growth lines that form wrinkles or undulations on the surface. The radial ribs commonly branch and are stronger on the front than on the rear. They run straight from the vicinity of the beak to the outer margin without interruption or change of direction. The ears are visible, separated from the rest of the shell by a furrow, though not well developed. The Alaskan specimens agree in all respects—great size, shape, and surface ornamentation—with those from the Tyrol.

This is one of the largest species of the Halobiidae, being surpassed only by *Halobia gigantea*. It is a good horizon marker, as it occurs in the same stratigraphic position in regions nearly 9,000 miles apart. However, on account of its rarity in the Tyrolian and the Alpine provinces, *Halobia dilatata* could hardly be chosen as a zone fossil.

Occurrence: *Halobia dilatata* was first described from the Noric beds of Sirius Kogel near Ischl, in the Tyrolian Alps. It was found by T. E. Bassett and C. O. Blackburn, of the Stanford University geologic expedition, in the *Halobia*-bearing beds of Noric age above the coral zone of Thompson Cove on Dall Head, Gravina Island, Alaska. The writer found this species immediately above the coral zone near the junction of Paddy and Eagle creeks, Blue Mountains, Baker County, Oreg.

Halobia distincta Mojsisovics

Plate XCVII, Figures 9–10

1874. *Halobia distincta*. Mojsisovics, Ueber die triadischen Pelecypoden-Gattungen *Daonella* und *Halobia:* K.-k. geol. Reichsanstalt Wien Abh., Band 7, Heft 2, p. 28, pl. 4, fig. 11.

1912. *Halobia distincta*. Kittl, Materialien zu einer Monographie der Halobiidae und Monotidae der Trias: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, Paleontologie, Band 2, p. 133, pl. 8, figs. 17, 18.

Shell small, inequilateral, oblique oval, somewhat longer than high. Hinge line rather long and straight, with the prominent beak situated three-fifths of the distance from the rear to the front. Anterior ear small but sharply defined, separated from the rest of the shell by a distinct furrow. Surface of the shell ornamented with radial ribs and fine concentric wrinkles parallel to the growth lines. The radial ribs are fine, dichotomous, and very numerous; they are so fine on the triangular area at the rear of the shell as to be almost invisible.

Halobia distincta resembles *H. lineata* but differs in its smaller size and more numerous and finer ribs. It differs from *H. salinarum* in its less oblique shape and slightly coarser ribs.

Mojsisovics in the description of his type says that the triangular area at the rear is smooth, but Kittl says that the type specimens show the ribs, and they are shown in Kittl's illustrations.

Occurrence: Rather common in beds of upper Karnic age, in the *Juvavites* subzone of the zone of *Tropites subbullatus*, at locality 8849, United States Geological Survey, a point at north entrance of Herring Bay, Admiralty Island, Alaska.

Halobia fallax Mojsisovics

Plate XCVIII, Figures 10, 11

1874. *Halobia fallax*. Mojsisovics, Ueber die triadischen Pelecypoden-Gattungen *Daonella* und *Halobia:* K.-k. geol. Reichsanstalt Wien Abh., Band 7, Heft 2, p. 29, pt. 5, figs. 5, 6.

1912. *Halobia fallax*. Kittl, Materialien zu einer Monographie der Halobiidae und Monotidae der Trias: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, Paleontologie, Band 2, p. 151, pl. 7, fig. 20, and text fig. 32.

Shell small, unsymmetric, somewhat oblique, with the beak nearly two-thirds forward on the hinge line. Anterior ear well defined, separated from the rest of the shell by a furrow. Surface ornamented with fine sharp ribs, which are much stronger toward the front, and generally in pairs. At a distance of about 12 millimeters from the beak the ribs bend sharply forward, with a distinct zigzag, and then continue their direction toward the outer border. The surface of the beak and young stage has fine concentric wrinkles parallel to the growth lines; these disappear toward the border. *Halobia fallax* is very closely related to *Halobia cordillerana*, from which it differs in its smaller size, finer ribs, and more oblique form. It is highly probable that they both belong to one variable species.

This species is also closely related to *Halobia zitteli* Lindström, as figured by Kittl;[25] the only differences in the two species are that the Arctic species has slightly coarser ribs and has the posterior ear differentiated.

Occurrence: Rather rare in beds of Karnic age in the Yukon Valley, locality No. 9383, United States Geological Survey, 2 miles above mouth of Nation River; associated with *Halobia lineata* and *Halobia halorica*.

It was first described from the lower Noric beds of the Austrian Alps but also occurs in the Karnic stage in that region.

Halobia gigantea Smith, n. sp.

Plate XCIII, Figures 6, 7; Plate XCIV, Figures 1–3

Form very large, oblique, beak prominent, somewhat excentric, slightly anterior, and with fine concentric wrinkles. Surface with fine sharp dichotomous ribs, which form a marked zigzag at a height of 15 millimeters from the apex and then continue their straight course to the margin. At this point there is a rather deep concentric furrow, separating the adolescent from the mature stage.

Halobia gigantea is very closely related to *H. superba* but differs in its much greater size and somewhat coarser ribs. It is also related to *Halobia zitteli*, as figured by Kittl, from which it is distinguished by its greater size and more distinct concentric wrinkles on the beak. It differs from *Halobia cordillerana* in its much greater size and coarser ribs; from *Halobia fascigera* Bittner, of the Indian region, in the greater length in proportion to the height, and in the lack of bundling of the ribs.

Occurrence: Very common in the Upper Triassic Hosselkus limestone, upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end of Brock Mountain, east side (Bear Cove), and west side, between Squaw Creek and Pit River, Shasta County, Calif. It also occurs in the lower or *Trachyceras* subzone of the zone of *Tropites subbullatus* on Brock Mountain but is much less common than in the upper subzone.

[25] Kittl, E., Die Triasfossilien vom Heureka Sund: Rept. Second Norwegian Arctic Expedition in the *Fram*, 1898–1902, No. 7, p. 14, pl. 1, figs. 7–11, 1907.

Halobia halorica Mojsisovics

Plate XCV, Figures 3, 4

1874. *Halobia halorica.* Mojsisovics, Ueber die triadischen Pelecypoden-Gattungen *Daonella* und *Halobia:* K.-k. geol. Reichsanstalt Wien Abh., Band 7, Heft 2, p. 33, pl. 5, fig. 1.

1912. *Halobia halorica.* Kittl, Materialien zu einer Monographie der Halobiidae und Monotidae der Trias: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, Paleontologie, Band 2, p. 116, fig. 25.

Form somewhat symmetric, wider than high. Surface with fine radial ribs dividing in twos and threes, somewhat bundled irregularly and lacking the usual zigzag at end of the adolescent stage. Ears very weakly developed. The adolescent stage from the beak to a height of 15 millimeters is covered with strong concentric wrinkles.

Halobia halorica is more symmetric and less oblique and has coarser ribs than *Halobia dilatata.*

Occurrence: Common in the Upper Triassic *Halobia*-bearing shales, of lower Noric age, above the coral zone, at Martin Bridge, near the junction of Paddy and Eagle creeks, Blue Mountains, Baker County, Oreg. It was also found at locality 9383, Yukon Valley, Alaska, 2 miles above the mouth of Nation River, associated with *Halobia fallax* and *H. lineata.*

This species was first described from the lower Noric of the Tyrolian Alps.

Halobia lineata (Muenster)

Plate XCVIII, Figures 13, 14

1833. *Monotis lineata.* Muenster (in Goldfuss), Petrifacta Germaniae, vol. 2, p. 140, pl. 121, fig. 3.

1874. *Halobia lineata.* Mojsisovics, Ueber die triadischen Pelecypoden-Gattungen *Daonella* und *Halobia:* K.-k. geol. Reichsanstalt Wien Abh., Band 7, Heft 2, p. 29, figs. 2–4.

1906. *Halobia lineata.* Arthaber, Lethaea Geognostica, Band 2, Teil 1, pl. 47, fig. 6.

1912. *Halobia lineata.* Kittl, Materialien zu einer Monographie der Halobiidae und Monotidae der Trias: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, Paleontologie, Band 2, p. 135.

Shell small, erect, with the beak two-thirds forward on the hinge line. Anterior ear narrow but sharply defined. Surface ornamented with fine regular concentric wrinkles parallel to the growth lines and with fine radial ribs, which are equally strong on the front and the rear and lack the zigzag break in direction that is so common on *Halobia. Halobia lineata* differs from *Halobia salinarum* in its finer ribs and more symmetric shape and from *Halobia celtica* chiefly in the flatter, finer ribs.

Occurrence: Rare in beds of upper Karnic or lower Noric age at locality 9383 United States Geological Survey, Yukon Valley, on Nation River, 2 miles above the mouth.

This species was first described from the lower Noric of the Tyrolian Alps but also occurs rarely in the upper Karnic.

Halobia occidentalis Whiteaves

Plate CVI, Figures 9, 10

1889. *Halobia occidentalis.* Whiteaves, Fossils of the Triassic rocks of British Columbia: Canada Geol. Survey, Contr. Canadian Paleontology, vol. 1, pt. 2, p. 134, pl. 17, figs. 5, 6.

Somewhat convex, inequilateral, a little higher than long. Marginal outline subovate, broadest above the middle. Posterior margin broadly rounded; anterior a little shorter than the posterior, also rounded but less broadly. Beaks in advance of the middle of the hinge line, which is long and straight.

Surface with numerous fine, raised, threadlike radial ribs, narrower than the interspaces and somewhat wavy; also with weak concentric growth lines. There is no interruption of the straight radial direction of the ribs, as there is in the group of *Halobia superba*, and the ear is less sharply differentiated from the rest of the shell than in that group.

Occurrence: Upper Triassic, in beds of lower Karnic (?) age, on Liard River, about 25 miles below Devil's Portage, British Columbia.

Halobia oregonensis Smith, n. sp.

Plate XCV, Figures 1, 2

Form suboval, oblique, wider than high; beaks small and excentric, situated two-fifths of the distance from the front. Shell with strong concentric wrinkles in youth, persisting almost through life. Surface with fine radial dichotomous ribs, with obscure zigzag at height of about 10 millimeters. Anterior ear sharply defined; posterior ear distinct but less sharply defined.

Halobia oregonensis is related to *Halobia cordillerana* but is distinguished by its more oblique shape, by the excentric position of the beak, and by the less distinct zigzag of the ribs at the end of the adolescent stage. It is more closely related to *H. zitteli* Lindström, as figured and described by Kittl,[26] but differs in its smaller size, greater obliquity, and less distinct zigzag of the ribs at the end of the adolescent stage.

Occurrence: Very common in the Upper Triassic *Halobia*-bearing shales of Baker County, Oreg. This horizon is about 500 feet below the beds with *Halobia dilatata* and *Halobia halorica.* It is thought to be of Karnic age and approximately equivalent to the *Halobia superba* zone of Shasta County, Calif.

Halobia ornatissima Smith, n. sp.

Plate XCIV, Figures 4–6; Plate XCVII, Figures 4–8

Form broad, with long, straight hinge line, high and prominent beak near middle of hinge line; wider than high. Anterior ear with raised ridge and groove, strongly ribbed radially and sharply set off from the rest of the shell. Posterior ear less sharply set off but marked by two distinct raised ridges. Surface of beak with strong concentric wrinkles down to a distance of 12 millimeters from the apex. Surface of shell with strong, sharp radial ribs, dividing in twos or threes, beginning near the apex, and making a sharp zigzag at a height of about 12 millimeters. These ribs cover the entire shell from anterior to posterior hinge.

Halobia ornatissima is closely related to *Halobia superba* but differs in its stronger ribs and a more distinct differentiation of the anterior and posterior ears.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone at the north end and west side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Halobia ornatissima is very common at locality 4823, north side of Hamilton Bay, Kupreanof Island, Alaska; also at locality 10180, United States Geological Survey, a point between Herring and Chapin bays, Alaska; at both places in the *Juvavites* subzone of the *Tropites subbullatus* zone.

Halobia rugosa Gümbel

Plate VII, Figures 7–10

1861. *Halobia rugosa.* Gümbel, Geognostische Beschreibung des bayerischen Alpengebirges, p. 275.

1863. *Posidonomya semiradiata.* Schafhäutl, Südbayerns Lethaea Geognostica, p. 368, pl. 69a, fig. 9.

1865. *Halobia haueri.* Stur, Die geologische Karte der nordöstlichen Kalkalpen: K.-k. geol. Reichsanstalt Wien Verh., p. 44.

1874. *Halobia rugosa.* Mojsisovics, Ueber die triadischen Pelecypoden-Gattungen *Daonella* und *Halobia*: K.-k. geol. Reichsanstalt Wien Abh., Band 7, Heft 2, p. 31, pl. 4, figs. 7, 8.

1906. *Halobia rugosa.* Arthaber, Die alpine Trias des Mediterran-Gebietes: Lethaea Geognostica, Teil 2, Das Mesozoicum, Band 1, pl. 42, figs. 1, 2.

1912. *Halobia rugosa.* Kittl, Materialien zu einer Monographie der Halobiidae und Monotidae der Trias: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, Paleontologie, Band 2, p. 149.

Form somewhat more symmetric than *Halobia superba;* surface with projecting beak of young shell ornamented with fine, sharp concentric wrinkles, without radial ribs; the rest of the shell is ornamented with sharp raised ribs, somewhat wavy, and with concentric wrinkles less distinct than on the beak. In other species of *Halobia* the radial ribs are incised, and on this species they project above the general level.

Occurrence: Common in the Upper Triassic *Halobia rugosa* zone of the Pit shale, with *Trachyceras storrsi*, about 200 feet below the *Tropites subbullatus* zone, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. The horizon is in the lower Karnic. The species was found first in the lower Karnic of the Austrian Alps, where it is very common.

[26] Kittl, E., Die Triasfossilien vom Heureka Sund: Rept. Second Norwegian Arctic Expedition in the *Fram*, 1898-1902, No. 7, p. 14, pl. 1, figs. 7-11, 1907.

Halobia salinarum Bronn

Plate XCV, Figure 7

1830. *Halobia salinarum.* Bronn, Ueber die Muschel-Versteinerungen des süddeutschen Steinsalzgebirges: Jahrb. Min., etc., 1830, p. 282, pl. 4, fig. 3.
1874. *Halobia salinarum.* Mojsisovics, Ueber die triadischen Pelecypoden-Gattungen *Daonella* und *Halobia:* K.-k. geol. Reichsanstalt Wien Abh., Band 7, Heft 2, p. 28, pl. 4, figs. 12–14.
1906. *Halobia salinarum.* Arthaber, Die Alpine Trias des Mediterran-Gebietes: Lethaea Geognostica, Teil 2, Das Mesozoicum, Band 1, pl. 48, figs. 4, 5.
1912. *Halobia salinarum.* Kittl, Materialien zu einer Monographie der Halobiidae und Monotidae der Trias: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, Paleontologie, Band 2, p. 134.

Shell small, oblique, with distinct anterior ear; ribs exceedingly fine, not bundled, and without the usual zigzag at end of adolescent stage. The ribs are finer even than on *Halobia dilatata.*

Occurrence: Common in the Upper Triassic *Halobia*-bearing shales, 500 feet below the coral zone, at Martin Bridge, near the junction of Paddy and Eagle creeks, Blue Mountains, Baker County, Oreg.; associated with *Halobia oregonensis* Smith. The horizon is supposed to be the approximate equivalent of the *Halobia superba* zone in Shasta County, Calif.

Halobia septentrionalis Smith, n. sp.

Plate XCVIII, Figures 1–4

Shell of medium size, oblique, somewhat longer than high, with long, straight hinge line, and prominent beak slightly in advance of the middle. Surface ornamented with very fine, sharp radial ribs, not bundled, and with strong concentric wrinkles parallel with the growth lines. The ribs at a distance of about 10 millimeters from the beak make a sudden change forward in their direction but without any zigzag such as occurs in many species of this group.

Halobia septentrionalis is closely related to *Halobia fallax* but differs chiefly in the greater fineness of the ribs, the strong concentric sculpture, and the less pronounced angle in the forward course of the ribs.

Occurrence: Rare at locality 10196, Keku Islet No. 1, Herring Bay, Admiralty Island, Alaska, in beds that appear to be of lower Noric or upper Karnic age.

Halobia superba Mojsisovics

Plate XCIII, Figures 1–5; Plate XCIV, Figure 7; Plate XCVII, Figures 1–3

1874. *Halobia superba.* Mojsisovics, Ueber die triadischen Pelecypoden-Gattungen *Daonella* und *Halobia:* K.-k. geol. Reichsanstalt Wien Abh., Band 7, Heft 2, p. 30, pl. 4, figs. 9, 10.
1904. *Halobia superba.* Smith, The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., Geology, vol. 1, No. 10, p. 403, pl. 48, figs. 1, 2.
1908. *Halobia superba.* Diener, Ladinic, Carnic, and Noric faunae of Spiti: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, Mem. 3, p. 94, pl. 16, fig. 7.
1912. *Halobia superba.* Kittl, Materialien zu einer Monographie der Halobiidae und Monotidae der Trias: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, Paleontologie, Band 2, p. 151, pl. 7, figs. 17, 18.

Form elongate, wider than high, rounded in front and rear; hinge line long and straight, with slender conical beak projecting slightly above it. Beak in advance of the center, making the shell slightly inequilateral. Anterior ear differentiated from the rest of the shell by a furrow, and by coarser ornamentation. Surface ornamented with fine radial ribs, not bundled, close set, and with interspaces narrower than the ribs. They increase by bifurcation and intercalation, becoming slightly coarser and much more numerous toward the margins. There are also faint but distinct concentric wrinkles, strongest on the young shell. At a height of 12 to 15 millimeters the ribs suddenly bend forward, at a strong concentric wrinkle, and then as suddenly resume their radial direction. This sudden change of direction happens again once or twice at greater age, giving a zigzag appearance to the ornamentation. In front and in the rear near the hinge line the ribs run straight from umbo to periphery.

Halobia superba is most nearly related to *Halobia gigantea* Smith but differs in its smaller size and somewhat finer ribs. It differs from *Halobia cordillerana* Smith in its coarser ribs and more oblique shape; from *Halobia oregonensis* Smith it differs in its greater size and more symmetric form. The writer is of the opinion that a large number of the so-called species of *Halobia,* distinguished by Mojsisovics and Kittl, in the works cited above, are nothing more than individual variations of *Halobia superba.*

Occurrence: Very common in the Upper Triassic Heosselkus limestone, in the zone of *Tropites subbullatus,* especially in the *Trachyceras* subzone, on Brock Mountain, on the divide between Squaw Creek and Pit River, 3 miles east of the forestry station, Shasta County, Calif.; also at the same horizon at many other places in Shasta and Plumas counties, Calif., and in Alaska. It was first described from the same horizon in the Tyrolian Alps in Austria and occurs at many places in the Mediterranean region; it also occurs in the *Tropites subbullatus* zone in the Himalayas in India. In all three regions it was associated with *Tropites subbullatus, Discotropites sandlingensis, Paratropites sellai, Sagenites herbichi,* and *Proclydonautilus triadicus.* It is the commonest and most widely distributed species of the Karnic fauna and is most useful in correlation because of its abundance and its diagnostic character.

Halobia superba has been found at a number of places in Alaska, invariably in beds of upper Karnic age. The best locality in that region is locality 4054, United States Geological Survey, Yukon Valley, one-fourth mile above the mouth of Nation River.

Halobia symmetrica Smith, n. sp.

Plate XCVIII, Figures 7, 8

Shell of moderate size, oval, much higher than long, with short, straight hinge line and rounded contour. Anterior ear small but well defined. Surface of shell shows strong concentric wrinkles parallel to the growth lines and very fine radial ribs, which run straight from back to periphery without any zigzag in their course. This character, as well as the shape, distinguishes *Halobia symmetrica* from *Halobia septentrionalis*. From *Halobia dalliana* it is distinguished by its symmetric shape. It is not nearly related to any European species of *Halobia* and is more like *Posidonia* than is common in the group.

Occurrence: Rather common in the Upper Triassic slates, of lower Noric? age, on Herring Bay, Admiralty Island, at locality 10196, Keku Islet No. 1. Collected by G. H. Girty.

Genus DAONELLA Mojsisovics

1874. *Daonella*. Mojsisovics, Ueber die triadischen Pelecypoden-Gattungen *Daonella* und *Halobia:* K.-k. geol. Reichsanstalt Wien Abh., Band 7, No. 2, p. 6.

It is not likely that any of the species listed below really belong to *Daonella*, but as they were described by Alpheus Hyatt under that name and not figured, it is now nearly impossible to determine their true relationship. They ought to be listed as mere nomina nuda, but as the names were accompanied by a partial description they are included in the present work for the sake of completeness.

Daonella? böchiformis Hyatt

1894. *Daonella böchiformis*. Hyatt, Trias and Jura in the Western States: Geol. Soc. America Bull., vol. 5, p. 415.

Form elliptical, with long, straight hinge line. Surface with concentric ridges and radial lines closely crowded. This species is said by Hyatt to resemble *Daonella böchi* Mojsisovics, from the upper Muschelkalk of Austria, but to differ from the European species in having the umbo nearer the middle, the concentric ridges more linear, and the radial lines more distinct and closely crowded.

This species has not been figured and only briefly described, so that it is doubtful whether it should be recognized.

Occurrence: Upper Triassic *Pseudomonotis* zone, of Noric age, in the Sailor Canyon formation, at Sailor Canyon, about 14 miles south of Cisco, Calif.

Daonella? cardinoides Hyatt

1894. *Daonella cardinoides*. Hyatt, Trias and Jura in the Western States: Geol. Soc. America Bull., vol. 5, p. 416.

Hyatt describes this species as follows:

> The valve of this shell often has an outline like some species of *Cardinia* and the longitudinal striae are correspondingly curved toward the anterior and posterior ends; otherwise it is similar to *D. böchiformis*.

This species has never been figured, and the above brief description by Hyatt leaves it almost unrecognizable.

Occurrence: In the Upper Triassic *Pseudomonotis* zone, of Noric age, in the Sailor Canyon formation, at Sailor Canyon, on American River, 14 miles south of Cisco, Calif.

Daonella? subjecta Hyatt

1894. *Daonella? subjecta*. Hyatt, Trias and Jura in the Western States: Geol. Soc. America Bull., vol. 5, p. 415.

Outline elliptical, length considerably greater than height; hinge line long and straight, without ears. Surface with coarse concentric ridges on the umbo, becoming finer outwardly; also with radial lines alternating in size, and more prominent near the middle.

This species was not figured and not fully described, so its position is in doubt.

Occurrence: In the Upper Triassic *Pseudomonotis* zone, of Noric age, in the Sailor Canyon formation, in Sailor Canyon, on American River, about 14 miles south of Cisco, Calif.

Genus MONOTIS Bronn

1830. *Monotis*. Bronn, Ueber die Muschel-Versteinerungen des süddeutschen Steinsalz-Gebirges: Neues Jahrb., Jahrg. 1, p. 279.

1886. *Monotis*. Teller, in Mojsisovics, Arktische Triasfaunen: Acad. sci. St.-Pétersbourg Mém., 7th ser., vol. 23, No. 6, p. 106.

1912. *Monotis*. Kittl, Materialien zu einer Monographie der Halobiidae und Monotidae der Trias: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, Paleontologie, Band 2, p. 166.

Shell inequivalve, obliquely ovate, with radial ribbing. Beak projecting toward the anterior end of the hinge line. Triangular posterior ear behind the beak. Anterior ear lacking, which is the sole difference separating this genus from *Pseudomonotis*.

The type is *Monotis salinaria* Bronn, a species almost world-wide in its occurrence in the Upper Triassic.

Represented in America by *Monotis alaskana*, a near relative of *Monotis salinaria*.

Monotis alaskana Smith, n. sp.

Plate CI, Figures 1, 2

Shell equivalve, unsymmetric, obliquely ovate, leaning strongly forward. Hinge long and straight. Beak slightly projecting, lying in the middle of the hinge line. Posterior triangular ear differentiated from the rest of the shell. Anterior ear undeveloped. Surface with strong, fine radial ribs alternating in size and very weak concentric growth lines.

Monotis alaskana differs from *Monotis salinaria* in its longer hinge line, more symmetric shape, and finer radial ribs. It differs from *Pseudomonotis subcircularis* in lacking the anterior ear and in having much weaker radial ribs and concentric growth lines.

Occurrence: Rare in the Upper Triassic *Pseudomonotis* zone, at locality 9961, United States Geological Survey, F. 43, on Mill Creek, near the forks, Copper River region, Alaska.

Genus PSEUDOMONOTIS Beyrich

1862. *Pseudomonotis*. Beyrich, Ueber zwei neue Formengruppen aus der Familie der Aviculiden: Deutsche geol. Gesell. Zeitschr., Band 14, p. 9.
1886. *Pseudomonotis*. Teller, in Mojsisovics, Arktische Triasfaunen: Acad. sci. St.-Pétersbourg Mém., 7th ser., vol. 23, No. 6, p. 105.
1900. *Pseudomonotis*. Bittner, Ueber *Pseudomonotis telleri* und verwandte Arten der unteren Trias: K.-k. geol. Reichsanstalt Wien Jahrb., Band 50, pp. 559–592.
1904. *Pseudomonotis*. Smith, The comparative stratigraphy of the marine Trias of western America: California Acad. Sci. Proc., 3d ser., Geology, vol. 1, No. 10, p. 407.
1913. *Pseudomonotis*. Wittenburg, Sur le forme caractéristique de *Pseudomonotis* du Trias supérieur du Caucase et d'Alaska: Acad. imp. sci. St.-Pétersbourg Bull., 6th ser., vol. 7, p. 475.
1918. *Pseudomonotis*. Trechmann, The Trias of New Zealand: Geol. Soc. London Quart. Jour., vol. 73, pt. 3, p. 191.

Type.—Pseudomonotis ochotica Keyserling.

Inequivalve, inequilateral, form oblique, higher than wide, hinge line straight and long. Left valve arched, right valve flatter; anterior ear on both valves distinct, with byssal notch in right valve. Strong radial ribs, with concentric wrinkles.

Beyrich named no type for the genus but made it clear that he meant this particular group. Accordingly, Teller and Bittner have kept *Pseudomonotis* for the group of *Pseudomonotis ochotica*. The genus in the broader sense has numerous species from the Permian through the Mesozoic; but the species of the genus as restricted by Teller and Bittner are limited to the Upper Triassic and are especially characteristic of the Noric stage, in the Arctic-Pacific and the American regions. This group of species has members in this horizon in Siberia, Alaska, Japan, Nevada, California, Oregon, Peru, Colombia, New Zealand, New Caledonia, the Indian Archipelago, and also in the Crimea, invariably in beds of Noric age.

Pseudomonotis circularis (Gabb)

Plate CIV, Figure 5

1869. *Monotis circularis*. Gabb, Descriptions of some secondary fossils from the Pacific States: Am. Jour. Conchology, vol. 5, p. 15, pl. 7, figs. 14, 14a.

Gabb describes this species as follows:

Shell large, flattened, nearly circular, beaks small, median; anterior side, bone, and posterior side forming a regular, continuous and nearly equal curve throughout; cardinal margin nearly straight and two-thirds as long as the width of the shell, ending anteriorly by a slight angle; posteriorly produced into a prominent ear a little longer than high. The lateral face of the ear is slightly emarginate below. Surface closely sculptured by very faint, flat, radiating ribs separated by linear depressions, the whole crossed by numerous minute and very regular concentric lines. Internally the radiating ribs are even more strongly marked than on the surface.

Occurrence: Upper Triassic *Pseudomonotis* zone, of lower Noric age, at New Pass, Desatoya Mountains, Nev.

Pseudomonotis ovalis (Whiteaves)

Plate CVI, Figure 8

1889. *Monotis ovalis*. Whiteaves, The fossils of the Triassic rocks of British Columbia: Contr. Canadian Paleontology, vol. 1, pt. 2, p. 132, pl. 17, fig. 4.

Shell small, compressed, oval in outline, broadly elliptical, slightly inequilateral; height about one-fourth greater than the length. Anterior side shorter than the posterior, with nearly straight margin; posterior broadly rounded. Surface ornamented with flat, radial ribs, in some places with a small, narrow, intercalary rib. Anterior ear unknown, the only specimen being a left valve.

Occurrence: Upper Triassic *Pseudomonotis* zone, of lower Noric age, about 25 miles below Devils Portage in Liard River, British Columbia.

Pseudomonotis subcircularis (Gabb)

Plate XCV, Figures 8, 9; Plate CI, Figure 8; Plate CIV, Figures 6, 7; Plate CVI, Figures 6, 7

1864. *Monotis subcircularis*. Gabb, California Geol. Survey, Paleontology, vol. 1, p. 31, pl. 6, figs. 29, 29a.
1886. *Pseudomonotis subcircularis*. Teller, in Mojsisovics Arktische Triasfaunen: Acad. imp. sci. St.-Pétersbourg Mém., 7th ser., vol. 23, No. 6, p. 113.
1889. *Monotis subcircularis*. Whiteaves, The fossils of the Triassic rocks of British Columbia: Contr. Canadian Paleontology, vol. 1, pt. 2, p. 131, pl. 17, figs. 3, 3a.
1894. *Monotis semiplicata*. Hyatt, Trias and Jura in the Western States: Geol. Soc. America Bull., vol. 5, p. 414.
1894. *Monotis symmetrica*. Hyatt, Trias and Jura in the Western States: Geol. Soc. America Bull., vol. 5, p. 414.
1904. *Pseudomonotis subcircularis*. Smith, California Acad. Sci. Proc., 3d ser., Geology, vol. 1, No. 10, p. 407, pl. 49, figs. 1–3.
1912. *Monotis subcircularis*. Kittl, Materialien zu einer Monographie der Halobiidae und Monotidae der Trias: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, Paleontologie, Band 2, p. 169.
1916. *Pseudomonotis subcircularis*. Martin, Triassic rocks of Alaska: Geol. Soc. America Bull., vol. 27, p. 712, pl. 29, fig. 1; pl. 30, figs. 1, 2.

Form and ornamentation extremely variable; pectinoid, inequilateral, inequivalve, oblique, broadly ovate, with the greatest height toward the rear. Front broadly rounded, rear sloping gently up to the hinge line. Left valve highly arched, right valve flatter. Hinge line straight, a little more than one-third of the total length of the shell. Length slightly greater than height. Anterior ear with byssal notch in right valve, the character that distinguishes this genus from *Monotis*. Posterior ears alike on both valves.

Surface ornamented with rather coarse radial ribs, about 26 in number, and between most of these there are fine intercalary ribs. The primary ribs begin near the beak, but the intercalaries do not appear until a height of about 15 millimeters is reached. The interspaces are considerably wider than the ribs. There are also fine concentric wrinkles or striae over the entire surface. In youth the shell is much more elliptical in shape, longer than high, and the ribs fewer as well as coarser in proportion to the size of the shell.

This species is nearly allied to the variety described by Teller [27] as *Pseudomonotis ochotica* var. *densistriata* and may be identical with it, but the writer is not convinced that all the so-called varieties of *Pseudomonotis ochotica* belong to that species, for the accompanying faunas are not identical, and some of them are not even very similar. At any rate this species, or group of species, is nearly circum-Pacific in distribution.

Occurrence: *Pseudomonotis subcircularis* is very common in the Upper Triassic *Pseudomonotis* zone, in the Swearinger slate of Genesee Valley near Robinson's ranch (Gifford's ranch), Plumas County, Calif.; also in the Brock shale on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.; also in Muttleberry Canyon, 9 miles east of Lovelocks, Humboldt County, Nev.; in the Blue Mountains (Eagle Mountains) of northeastern Oregon; in British Columbia; and at several places in Alaska. It is also cited from Peru and Colombia. The kindred species, *Pseudomonotis ochotica*, ranges from Siberia to Japan, the Crimea, and the Indian Archipelago, in all these regions at the same horizon.

Pseudomonotis subcircularis was associated, in Plumas County, with *Halorites americanus*, and *Rhabdoceras russelli;* in Nevada with *Halorites americanus*, *Rhabdoceras russelli*, *Arcestes andersoni*, and *Placites humboldtensis*.

Genus EUMORPHOTIS Bittner

1900. *Eumorphotis*. Bittner, Ueber *Pseudomonotis telleri* und verwandte Arten der unteren Trias: K.-k. geol. Reichsanstalt Wien Jahrb., Band 50, p. 566.

1903. *Eumorphotis*. Boehm, Ueber die obertriadische Fauna der Büreninsel: K. svenska Vet.-Akad. Handl., Band 37, No. 3, p. 27.

This genus was established to include the *Pecten*-like forms of what had been called *Pseudomonotis*. It is common in the European and the Arctic Triassic.

Eumorphotis nationalis Smith, n. sp.

Plate CI, Figure 12

Shell small, compact, pectinoid, with anterior ear developed but without byssal notch; posterior ear hardly differentiated. Surface gently arched and ornamented with fine radial alternating ribs.

This species is somewhat related to *Eumorphotis arctus* Boehm from the Upper Triassic *Dawsonites* zone of Bear Island, Arctic Ocean.

Occurrence: Very rare in the Triassic beds of lower Karnic ? age at locality 9385, south bank of Yukon River, opposite Nation River, Alaska, in what is probably the *Dawsonites* zone.

Genus PECTEN Klein

Pecten deformis Gabb

Plate CIV, Figure 2

1864. *Pecten deformis*. Gabb, Description of the Triassic fossils of California and the adjacent territories: California Geol. Survey, Paleontology, vol. 1, p. 33, pl. 6, fig. 34.

Gabb describes this species as follows:

> Shell small, thin, compressed, inequilateral, base oblique, ends subequal; sides sloping with a slight convexity from the apex; ears subequal, moderate in size. Surface marked by about 25 irregular, rather large, radiating ribs, a few of which arise at some distance from the beaks. These are crossed by very fine concentric lines.

Occurrence: Upper Triassic *Pseudomonotis* zone, in the Swearinger slate at Robinson's (Gifford's) ranch, Genesee Valley, Plumas County, Calif.

Subgenus ENTOLIUM

Pecten (Entolium) ceruleus Smith, n. sp.

Plate XCV, Figure 13

Form nearly circular, with short straight hinge line and ears little developed. Attachment line of mantle deep. Surface smooth, without radial or concentric sculpture.

This species is very closely related to *Pecten hallensis* Wöhrmann, as figured by Arthaber,[28] but differs chiefly in the depth of the mantle attachment lines.

Occurrence: In the Upper Triassic *Halobia oregonensis* zone at the junction of Paddy and Eagle creeks, Baker County, Blue Mountains, Oreg.

Pecten (Entolium) pittensis Smith, n. sp.

Plate VII, Figure 5

Form small, subcircular, with small equal ears and coarse concentric wrinkles parallel to the growth lines.

Occurrence: Rare in the Upper Triassic *Halobia rugosa* zone, in the upper part of the Pit shale on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

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[27] Teller, F., in Mojsisovics, E. von, Arktische Triasfaunen: Acad. sci. St.-Pétersbourg Mém., 7th ser., vol. 23, No. 6, p. 116, pl. 17, figs. 7-15

[28] Arthaber, G. von, Die alpine Trias des Mediterran-Gebietes: Lethaea Geognostica, Teil 2, Das Mesozoicum, Band 1, pl. 42, fig. 6, 1906.

Pecten (Entolium) yukonensis Smith, n. sp.

Plate CI, Figures 9, 10

Shell large, nearly circular in outline. Surface nearly smooth, with extremely fine radial lines. Contour gently arched. Inner cast shows sharp angles running from the beak toward the periphery, dividing the shell into three nearly equal areas. Angle of the beak very obtuse. Ears short, anterior and posterior equally developed, with the reentrant angle characteristic of *Entolium*.

This species is closely related to *Pecten oebergi* Lundgren, from the *Dawsonites* zone of Bear Island, but differs in its greater size, blunter apical angle, and more oblique position of the ears.

Occurrence: Very rare in Upper Triassic beds of Karnic age, probably *Dawsonites* zone at locality 9384 (=8849) United States Geological Survey, south bank of Yukon River, opposite Nation River, Alaska.

Genus DIMYODON Munier-Chalmas

Dimyodon storrsi Smith, n. sp.

Plate XCVI, Figure 1

Shell small, suboval, with narrow hinge line, and prominent beak. Surface with wavy radial lines, cancellated by the concentric growth lines. Surface somewhat wrinkled. Hinge not visible, but the shape and ornamentation make the generic reference certain. It has a strong similarity to *Dimyodon intustriatum* Emmrich, of the Rhaetic beds of Austria, differing in its broader form and more highly ornate surface.

Named in honor of James Storrs.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Genus LIMA Bruguière

Lima kimballi Smith, n. sp.

Plate VII, Figure 6

Shell small, somewhat oblique, with narrow hinge line and elongate shell. Surface with fine radial ribs.

Named in honor of E. B. Kimball, who assisted in collecting this fauna.

Occurrence: Rare in the Upper Triassic, in the *Halobia rugosa* zone of the Pit shale of Brock Mountain between Squaw Creek and Pit River, Shasta County, Calif.

Lima blackburnei Smith, n. sp.

Plate CIII, Figure 11

Shell small, oblique, with very short hinge line. Known only as an inner cast, without impress of sculpture from the outside. Mantle line and muscle impressions very prominent. Wholly unlike the other known American Triassic species of *Lima*.

Occurrence: Very rare in the Upper Triassic, presumably in beds of Karnic age, at locality 10093, Copeland Creek at Camp July 14, 1917, S. R. C[apps], Alaska; it is associated with *Protorcula alaskana*.

Lima martini Smith, n. sp.

Plate CI, Figure 11

Shell large, oblique, oval, with short hinge line and moderately prominent beak. Surface strongly convex, ornamented with numerous fine, sharp radial ribs with interspaces slightly wider than the ribs. Concentric growth lines strongly impressed.

Lima martini is closely related to *L. swenanderi* Boehm,[29] from the *Dawsonites* zone of Bear Island, but differs from that species in its somewhat finer ribs and in the lack of alternation in them.

Named in honor of Dr. G. C. Martin.

Occurrence: Very rare in the beds below those that carry *Halobia cordillerana* at locality 9384, United States Geological Survey, Yukon Valley, south bank, opposite Nation River; in a fauna that may possibly correspond to the *Dawsonites* fauna of British Columbia and the Arctic sea.

Phylum MOLLUSCOIDEA

Class BRACHIOPODA

Genus RHYNCHONELLA Fischer de Waldheim

Rhynchonella blackwelderi Smith, n. sp.

Plate CII, Figures 1, 3

Shell of medium size, compact, trigonal. Both valves rather highly arched; pedicle valve with deep sinus and brachial valve with corresponding high rounded central ridge. Surface ornamented with fine radial ribs, which are most distinct on the sinus and on the median ridge.

Rhynchonella blackwelderi is very closely related to *Rhynchonella generosa* Bittner,[30] differing chiefly in the somewhat coarser radial ribs.

Named in honor of Dr. Eliot Blackwelder.

Occurrence: Very rare in the Upper Triassic, in beds of Karnic age, at locality 8895, United States Geological Survey, in the Yukon Valley, mouth of Nation River, Alaska.

Rhynchonella howardi Smith, n. sp.

Plate XCVI, Figures 16–18

Form robust, thick set, with shallow median sinus; one strong plication on the sinus and two on the median ridge of the opposite valve; two smaller plications on the sides.

Rhynchonella howardi differs from *Rhynchonella richardsoni* in the shallower sinus and fewer plications.

[29] Boehm, J., Ueber die obertriadische Fauna der Bäreninsel: K. svenska Vet.-Akad. Handl., Band 37, No. 3, p. 20, pl. 2, figs. 7, 8, 15, 21, 1903.

[30] Bittner, Alexander, Brachiopoden der alpinen Trias: K.-k. geol. Reichsanstalt Wien Abh., Band 14, p. 227, pl. 39, fig. 10, 1890.

Named in honor of J. C. Howard, to whom the writer is greatly indebted for hospitality and assistance while collecting in Shasta County.

Occurrence: Rather common in the Upper Triassic Hosselkus limestone, at the lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Rhynchonella richardsoni Smith, n. sp.

Plate XCVI, Figures 19–21

Form small, compact; high median ridge with three or four plications on the upper valve; deep sinus with two or three plications on the lower valve; sides with two smaller plications on either side. Beak pointed and not prominent. Very like *R. trinodosi* Bittner, of the Middle Triassic of the Alps and the Himalayas, but more than twice as large and with more pronounced median sinus. This is the most abundant species of *Rhynchonella* in the Californian Triassic, and is named in honor of G. B. Richardson, who assisted in preparing the Redding folio.

Occurrence: Very common in the Upper Triassic Hosselkus limestone, lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, on the south end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Rhynchonella winnemae Smith, n. sp.

Plate XCVI, Figures 22–24

Form somewhat compressed, with hardly any sinus and small beak; three small plications on the sinus and several very fine plications on the sides. Less rounded and robust than *Rhynchonella richardsoni* and with finer and more numerous plications.

Named for a legendary heroine of the Shasta tribe, who lived on the slopes of Brock Mountain.

Occurrence: Not uncommon in the Upper Triassic Hosselkus limestone, lower horizon (*Trachyceras* subzone) of the *Tropites subbullatus* zone, of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus DIELASMA King

Dielasma chapini Smith, n. sp.

Plate CII, Figures 4–6

Shell small, subovate, with brachial valve highly arched; pedicle valve concave. Margin with high ridge on brachial valve with two strong plications; deep sinus on pedicle valve with one plication.

This species is closely related to *Dielasma julicum* of the Upper Triassic of the Alps, India, and California, from which it differs chiefly in the strength of the plication.

Occurrence: Very rare in the Upper Triassic, in beds of Karnic age, at locality 9384, United States Geological Survey, mouth of Nation River, Yukon Valley, Alaska. The specific name is given in honor of Mr. Theodore Chapin, whose work has added greatly to our knowledge of the stratigraphy of Alaska.

Dielasma hamiltonense Smith, n. sp.

Plate CII, Figures 14–16

Shell small, subovate, both valves arched; strong median fold that forms a ridge with three strong longitudinal plications on the brachial valve, and a sinus with two similar plications on the pedicle valve.

This species is very closely related to *Dielasma julicum*, but differs in the greater number and strength of the plications.

Occurrence: Very rare in the Upper Triassic, in beds of Karnic age, at locality 4822, United States Geological Survey, on Hamilton Bay, Kupreanof Island, Alaska; it is associated with *Protrachyceras* sp.

Dielasma liardense (Whiteaves)

Plate CVI, Figures 2–5

1889. *Terebratula liardensis*. Whiteaves, The fossils of the Triassic rocks of British Columbia: Contr. Canadian Paleontology, vol. 1, pt. 2, p. 130, pl. 17, figs. 2a–c.

Shell small, robust, oval; both valves convex, the ventral more so; beak moderately prominent, with rounded foramen. Umbo of dorsal valve small. Surface smooth, with three broad gentle marginal plications and faint concentric growth lines.

This species is closely related to *Dielasma* aff. *D. piriforme* Suess, as figured in the present work, but differs in the less prominent beak, smaller size, less robust form, and stronger plications. It may be identical with the true *Dielasma piriforme*.

Occurrence: In the Upper Triassic *Pseudomonotis* zone about 25 miles below Devils Portage on Liard River, British Columbia.

Dielasma julicum (Bittner)

Plate XCVI, Figures 12–13

1890. *Terebratula julica*. Bittner, Brachiopoden der alpinen Trias: K.-k. geol. Reichsanstalt Wien Abh., vol. 14, p. 125, pl. 4, figs. 14 and 15; pl. 39, figs. 15, 16.
1900. *Terebratula julica*. Bittner, Brachiopoden aus der Trias des Bakonyerwaldes: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, p. 5, pl. 1, figs. 8–28; pl. 5, figs. 20, 21.
1908. *Dielasma julicum*. Diener, Ladinic, Carnic, and Noric faunae of Spiti: India Geol. Survey Mem., Palaeontologia Indica, ser. 15, vol. 5, Mem. 3, p. 92, pl. 16, fig. 4.
1913. *Dielasma julicum*. Diener, Triassic faunae of Kashmir: India Geol. Survey Mem., Palaeontologia Indica, new ser., vol. 5, Mem. 1, p. 114, pl. 13, fig. 27.

Shell small, suboval; beaks slender, curving forward only slightly. Surface with only fine growth lines.

Margins strongly plicate, forming two high marginal ridges on the dorsal valve, and corresponding sinuses on the ventral.

Occurrence: Rare in the Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the zone of *Tropites subbullatus*, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was also found in the Upper Triassic of Austria and India.

Dielasma suttonense (Clapp and Shimer)

Plate CV, Figure 7

1911. *Terebratula suttonensis.* Clapp and Shimer, Boston Soc. Nat. Hist. Proc., vol. 34, No. 12, p. 432, pl. 40, figs. 2, 3.

Clapp and Shimer describe this species as follows:

> Elongate biconvex, truncate anteriorly; pedicle valve broadly convex toward the beak, becoming flattened toward the front, forming there a broad sinus in which is a low median ridge with a shallow depression on either side. The outer side of the prominent ridges bordering the median sinus flattened, giving to this portion of the shell a somewhat flattened appearance. Brachial valve regularly convex from back to front, with a shallow median depression anteriorly, bounded by rather prominent folds on either side. Laterally from each of these folds is a broad sinus corresponding to the prominent ridges of the pedicle valve. Surface smooth except for low concentric growth lines. Length about 3 centimeters, breadth about 2 centimeters.

Occurrence: In the Sutton formation of Cowichan Lake, Vancouver Island, British Columbia, assigned by Clapp and Shimer to the Lower Jurassic but more likely belonging to the lower Noric horizon of the Upper Triassic. Better specimens will probably show this species to be identical with *Dielasma julicum* Bittner, a widespread species in the Upper Triassic of Europe, Asia, and America.

Genus TEREBRATULA Klein

Terebratula? piriformis Suess

Plate XCVI, Figures 14, 15

1890. *Terebratula* aff. *T. piriformis.* Bittner, Brachiopoden der alpinen Trias: K.-k. geol. Reichsanstalt Wien Verh., vol. 14, p. 157, pl. 39, figs. 12–14.

1900. *Terebratula* aff. *T. piriformis.* Bittner, Brachiopoden aus der Trias des Bakonyerwaldes: Resultate der wissenschaftlichen Erforschung des Balatonsees, Band 1, Teil 1, p. 9, pl. 1, figs. 29–39.

1906. *Terebratula piriformis.* Arthaber, Die alpine Trias des Mediterran-Gebietes: Lethaea Geognostica, Teil 2, Das Mesozoicum, Band 1, pl. 49, figs. 13a–d.

Shell small, suboval, both valves strongly arched; beak moderately slender, curved gently forward. Surface with only delicate concentric growth lines. Margin gently plicate.

This common species appears to be identical with the form described by Bittner under the above name from Austria. He did not identify it positively with *Terebratula piriformis* Suess but thought it might be identical.

Occurrence: Very common in the Upper Triassic Hosselkus limestone, in the Trachyceras subzone of the zone of *Tropites subbullatus*, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus SPIRIFERINA D'Orbigny

Spiriferina borealis Whiteaves

Plate CVI, Figure 1

1889. *Spiriferina borealis.* Whiteaves, The fossils of the Triassic rocks of British Columbia: Contr. Canadian Paleontology, vol. 1, pt. 2, p. 128, pl. 17, fig. 1.

Shell robust, subelliptical; hinge line relatively short; ventral valve with broad, high curved beak; area broadly triangular, three times as broad as the height; dorsal valve with low rounded umbo; and a broad marginal fold corresponding to the sinus on the ventral valve. Surface of dorsal valve marked by 11 broad angular plications; ventral valve similarly ornamented by 10 plications.

Occurrence: Upper Triassic *Pseudomonotis* zone of lower Noric age, about 25 miles below Devils Portage, on Liard River, British Columbia.

Spiriferina coreyi Smith, n. sp.

Plate XCV, Figure 12

Form robust (lower valve only known), with high curved beak, broad median sinus with sharp central ridge and four coarse plications on either side.

Named in memory of Henry M. Corey, who assisted in collecting this fauna.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Spiriferina pittensis Smith, n. sp.

Plate XCV, Figures 10, 11

Form compact, square shouldered; lower valve with rather low beak, deep median sinus, and seven coarse plications on either side; upper valve with high median ridge with seven plications on the sides.

Occurrence: Exceedingly common in the Upper Triassic Hosselkus limestone, in the *Spiriferina* zone above the coral zone, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Spiriferina yukonensis Smith, n. sp.

Plate CI, Figures 13, 14

Size medium, broad, square shouldered, thick set. Brachial valve with broad high median ridge without ribs; flanks with seven sharp radial ribs on either side. Pedicle valve with broad, deep median sinus, without ribs, flanked by seven sharp lateral ribs on either side. Hinge area wide, beak high and sharp. Concentric growth lines sharply defined.

Spiriferina yukonensis resembles *S. fortis* Bittner of the Upper Triassic of the Alpine region, differing in its finer and more numerous radial ribs on the flanks.

Occurrence: Very rare in the Upper Triassic zone of *Halobia cordillerana*, at locality 9385, one-third of a mile northeast of the mouth of Nation River, Yukon Valley, Alaska. It is associated with *Trachyceras* cf. *T. lecontei* and *Cladiscites martini*.

Genus SPIRIGERA D'Orbigny

Spirigera milesi Smith, n. sp.

Plate XCVI, Figures 10, 11

Form elongate, narrow, high-shouldered, compressed, slender, with very weak marginal plications. Weathered specimens show traces of the spiral brachia. Very like *Spirigera stoliczkai* Bittner, of the Middle Triassic of India, but more slender and elongate and much larger.

Named in memory of John Miles, the pioneer settler of Squaw Creek.

Occurrence: Not uncommon in the Upper Triassic Hosselkus limestone, upper horizon (*Juvavites* subzone) of the *Tropites subbullatus* zone, at the north end and west side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Phylum ECHINODERMATA

Class CRINOIDEA

Genus ISOCRINUS von Meyer

Isocrinus californicus Clark

Plate XCV, Figure 6; Plate CIV, Figure 13

1915. *Isocrinus californicus*. Clark and Twitchell, The Mesozoic and Cenozoic Echinodermata of the United States: U. S. Geol. Survey Mon. 54, p. 21, pl. 1, figs. 2a–c.

Clark describes this species as follows:

Column composed of medium-sized rather thin pentagonal joints, with sharp reentering angles. The crenulated ridges are rather narrowly petaloid, and each area is sharply terminated at its outer extremity. Column perforated by large canal. Dimensions, column: Diameter of joint, 2 to 5 millimeters; length of joint, ½ to 1 millimeter.

Occurrence: Very common in the Upper Triassic Hosselkus limestone of Rush Creek, Plumas County, Calif.; also in the "Cedar formation," 2½ miles west of Round Mountain, Shasta County, Calif.; also in the Hosselkus limestone, *Juvavites* subzone of the zone of *Tropites subbullatus*, of Brock Mountain, Shasta County, Calif.

Genus ENCRINUS Schulze

Encrinus hyatti Clark

Plate CIV, Figures 14, 15

1915. *Encrinus hyatti*. Clark and Twitchell, The Mesozoic and Cenozoic Echinodermata of the United States: U. S. Geol. Survey Mon. 54, p. 22, pl. 1, figs. 3a, 3b.

Clark describes this species as follows:

Column composed of large, thin, round to oval joints. Surfaces of joints covered with fine, bifurcating striations, producing a close suture. Column perforated with canal of rather small size. Dimensions, column: Diameter of joint, 5 to 10 millimeters; length of joint, 1 to 3 millimeters.

Occurrence: Rare in the Upper Triassic "Cedar formation," at Oscar tunnel, 2½ miles southeast of Longville, Plumas County, Calif.

Class ECHINOIDEA

Genus CIDARIS Leske

Cidaris shastensis Clark

Plate CIV, Figure 11

1915. *Cidaris shastensis*. Clark and Twitchell, The Mesozoic and Cenozoic Echinodermata of the United States: U. S. Geol. Survey Mon. 54, p. 23, pl. 7, fig. 5.

Clark describes this species as follows:

Test apparently large. Interambulacral areas wide. Tubercles large, circular, with depressed areolas; miliary space large.

Occurrence: Known only in a single fragmentary specimen from the equivalent of the Upper Triassic Hosselkus limestone in the "Cedar formation," 2½ miles west of Round Mountain, Shasta County, Calif.

Cidaris dilleri Clark

Plate CIV, Figure 12

1915. *Cidaris dilleri*. Clark and Twitchell, The Mesozoic and Cenozoic Echinodermata of the United States: U. S. Geol. Survey Mon. 54, p. 23, pl. 1, fig. 6.

Clark describes this species as follows:

Test apparently of medium size; ambulacral areas narrow, flexuous, with two rows of granules between the poriferous avenues; interambulacral areas of moderate width. Tubercles of medium size with oval areolas; boss crenulated; mamelon perforated; miliary space narrow.

Occurrence: Known only in a single fragmentary specimen from equivalent of the Upper Triassic Hosselkus limestone in the "Cedar formation," 2½ miles west of Round Mountain, Shasta County, Calif.

Upper Triassic coral zone fauna of lower Noric age, in western America

	California	Oregon	Vancouver Island	Gravina Island, Alaska	Cook Inlet, Alaska
Thecosmilia caespitosa Frech	?				×
delicatula Frech			×		
fenestrata Reuss	?		×	×	×
norica Frech		×			
Montlivaultia marmorea Frech	×				
martini Smith					×
norica Frech		×		×	
Stylophyllopsis mojsvari Frech	×				×
zitteli Frech		×		×	
Isastrea parva Smith				×	
profunda Reuss	×		×	×	×
vancouverensis Clapp and Shimer	×		×	×	?
Latimaeandra alaskana Smith				×	
eucystis Frech	×				
Confusastrea decussata Reuss	×		×	×	×
grandissima Frech	×			×	
incrassata Frech					×
borealis Smith				×	
cowichanensis Clapp and Shimer			×	×	
Astrocoenia shastensis Smith	×				
martini Smith				×	
Stephanocoenia juvavica Frech	×			×	
Thamnastraea borealis Smith				×	
rectilamellosa Winkler	×				
var. minor Frech	×			×	
Halomitra triadica Smith				×	
Spongiomorpha dendriformis Smith	×				
gibbosa Frech	×			×	?
ramosa Frech				×	
tenuis Smith	×				
Heptastylis aquilae Smith		×			
oregonensis Smith		×			
Stromatomorpha californica Smith	×			×	

Phylum COELENTERATA

Class ANTHOZOA

Subclass HEXACORALLA

Family ASTRAEIDAE

Genus MONTLIVAULTIA Lamoroux

Solitary Hexacoralla, cylindrical, conical, or turbinate. Septa numerous, with upper edges serrated. Columella absent.

This genus is common in the Triassic and Jurassic and disappears in the Tertiary. It is represented in the Triassic of western America by three characteristic species.

Montlivaultia marmorea Frech

1890. *Montlivaultia marmorea.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 41, pl. 11, figs. 6, 6a.

Large single Hexacoralla, with bluntly conical shape, and elliptical cross section. Septa exceedingly fine and numerous, meeting along a line, without columella. This species is distinguished from all others in the group by its gigantic size and the extreme fineness and great number of the septa.

Occurrence: Very rare in the Upper Triassic limestone of Noric age, in Dunlap Canyon, at the north end of Pilot Mountain, Esmeralda County, near Mina, Nev. Collected by H. W. Turner.

Montlivaultia martini Smith, n. sp.

Plate CXXI, Figure 6

Cross section elongate oval. Outer wall thickened. Septa comparatively few in number, arranged in three cycles, first and second of 12 each, third of 24. Only the first cycle reaches the center. Dissepiments form continuous concentric rings, especially near the center.

Montlivaultia martini differs from *Montlivaultia norica* in its more oval cross section, its fewer septa, and the rings formed by dissepiments.

Named in honor of the collector, Dr. G. C. Martin.

Occurrence: Very rare in the Upper Triassic coral zone of lower Noric age at Iliamna Lake, near Cook Inlet, Alaska.

Montlivaultia norica Frech

Plate CXI, Figure 6

1854. *Montlivaultia capuliformis.* Reuss (not Milne-Edwards and Haime), Beiträge zur Characteristik der Kreideschichten in den Ostalpen, besonders im Gosauthale und am Wolfgangsee: K. Akad. Wiss. Wien Denkschr., Band 7, pl. 6, figs. 16, 17.

1890. *Montlivaultia norica.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 39, pl. 3, figs. 9a–b; pl. 10, figs. 1–5; pl. 13, figs. 1–7; pl. 18, figs. 17, 17a.

Form conical, thick set, with elongate elliptical cross section. Septa very numerous, at least 150, not meeting in a point but on a line, in keeping with the elliptical form. The elliptical cross section is not constant but rather irregular.

Occurrence: Rare in the Upper Triassic coral zone of lower Noric age, about 500 feet above the shales with *Halobia oregonensis*, at Martin Bridge over Eagle Creek at the junction with Paddy Creek, Blue Mountains, Oreg. This species was first described from the lower Noric Zlambach beds, of the Austrian Alps, where it is the commonest species of the entire coral fauna. It was also found in the coral zone of lower Noric age on Gravina Island, locality 8835, United States Geological Survey, on the north arm of the cove 3 miles north of Dall Head, Alaska.

Genus STYLOPHYLLOPSIS Frech

1890. *Stylophyllopsis*. Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 48.

Type.—Stylophyllopsis zitteli Frech.

Simple or only slightly divided Hexacoralla, with round cross section and few septa, which are between the isolated rods of *Stylophyllum* and the compact lamellae of *Montlivaultia*.

Occurrence: Represented in the Triassic of North America by a single species; common in the Triassic and Jurassic of Europe.

Stylophyllopsis mojsvari Frech

Plate CXVIII, Figure 10

1890. *Stylophyllopsis mojsvari*. Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 52, pl. 10, figs. 7–14; pl. 12, fig. 15; pl. 13, fig. 16.

Form bluntly conical, with subelliptical cross section. Septa few, and meeting in the center, without columella. Resembles *Montlivaultia norica* Frech, of the Alpine region and of the Blue Mountains of Oregon, from which species it differs in its rounder cross section and much fewer septa.

Occurrence: Very rare in the Upper Triassic Hosselkus limestone, in the coral zone of lower Noric age, about 100 feet above the zone of *Tropites subbullatus*, at the north end and west side of Brock Mountain, about 9 miles northeast of Bully Hill, Shasta County, Calif.

Stylophyllopsis zitteli Frech

Plate CXI, Figures 7–9

1890. *Stylophyllopsis zitteli*. Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 48, pl. 13, figs. 9–15, 17–24.

Roundish cross section, branching forms less common than single. Septa ordinarily in three cycles, 24; more rarely 34, 42, 56.

Smaller than *Stylophyllopsis mojsvari*, with more numerous septa, and commonly distinctly branching stocks.

Occurrence: In the lower Noric Zlambach beds of the Fischerwiese, in the Austrian Alps; very rare in the coral zone of lower Noric age at Martin Bridge on Eagle Creek, Blue Mountains, Baker County, Oreg.; also in the same zone at locality 8834, Threemile Cove, Gravina Island, Alaska.

Genus THECOSMILIA Milne-Edwards and Haime

Stock thick, branching, bushy, with deeply embedded calyces. Septa numerous, with spines or knobs. Thick walls, longitudinally ribbed, and a few transverse wrinkles. Columella lacking or rudimentary. Rather common in the Upper Triassic of America.

Thecosmilia caespitosa Reuss

Plate CXXI, Figure 7

1865. *Thecosmilia caespitosa*. Reuss, Ueber einige Anthozoen der Kössener Schichten und der alpinen Trias: K. Akad. Wiss. Wien Sitzungsber., Band 50, p. 159, pl. 3, fig. 2.

1890. *Thecosmilia caespitosa*. Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 7, pl. 1, figs. 1–13.

Irregular branching stocks, about 10 millimeters in diameter, of oval cross section. Septa arranged in four cycles, numbering in all from 42 to 48.

This species differs from *Thecosmilia norica* in its smaller size and much finer and more widely separated septa. It differs from *Thecosmilia fenestrata* in its greater average size and less numerous septa.

Occurrence: Very rare in the coral zone of lower Noric age of Iliamna Lake near Cook Inlet, Alaska. It was first described from the same horizon of the Zlambach beds of the Fischerwiese, Tyrolian Alps.

Thecosmilia delicatula (Frech)

Plate CV, Figure 4

1890. *Rhabdophyllia delicatula*. Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 19, pl. 3, figs. 1a–c.

1911. *Calamophyllia dawsoni*. Clapp and Shimer, The Sutton Jurassic of the Vancouver group, Vancouver Island, B. C.: Boston Soc. Nat. Hist. Proc., vol. 34, No. 12, p. 431, pl. 40, fig. 1; pl. 42, fig. 16.

Clapp and Shimer describe this species as follows:

> Similar to *C. suttonensis* in number and cycles of costae and presumably of septa (the septa are not sufficiently well preserved to be made out with certainty). The corallites are smaller (3 to 3.5 millimeters in diameter), branch more frequently, are more irregularly diverging, and are separated by about their diameter.

Occurrence: In the Sutton formation, Cowichan Lake, Vancouver Island, British Columbia, assigned by Clapp and Shimer to the Lower Jurassic, but belonging to the Upper Triassic coral zone of lower Noric age.

This species was first described from the Rhaetic stage of the Upper Triassic of the Tyrolian Alps.

Thecosmilia fenestrata (Reuss)

Plate CV, Figures 1, 9

1854. *Calamophyllia fenestrata.* Reuss, Beiträge zur Characteristik der Kreideschichten in den Ostalpen: K. Akad. Wiss. Wien Denkschr., Band 7, pl. 5, figs. 20, 21.
1890. *Thecosmilia fenestrata.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 9, pl. 1, figs. 25–27; pl. 2, figs. 1–17.
1911. *Calamophyllia suttonensis.* Clapp and Shimer, The Sutton Jurassic of the Vancouver group, Vancouver Island, B. C.: Boston Soc. Nat. Hist. Proc., vol. 34, No. 12, p. 431; pl. 40, figs. 5–7; pl. 41, fig. 15.

Thick-set branching stocks, 5 to 10 millimeters thick, with numerous septa, in four or five cycles, up to 50, of which from 9 to 12 stand out as primaries. Spines on the septa well developed. The branches are connected and supported by many irregular apophyses.

Thecosmilia fenestrata differs from *T. norica* in its smaller size and less numerous septa.

Occurrence: Rare in the Upper Triassic coral zone of lower Noric age, on Iliamna Lake, near Cook Inlet, Alaska; also at the same horizon and in the same association near Dall Head on Gravina Island, Alaska; also under the name of *Calamophyllia suttonensis* Clapp and Shimer, described from the Sutton beds of Vancouver Island, assigned by Clapp and Shimer to the Jurassic but certainly belonging to the Upper Triassic. It was first described from the lower Noric coral zone of the Austrian Alps, Zlambach beds, where it is extremely common.

Thecosmilia norica Frech

Plate CXI, Figures 1–4

1890. *Thecosmilia norica.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 9, pl. 1, figs. 14–24; pl. 10, figs. 6, 6a.

Stocks branching, bushy, thick set. Cross section subelliptic. Corallites large, up to 20 millimeters diameter. Septa arranged in four or five cycles, of which the first and second reach the center.

This species is distinguished from *Thecosmilia fenestrata* by its greater size, irregular branching, and by the lack of the lateral rootlike projections which characterize most species of this genus.

Occurrence: Rather common in the Upper Triassic coral zone of lower Noric age near Martin Bridge, at the junction of Paddy and Eagle creeks, Blue Mountains, Baker County, Oreg. This species was first described from the same horizon, in the Zlambach beds of the Fischerwiese, Tyrolian Alps, where it is one of the common species.

Genus ISASTREA Milne-Edwards and Haime

Compound Hexacoralla, with corallites prismatic and closely crowded. Calyces polygonal, with fused walls; columella imperfect or absent.

This genus is a notable reef former from the Triassic to the Cretaceous periods; it is represented in the American Triassic by three species.

Isastrea parva Smith, n. sp.

Plate CXIV, Figures 7–9

Stocks small, irregular, incrusting. Calyces irregular, polygonal, shallow, about 1 millimeter in width; septa about 24, apparently in three cycles.

This species greatly resembles *Isastrea vancouverensis*, with which it is associated, and differs only in the smaller size of the stocks and the calyces, which are less than half the diameter of those of *Isastrea vancouverensis*.

Occurrence: Very rare in the Upper Triassic coral zone of lower Noric age at Threemile Cove, Gravina Island, Alaska.

Isastrea profunda Reuss

Plate CV, Figure 8; Plate CXII, Figures 5, 6; Plate CXIV, Figures 1–3

1854. *Isastraea profunda.* Reuss, K. Akad. Wiss. Wien Denkschr., Band 7, p. 116, pl. 9, figs. 5, 6.
1890. *Isastraea profunda.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 21, pl. 5, figs. 1–3.
1911. *Isastrea whiteavesi* (part). Clapp and Shimer, The Sutton Jurassic of the Vancouver group, Vancouver Island, B. C.: Boston Soc. Nat. Hist. Proc., vol. 34, No. 12, p. 429, pl. 40, fig. 9 (not fig. 10, which = *Confusastrea decussata*).

Compound incrusting stocks; calyces polygonal, somewhat irregular in shape, averaging 3 millimeters in diameter, with thickened walls. Septa arranged in three or four cycles, numbering from 24 to 40. Columella absent.

Isastrea profunda differs from *Isastrea vancouverensis*, with which it is associated, in the greater size of its calyces and more regular polygonal shape.

Occurrence: Rare in the coral zone of lower Noric age in the Upper Triassic Hosselkus limestone of Bear Cove at the north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. It was first described from the same horizon in the Zlambach beds of the Fischerwiese in the Tyrolian Alps. It is also common in the same zone at Threemile Cove near Dall Head, Gravina Island, Alaska. A specimen from the Sutton formation on Vancouver Island was named by Clapp and Shimer *Isastrea whiteavesi*.

Isastrea vancouverensis Clapp and Shimer

Plate CV, Figure 10; Plate CXII, Figures 1–4; Plate CXIV, Figures 4–6; Plate CXXI, Figures 4, 5

1911. *Isastrea vancouverensis.* Clapp and Shimer, The Sutton Jurassic of the Vancouver group, Vancouver Island, B. C.: Boston Soc. Nat. Hist. Proc., vol. 34, No. 12, p. 430; pl. 40, fig. 8; pl. 42, fig. 17.

Clapp and Shimer describe this species as follows:

Corallum massive; closely crowded corallites irregularly hexagonal or rounded, united directly by their relatively thin walls. Calyces exceedingly deep, with average diameter of about 2 millimeters. In the best preserved corallites the septa reach almost to the center. The septa are very poorly preserved, seldom appearing except as vertical ridges on the inner walls. They are apparently from 20 to 30 in number and there are indications of two cycles. There is a suggestion of the presence of a spongy columella and of tabulae.

In good specimens there are three cycles of septa, much more distinct than one would infer from the above description.

Occurrence: In the Sutton formation of Cowichan Lake, Vancouver Island, British Columbia, which was assigned by Clapp and Shimer to the Lower Jurassic, but which belongs to the Upper Triassic coral zone of lower Noric age, as developed in California, Oregon, and Alaska. This species is common in this zone, in the Hosselkus limestone on Brock Mountain, Shasta County, Calif.; also at Iliamna Lake, near Cook Inlet, Alaska; and at Threemile Cove and Fivemile Cove, near Dall Head, on Gravina Island, Alaska.

Genus CONFUSASTREA D'Orbigny

1849. *Confusastrea.* D'Orbigny, Note sur les polypiers fossiles, p. 10.

1851. *Confusastrea.* Milne-Edwards and Haime, Polypiers fossiles des terrains paléozoïques: Mus. hist. nat. Archives, vol. 5, p. 98.

1854. *Adelastrea.* Reuss, Beiträge zur Characteristik der Kreideschichten in den Ostalpen: K. Akad. Wiss. Wien Denkschr., Band 7, p. 115.

1856. *Confusastrea.* Milne-Edwards and Haime, Histoire naturelle des coralliaires, vol. 2, p. 481.

1885. *Confusastrea.* Koby, Monographie des polypiers jurassiques de la Suisse: Schweizer. paleont. Gesell. Abh., vol. 12, p. 257.

1890. *Phyllocoenia.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 26.

Not *Phyllocoenia* Milne-Edwards and Haime (=*Orbicella*).

Type.—Confusastrea burgundiae Michelin.

Compact on branching stocks. Calyces with indistinct walls, and several cycles of septa. The coenenchym is crossed by some of the septa, as in *Orbicella.* The principal septa are thickened in the middle, which, together with the scantiness of the dissepiments, appears to be the chief distinction between this genus and *Orbicella.*

Frech has erroneously united *Confusastrea* with *Phyllocoenia,* but the irregular calyces, the multiplication by subdivision, and the scantiness of the dissepiments are sufficient for generic separation. Also Vaughan[31] has shown that *Phyllocoenia* is nothing more than a synonym of *Orbicella.* It therefore seems proper to return to the old name for the genus. *Confusastrea* may be ancestral to the late Mesozoic, Tertiary, and modern *Orbicella* (*Phyllocoenia, Heliastrea*) but can hardly be congeneric with them.

[31] Vaughan, T. W., U. S. Nat. Mus. Bull. 103, p. 395, 1911.

Confusastrea is a notable reef former in the Jurassic of Europe; it also is common in the Upper Triassic of the Alps; of Shasta County, Calif.; of the Sutton formation on Vancouver Island; and in the coral zone of lower Noric age on Gravina Island, Alaska; and on Iliamna Lake, Alaska.

Confusastrea borealis Smith, n. sp.

Plate CXVI, Figures 1, 2

Stocks large, branching, arboriform, as much as 50 centimeters in length, and with the branches 3 or 4 centimeters in thickness. The oval calyces are about 2.5 millimeters in width, depressed and shallow and are 1 millimeter apart but are united by costae. The septa are in three cycles, 6 : 6 : 12. Of these, the primaries reach the center, the secondaries almost, and the Tertiary septa are short. Columella rudimentary. *Confusastrea borealis* has some resemblance to *Confusastrea cowichanensis* Clapp and Shimer, but differs in the much larger size of the stocks, in being arboriform instead of compact or incrusting, and in the fewer septa, 24 instead of 36.

This species belongs to the group formerly assigned by Frech to *Phyllocoenia.*

Occurrence: Rare in the coral zone of lower Noric age at Threemile Cove, near Dall Head, on Gravina Island, Alaska, associated with *Confusastrea decussata, Confusastrea grandissima, Isastrea profunda,* and other species.

Confusastrea cowichanensis Clapp and Shimer

Plate CV, Figure 3; Plate CXIV, Figures 10–13; Plate CXXI, Figure 1

1911. *Isastrea cowichanensis.* Clapp and Shimer, The Sutton Jurassic of the Vancouver group, Vancouver Island, B. C.: Boston Soc. Nat. Hist. Proc., vol. 34, No. 12, p. 429, pl. 41, fig. 11.

Clapp and Shimer describe this species as follows:

Corallum incrusting, calyces irregularly hexagonal, united to one another by relatively thick walls with evidences of coenenchyma upon the sides as in *Isastrea whiteavesi.* Calyces rather deep (1.5 to 2 mm.), diameter about 3 mm.; walls about 0.8 mm. thick. Septa 24, in three cycles, the third rudimentary. There is a tendency for the first two cycles to be irregularly developed, so that the symmetry is apparently quadrameral. Columella rudimentary.

Occurrence: In the Sutton formation of Cowichan Lake on Vancouver Island, British Columbia, assigned by Clapp and Shimer to the Lower Jurassic, but belonging to the Upper Triassic coral zone of lower Noric age, as seen in California, Oregon, and Alaska. This species also occurs in this zone at locality 8834, near Dall Head, on Gravina Island, north arm of cove 3 miles north of Dall Head, associated with a genuine Upper Triassic fauna. Also in the same zone on Iliamna Lake, near Cook Inlet, Alaska. It belongs to *Confusastrea* and not to *Isastrea,* and there are four cycles with 36 septa instead of three with 24.

Confusastrea decussata (Reuss)

Plate CXIII, Figure 7; Plate CXV, Figures 1–3; Plate CXXI, Figure 2

1854. *Phyllocoenia decussata.* Reuss, Beiträge zur Characteristik der Kreideschichten in den Ostalpen: K. Akad. Wiss. Wien Denkschr., Band 7, p. 99, pl. 13, figs. 2, 3.

1890. *Phyllocoenia decussata.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 28, pl. 7, figs. 1–10.

1911. *Isastrea whiteavesi* (part). Clapp and Shimer, The Sutton Jurassic of the Vancouver group, Vancouver Island, B. C.: Boston Soc. Nat. Hist. Proc., vol. 34, No. 12, p. 429, pl. 40, fig. 10 (not fig. 9).

Compact, flattened as knobby stocks, never branched. Polygonal calyces separated by a more or less distinct wall and united by long ribs. Real confluence of the septa of neighboring calyces does not occur. Diameter of the calyces from 4 to 6 millimeters. Septa numbering 36 when complete, in four cycles. The thickening of the septa corresponds to the ringlike elevation that surrounds the calyx.

This species was regarded by Frech as belonging to *Phyllocoenia;* however, the type of *Phyllocoenia* (*Phyllocoenia irradians*), from the Tertiary of Italy, has been shown by Vaughan to belong to *Orbicella.* Hence we must return to D'Orbigny's old name *Confusastrea* for the group.

Occurrence: Rare in the coral zone of the Upper Triassic Hosselkus limestone at Bear Cove, on Brock Mountain, Calif.; also in the same zone at Threemile Cove, Dall Head, Gravina Island, Alaska. Associated with *Confusastrea grandissima, Isastrea profunda, Astrocoenia, Stephanocoenia, Thamnastraea, Spongiomorpha,* and other species. Also in the Sutton formation of Vancouver Island, confused by Clapp and Shimer with *Isastrea whiteavesi,* which itself is a synonym for *Isastrea profunda.* Doubtfully identified from the coral zone of lower Noric age at Iliamna Lake, near Cook Inlet, Alaska.

Confusastrea grandissima (Frech)

Plate CXV, Figure 4

1890. *Phyllocoenia grandissima.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 31, pl 3, figs. 10, 11; pl. 9, figs. 1–7a.

Irregular stocks, with very large calyces, not distinctly separated. Diameter of calyces as much as 20 millimeters. Septa in three cycles 36 in maximum number, and running across the space between the calyces.

Confusastrea grandissima is distinguished from all other Triassic species of this genus by its large size and the coarseness of its septa, as well as by the irregularity of its calyces.

Occurrence: Very rare in the Upper Triassic coral zone of lower Noric age at locality No. 9537, on Fivemile Cove near Dall Head, on Gravina Island, Alaska (15 A. Ch., 130); also at Threemile Cove on Gravina Island, Alaska; also in the same zone and in the same association in the Hosselkus limestone of Cow Creek near Ingot, Shasta County, Calif.

Confusastrea incrassata (Frech)

Plate CXXI, Figure 3

1890. *Phyllocoenia incrassata.* Frech, Die Korallen der juvavischen Triasprovinz: Band 37, p. 30, pl. 8, figs. 1–14.

Irregular, branching, in some specimens dendritic stocks. Calyces roundish or oval, with distinct walls, and united by ribs. Septa numerous, 40 to 50. Calyces 4 to 7 millimeters in diameter.

Confusastrea incrassata differs from *Confusastrea decussata,* with which it is associated in both Europe and America, in the branching stocks, the larger size of the calyces and the more numerous septa.

Occurrence: Rare in the coral zone of lower Noric age at Iliamna Lake, near Cook Inlet, Alaska. It was first described from the lower Noric Zlambach beds of the Fischerwiese, Austrian Alps.

Genus LATIMAEANDRA D'Orbigny

Compound branching stocks, with elongate calyces merging into one another, arranged in rows. Septa numerous and thin, formed of trabeculae in fanlike order. Synapticulae in horizontal rows.

Rare in the Triassic, Jurassic, and Cretaceous systems.

Represented in the Upper Triassic beds of Europe by several species and in America by two species.

Latimaeandra alaskana Smith, n. sp.

Plate CXV, Figures 11, 12

Stocks small, compact. Calyces small, elongate, confluent, fusing together in a very irregular manner. The calyces vary greatly in size and shape, some being regular and nearly circular, averaging about 3 millimeters in diameter; others are oblong, 6 millimeters in length, and 2.5 millimeters in width. The septa are poorly preserved but appear to be about 24 in three cycles.

This species resembles *Latimaeandra norica* var. *minor* Frech, from the Noric beds of the Tyrolian Alps, but differs from the European form in its much smaller size and less numerous septa.

Occurrence: Very rare in the coral zone of lower Noric age at Threemile Cove, near Dall Head, Gravina Island, Alaska.

Latimaeandra eucystis Frech

Plate CXIII, Figures 8, 9

1890. *Isastraea* (*Latimaeandra*) *eucystis.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 26, pl. 6, fig. 10; pl. 7, figs. 11, 12.

Stocks small. Calyces elongate, fusing together in an irregular manner, with septa meeting along a line instead of in a center, giving a strong resemblance to *Maeandra*. This character distinguishes the species from all other American Triassic corals.

Occurrence: Very rare in the Upper Triassic coral zone of lower Noric age in the Hosselkus limestone on the North Fork of Squaw Creek, 3 miles northwest of Kelly's ranch; also in the same zone near the junction of Cow and Cedar creeks, 3 miles east of Ingot, Shasta County, Calif. It was first described from the lower Noric Zlambach beds of the Fischerwiese in the Tyrolian Alps.

Family FUNGIDAE Dana

Genus THAMNASTRAEA Lesauvage

Compound flattened stocks. Calyces without walls, united by riblike septa. Columella rodlike or rudimentary. The well-developed septa are spread out fanlike, and consist of rows of cylindrical trabeculae bound together by synapticulae.

Occurrence: A common reef coral from the Triassic to the Tertiary.

Thamnastraea rectilamellosa Winkler

Plate CXIII, Figures 1–6

1861. *Thamnastraea rectilamellosa.* Winkler, Der Oberkeuper, nach Studien in den bayrischen Alpen: Deutsche geol. Gesell. Zeitschr., Band 13, p. 487, pl. 8, fig. 7.
1861. *Thamnastraea alpina.* Winkler, idem, p. 487, pl. 8, fig. 8.
1861. *Thamnastraea plana.* Winkler, idem, p. 488, pl. 7, fig. 9.
1890. *Thamnastraea rectilamellosa.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 60, pl. 16, figs. 1–15; pl. 17, figs. 7, 8.

Stocks flattened, mushroom-like, or irregularly convex. Calyces rather large, 7 or 8 millimeters in diameter, without walls, and united by ribs. Septa fused in the center to a spongy mass resembling a columella; arranged in two distinct cycles and numbering from 20 to 26.

Thamnastraea rectilamellosa differs from *Thamnastraea norica* in the smaller size of the calyces, in the less distinct alternation of the cycles, and in the development of the pseudocolumella.

Occurrence: Very common in the Upper Triassic coral zone of lower Noric age in the Hosselkus limestone near the junction of Cow and Cedar creeks, about 3 miles east of Ingot, Shasta County, Calif.; also in the same zone at the north end of Brock Mountain, Shasta County, Calif. It was first described from the lower Noric Zlambach beds of the Fischerwiese in the Tyrolian Alps and occurs also at the Rhaetic horizon in the Alps.

Thamnastraea rectilamellosa Winkler var. minor Frech

Plate CXVI, Figure 3; Plate CXVIII, Figures 5–6

1890. *Thamnastraea rectilamellosa* var. *minor.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 62, pl. 17, fig. 12.

Stocks small, calyces about half the size of the typical form. Septa eighteen, not distinctly alternating, meeting in the center in a pseudocolumella.

This variety is closely related to the typical form of the species but differs in its smaller size and more slender and delicate septa.

Occurrence: Very rare in the Upper Triassic coral zone of lower Noric age at Threemile Cove near Dall Head, Gravina Island, Alaska, associated with *Confusastrea borealis, Confusastrea decussata,* and other species. Collected by T. E. Bassett and C. O. Blackburn, of the Stanford University geological expedition. The writer has also collected this variety in the same zone in the Hosselkus limestone at Bear Cove, at the north end and east side of Brock Mountain, Shasta County, Calif.

Thamnastraea borealis Smith, n. sp.

Plate CXV, Figures 6–10

Stocks small, compact, knobby or branching. Calyces small, about 3 millimeters in diameter, placed at regular intervals, without walls, and united by ribs. Septa 24, in three cycles, 6 : 6 : 12; the third, which is rudimentary and without columella, unites the calyces.

Thamnastraea borealis differs from *Thamnastraea rectilamellosa* in its much smaller size, fewer septa, and branching compact stocks.

Occurrence: Very rare in the Upper Triassic coral zone of lower Noric age at Dall Head, Gravina Island, Alaska. It occurs at locality 9900, United States Geological Survey, 11 A. Ch. 1337, A. 20, Gravina Island; also at locality 9537, United States Geological Survey, 15 A. Ch. 130, west coast of Gravina Island, 7 miles north of Dall Head, from which place the type specimen came.

Genus HALOMITRA Dana

1846. *Halomitra.* Dana, U. S. Expl. Exped. during the years 1838, 1839, 1840, 1841, 1842, under the command of Charles Wilkes, U. S. N., vol. 7, p. 311.

Halomitra triadica Smith, n. sp.

Plate CXX, Figures 7, 8

Stock small, cap-shaped, roughly conical. Upper surface convex, with calyces radiating from the central apex. Septa of the individual calyces leaving the radial arrangement around their own centers and becoming radial from the apex. Lower surface with epitheca, concave.

This species has some resemblance to the modern "Neptune's cap" of the south seas and is probably generically related to that form. There are no known species of this group in the immense interval between the Upper Triassic and the present, but that is no reason why they should not have existed. The rarity of the modern *Halomitra* shows it to be an old group.

Occurrence: Very rare in the Upper Triassic coral zone of lower Noric age at locality 10097, United States Geological Survey, on Threemile Bay, near Dall Head, south end of Gravina Island, Alaska.

Family STYLOPHORIDAE Milne-Edwards and Haime

Genus ASTROCOENIA Milne-Edwards and Haime

Type.—Astrocoenia numismalis Defrance.

Irregular knoblike stocks, with small roundish or polygonal calyces, united by walls; consisting of several rows of primary trabeculae bound together by steroplasm. Septa well developed, grouped in cycles, with distinct columella and without pali. Dissepiments horizontal and scanty.

This genus is a notable reef former from the Triassic to the Tertiary. Represented in Upper Triassic beds of lower Noric age in America by two species.

Astrocoenia martini Smith, n. sp.

Plate CXV, Figure 5

Stocks small, compact, irregular. Calyces shallow, rather close set, united by coenenchym. Diameter of calyces, about 3 millimeters. Septa 12, in two cycles.

Astrocoenia martini has some resemblance to *Astrocoenia waltheri* Frech, from the Noric coral zone of the Austrian Alps, but differs in its larger calyces and fewer septa.

Occurrence: Very rare in the Upper Triassic coral zone of lower Noric age at Dall Head, Gravina Island, Alaska. Type from locality 8830, United States Geological Survey, collected by G. C. Martin, after whom the species is named.

Astrocoenia shastensis Smith, n. sp.

Plate CXII, Figures 11–13

Compact spreading stocks, with small rounded calyces from 2 to 3 millimeters in diameter, connected by the walls and some coenenchym. Septa about 24, arranged in two or more cycles, all distinctly dentate, and united with the slender columella. Dissepiments horizontal and numerous.

Astrocoenia shastensis differs from *Astrocoenia waltheri* in the much greater size of the stock, smaller columella, and more numerous finely dentate septa.

Occurrence: Very rare in the Upper Triassic coral zone of lower Noric age in the Hosselkus limestone on the north end and west side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif.

Genus STEPHANOCOENIA Milne-Edwards and Haime

Massive stocks with polygonal calyces, united by their walls. Septa numerous and long; only radial plates, and no synapticulae, in the visceral space. Columella pencil-shaped, surrounded by rods. Dissepiments spongy and well developed.

This genus ranges from the Triassic to the present but is particularly abundant in the Triassic, in which formation it is represented by several species in Europe and one in America. The type of the genus is the Recent species, *Stephanocoenia intersepta* Esper, from the Caribbean Sea.

Stephanocoenia juvavica Frech

Plate CXII, Figures 7–10

1890. *Stephanocoenia juvavica.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 38, text figure.

Compact, massive, knobby stocks, with small round calyces well separated. Septa not numerous, from 24 to 30, somewhat irregular, not arranged in distinct cycles, joining the central columella, which is surrounded by irregular rods or pali, which are distinctly visible only in the calyces. In some specimens the septa merge in the middle to a spongelike mass.

Occurrence: Rare in the coral zone of lower Noric age in the Upper Triassic Hosselkus limestone of Brock Mountain, Shasta County, Calif.; also in the same zone on Iliamna Lake near Cook Inlet, Alaska. It was first described from the lower Noric Zlambach beds of the Fischerwiese in the Tyrolian Alps.

Family PORITIDAE Dana

Subfamily SPONGIOMORPHINAE Frech

Composite tuberous Hexacoralla of very irregular form, with skeleton consisting of columns or trabeculae, bound together by synapticulae at approximately equal altitudes, forming somewhat regular layers.

Represented in America by *Spongiomorpha, Heptastylis* and *Stromatomorpha.*

Frech has named also a subgenus *Heptastylopsis,* which differs from *Heptastylis* in no very essential respect. The writer can also find no real difference separating *Spongiomorpha* from *Stromatomorpha;* but for convenience the forms in which radial structure predominates are assigned to *Spongiomorpha,* whereas those in which concentric layers predominate are ascribed to *Stromatomorpha.*

This group is supposed to be ancestral to the Poritidae, and *Heptastylis* bears a close resemblance to the modern family, especially to the genus *Goniopora* Quoy and Gaimard, which is the simplest Recent genus of Hexacoralla. This group may represent the ancestral type of Hexacoralla, although its first appearance is along with well-developed Astraeidae, Fungidae, and Stylophoridae.

Genus SPONGIOMORPHA Frech

1890. *Spongiomorpha.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 68.

Type.—Spongiomorpha acyclica Frech.

Skeleton composed of strong primary rods without any trace of radial arrangement in calyces; horizontal apophyses at more or less regular intervals.

This genus is fairly common in the Upper Triassic of the Alps, California, Oregon, and Alaska and is represented by several species that are notable reef formers.

Subgenus HEPTASTYLOPSIS Frech

1890. *Heptastylopsis.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 68.

Type.—Heptastylopsis gibbosa Frech.

Stocks of irregular shape, consisting of well-developed radial rods or trabeculae and horizontal rods or synapticulae, which form more or less distinct concentric layers. Calyces consisting of six or more primary rods arranged in irregular radial symmetry around a vertical rod that acts as a columella.

This subgenus appears to differ from *Heptastylis* chiefly in the less regular arrangement of the calyces. To the writer this difference seems to be specific rather than generic.

Represented in the Upper Triassic of America by *Heptastylopsis gibbosa* Frech, *Heptastylopsis ramosa* Frech, *Heptastylopsis dendriformis* Smith, and *Heptastylopsis tenuis* Smith.

Spongiomorpha (Heptastylopsis) dendriformis Smith, n. sp.

Plate CXVII, Figure 1; Plate CXVIII, Figures 1, 2

Stocks large, arboriform, from 25 to 30 centimeters long, and with the branches from 8 to 10 millimeters in diameter, diverging from the main stock but keeping roughly parallel. The inner structure consists of minute primary radial rods or trabeculae united by synapticulae at irregular intervals. The calyces consist of six or more primary rods arranged with some radial symmetry around a central rod that acts as a columella.

Spongiomorpha dendriformis is closely related to *Spongiomorpha ramosa* Frech, from which it differs in its much greater size and more prolific branching of the stocks.

Occurrence: Very common in the Upper Triassic coral zone of lower Noric age in the Hosselkus limestone, at Bear Cove on the east side of Brock Mountain, and on Little Cow Creek half a mile east of the junction with Cedar Creek, in Shasta County, Calif. This species must have played the part in the ancient reefs that now falls to the madrepores.

Spongiomorpha (Heptastylopsis) gibbosa Frech

Plate CXX, Figures 1–3; Plate CXXI, Figures 14, 15

1890. *Spongiomorpha (Heptastylopsis) gibbosa.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 75, text figs. a–e.

Stocks small, irregular, compact, consisting of radial primary rods or trabeculae and horizontal dissepiments or synapticulae, forming more or less regular concentric layers. Calyces formed by about six rods arranged irregularly in radial symmetry around a seventh rod as a columella. This arrangement is visible only on the unweathered surface of the stock and has not been observed on any of the American specimens.

Occurrence: Rare in the Upper Triassic coral zone of lower Noric age at localities 8834 and 8835, United States Geological Survey, near Dall Head, on Gravina Island, Alaska. Also doubtfully in the same zone on Eagle River, Blue Mountains, Baker County, Oreg.; in the same zone on Iliamna Lake near Cook Inlet, Alaska; and in the same zone of the Hosselkus limestone near the junction of Cedar and Cow creeks, Shasta County, Calif.

Spongiomorpha (Heptastylopsis) ramosa Frech

Plate CXX, Figures 4, 5; Plate CXXI, Figures 10–13

1890. *Spongiomorpha (Heptastylopsis) ramosa.* Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 76, text figs. a–e.

Stocks small, irregular, branching, a few centimeters long and 1 or 2 centimeters in diameter. The inner structure consists of radially divergent trabeculae or primary rods, strongly developed, with weak synapticulae forming poorly developed dissepiments at rather irregular intervals. The calyces are shown by six or more trabeculae, which are arranged in rude radial symmetry around a seventh rod as a columella. This structure is in all essentials like that of *Porites*, and even more like that of *Goniopora*, except that in *Spongiomorpha* there is no coalescence of the rods into septa or true dissepiments.

Occurrence: Very rare in the coral zone of lower Noric age at Threemile Cove near Dall Head, on Gravina Island, Alaska. Rather doubtful in the same zone at Iliamna Lake, near Cook Inlet, Alaska. This species was first described from the same horizon, from the classic locality of the Zlambach beds in the Tyrolian Alps.

Spongiomorpha (Heptastylopsis) tenuis Smith, n. sp.

Plate CXVIII, Figure 3

Stocks small, irregular, incrusting or slightly branching, composed of radial diverging slender tubes or rods, connected by apophyses at fairly regular intervals, forming rather distinct layers. Some slight radial symmetry of the rods as septa in calyces was observed.

This species is very closely related to *Spongiomorpha ramosa* Frech and differs chiefly in the slenderness of the rods.

Occurrence: Very rare in the coral zone of lower Noric age in the Upper Triassic Hosselkus limestone on North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

Genus HEPTASTYLIS Frech

1890. *Heptastylis*. Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 69.

Type.—Heptastylis stromatoporoides Frech.

Composite colonial Hexacoralla, with irregular calyces, composed of a number of rods arranged with more or less radial symmetry around a columella, without any trace of septal plates. The primary rods fill up the spaces between the calyces and are connected at more or less regular intervals by horizontal synapticulae. It will be seen that *Heptastylis* has a very close resemblance to the modern genus *Goniopora* Quoy and Gaimard.

Heptastylopsis was described by Frech as a subgenus under *Spongiomorpha*, whereas *Heptastylis* was described by him as an independent genus. The writer, however, can find in Frech's descriptions and figures no essential difference between *Heptastylopsis* and *Heptastylis*.

Occurrence: Rare in the Noric coral zone in the Tyrolian Alps and in the same zone of the Blue Mountains of Oregon.

Heptastylis aquilae Smith, n. sp.

Plate CIX, Figures 1–6; Plate CXI, Figure 5

Stocks compact, irregular, in some specimens kidney-shaped, as much as 10 centimeters in diameter. The primary rods radiate from a common center in close-set order and are closely connected at rather irregular intervals by synapticulae, forming rather indistinct concentric layers. There is some slight regularity in the radial symmetry of the calyces.

Heptastylis aquilae is associated with and closely related to *Heptastylis oregonensis*, from which it differs in the greater size of the primary rods, the more distinct apophyses, and the irregularity of the concentric layers. It is somewhat similar to that species in shape and size but is easily distinguished by its much more irregular and branching form.

Occurrence: Very common in the coral zone of lower Noric age about 500 feet above the beds with *Halobia oregonensis*, at Martin Bridge, at the junction of Eagle and Paddy creeks, Blue Mountains, Baker County, Oreg.

Heptastylis oregonensis Smith, n. sp.

Plate CX, Figures 1–5

Form subspherical, oval, or kidney-shaped, in masses as much as 10 centimeters in diameter. Composed of close-set primary rods arranged in irregular radial symmetry in calyces around a rod acting as a columella, and connected at regular intervals by horizontal apophyses or synapticulae, which form distinct layers. The calyces are visible only on the unweathered surface of the coral head.

This species resembles *Heptastylopsis gibbosa* Frech but differs chiefly in its greater size, longer tubes, and much more distinct calyces.

It is more nearly related to *Heptastylis aquilae*, with which it is associated, but differs from that species in the smaller size of the primary rods, more regular shape, and more distinct concentric layers.

Occurrence: Rather rare in the Upper Triassic coral zone of lower Noric age, about 500 feet above the beds with *Halobia oregonensis*, at Martin Bridge, at the junction of Eagle and Paddy creeks, Blue Mountains, Baker County, Oreg.

Genus STROMATOMORPHA Frech

1890. *Stromatomorpha*. Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 69.

Type.—Stromatomorpha stylifera Frech.

Skeleton composed of trabeculae without any trace of radial arrangement as septa. Horizontal synapticulae at regular altitudes, forming definite concentric layers.

Chiefly confined to the Upper Triassic Noric horizon of the Tyrolian Alps, the Klamath Mountains of Shasta County, Calif., and the coral zone of Alaska.

Stromatomorpha californica Smith, n. sp.

Plate CXVIII, Figure 4; Plate CXIX, Figure 1; Plate CXX, Figure 6

Large, compact stocks as much as 40 centimeters in width, composed of fine primary rods or trabeculae, without any trace of radial arrangement as septa in calyces. Horizontal apophyses or synapticulae at regular altitudes, forming definite concentric layers, which are much more prominent than the radial elements.

Stromatomorpha californica differs from all known species of the Spongiomorphidae in its enormous size and more predominant horizontal layers.

Occurrence: Very common in the Upper Triassic coral zone, of lower Noric age, in the Hosselkus limestone, on the east side of Brock Mountain, on Pit River, at the mouth of Brock Creek, Shasta County, Calif., where it is the most common coral; also in the same zone at locality 9900, United States Geological Survey, 11 A. Ch. 137 (Theodore Chapin), near Dall Head, on Gravina Island, Alaska.

Class HYDROZOA

Genus HETERASTRIDIUM Reuss

Roundish or oval bodies, composed of fine-branching radial calcareous fibers. The rather compact skeleton is penetrated by the polyp tubes, of which there are two sorts: the larger one with circular openings and smaller ones with radial septa.

Heterastridium appears to be intermediate between the Paleozoic *Stromatoporoidea* and the Recent *Hydrocoralla*. It is fairly common in the Upper Triassic from India, through the Alps, to Alaska. Represented in America by a single species.

Heterastridium conglobatum Reuss

Plate CXVIII, Figures 7–9

1865. *Heterastridium conglobatum*. Reuss, Ueber einige Anthozoen der Kössener Schichten und der alpinen Trias: K. Akad. Wiss. Wien Sitzungsber., Band 51, p. 6, pls. 1, 2; pl. 4, fig. 3.

1890. *Heterastridium conglobatum*. Frech, Die Korallen der juvavischen Triasprovinz: Palaeontographica, Band 37, p. 96, text fig.

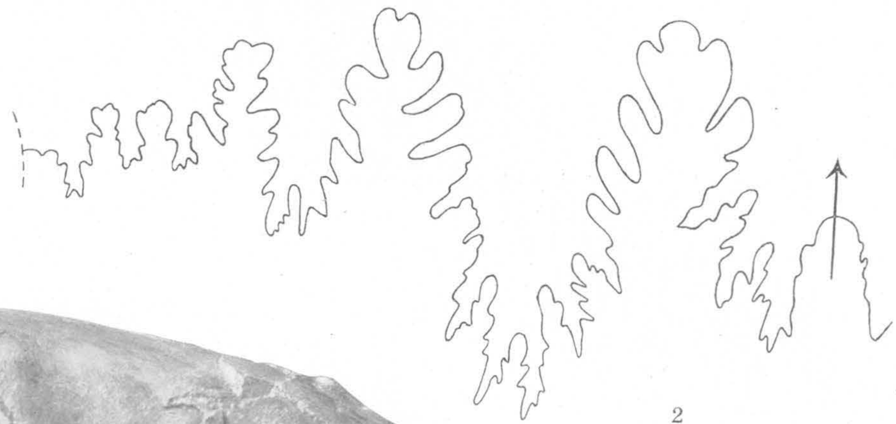
Roundish or oval bodies, the largest of which are 10 centimeters in diameter. Inner structure of radial calcareous fibers, which are united at nearly equal intervals by apophyses, giving a distinctly concentric structure to cross sections. These fibers are arranged radially around two sorts of calyces, round ones without septa, and the other in which the rods stand in radial symmetric arrangement.

Occurrence: Rare in the Upper Triassic beds of Noric age at locality "10241, United States Geological Survey, East Fork of Chulitna River, 1½ miles below Camp 9, Alaska."

PLATES I–CXXI

PLATE I

FIGURES 1, 2. *Trachyceras* (*Protrachyceras*) *californicum* Smith, n. sp. (pp. 79–80). Type. From the Upper Triassic Hosselkus limestone, *Trachyceras* subzone of the zone of *Tropites subbullatus* on Brock Mountain, 3 miles east of Madison's ranch, Shasta County, Calif. Collection of J. P. Smith.



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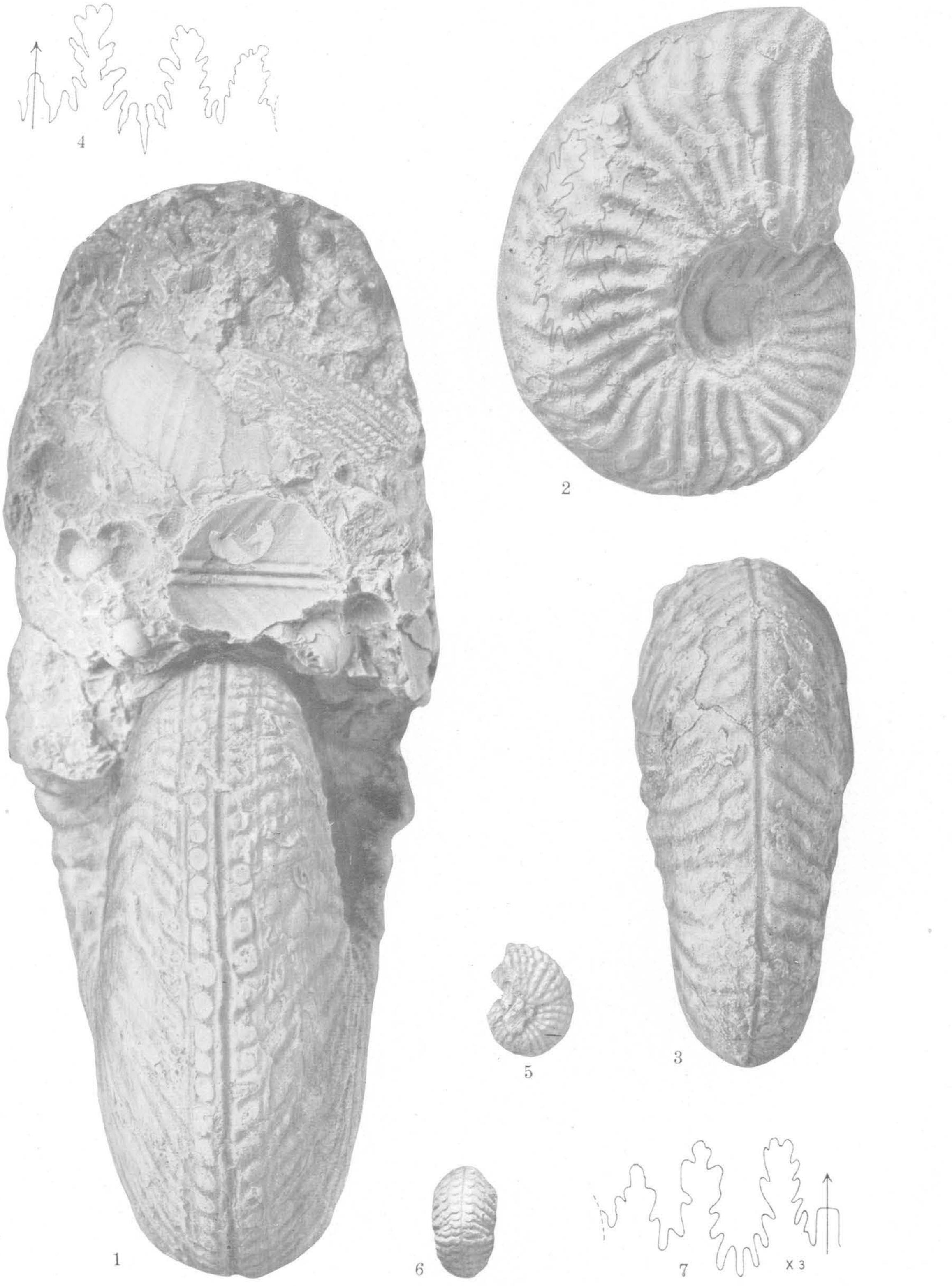
UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE II

FIGURES 1–7. *Trachyceras* (*Protrachyceras*) *californicum* Smith, n. sp. (pp. 79–80).

1. Type.

2–4. Early mature stage.

5–7. Adolescent stage.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, *Trachyceras* subzone of the zone of *Tropites subbullatus* on Brock Mountain, 3 miles east of Madison's ranch, Shasta County, Calif. Collection of J. P. Smith.

PLATE III

FIGURES 1–6. *Trachyceras* (*Protrachyceras*) *lindgreni* Smith, n. sp. (p. 80).

1–3. Type.

4–6. Immature specimen.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, *Trachyceras* subzone of the *Tropites subbullatus* zone of Brock Mountain, 3 miles east of Madison's ranch, Shasta County, Calif. Collection of J. P. Smith.

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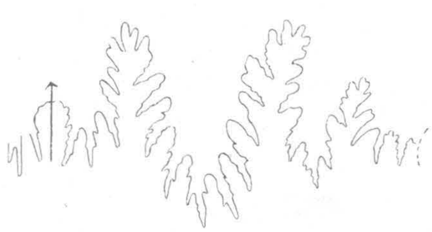

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UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

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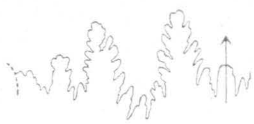

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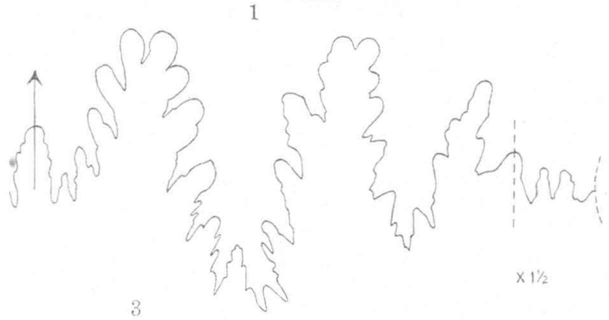

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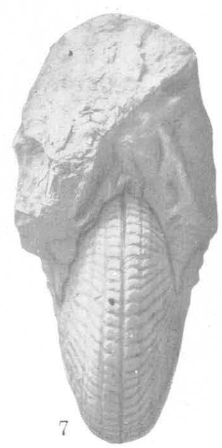

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UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE IV

FIGURES 1–8. *Trachyceras* (*Protrachyceras*) *beckeri* Smith, n. sp. (p. 79).

1–3. Type.

4. Early mature stage.

5–8. Immature specimen showing the change in sculpture.

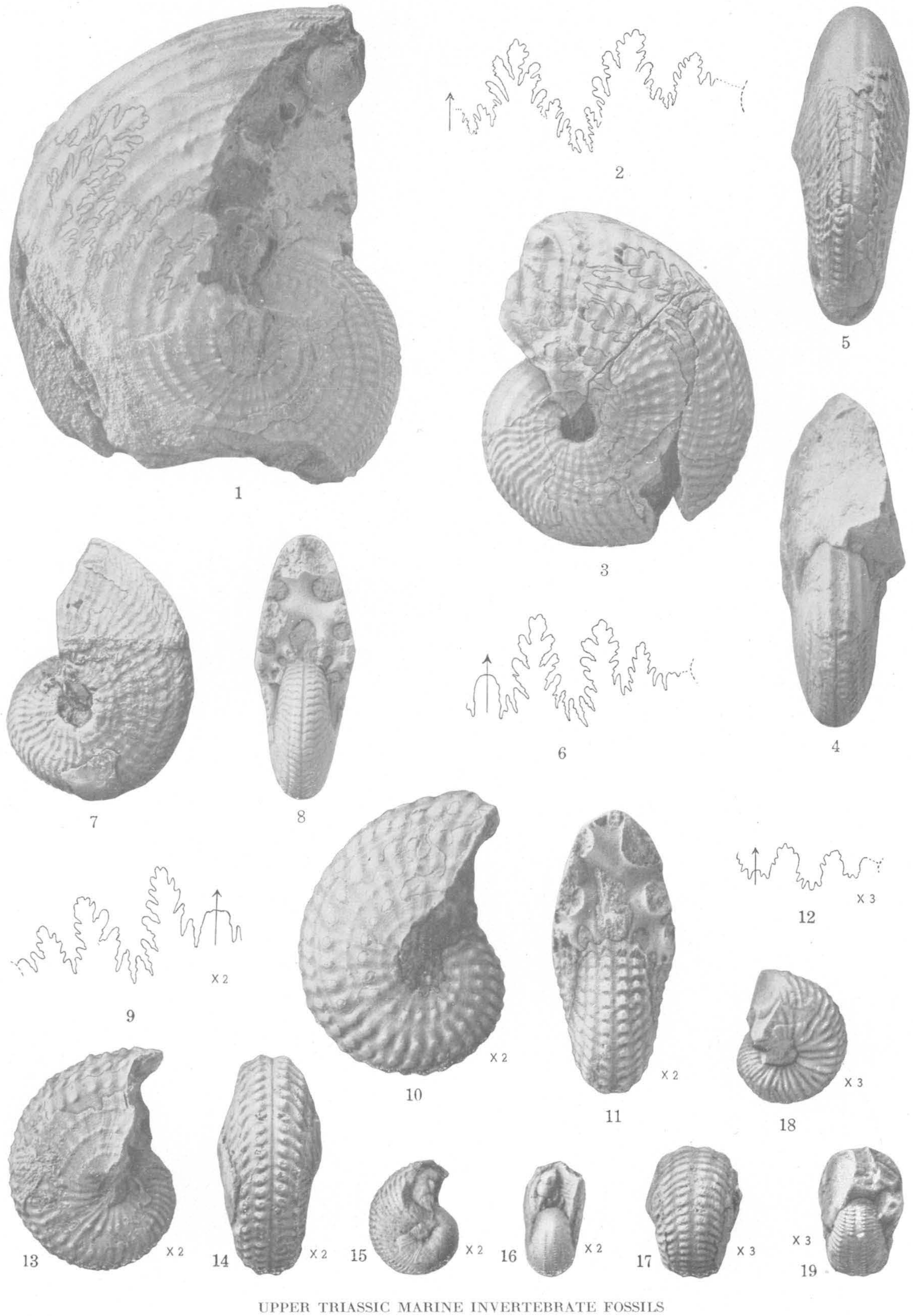
All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, *Trachyceras* subzone of the zone of *Tropites subbullatus* at the south end of Brock Mountain, Shasta County, Calif. Collection of J. P. Smith.

PLATE V

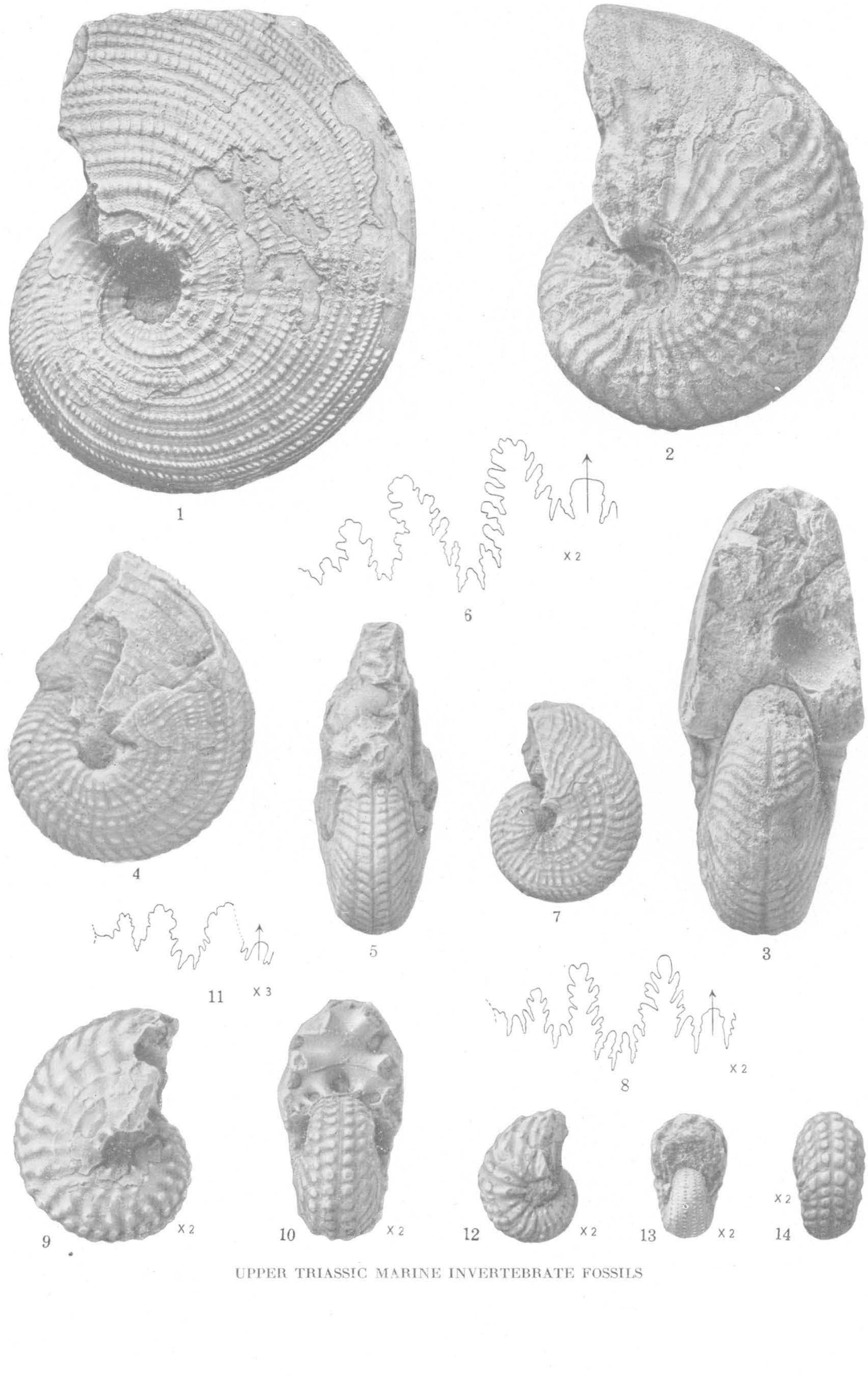
FIGURES 1–19. *Trachyceras* (*Protrachyceras*) *shastense* Smith (p. 81).

1, 2. Side view and septa.
3–6. Type, refigured.
7, 8. Immature shell.
9. Septa of the same.
10, 11. Immature shell.
12. Septa of the same shell.
13, 14. Adolescent stage.
15, 16. Early adolescent stage.
17–19. Transition from larval stage.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, *Trachyceras* subzone of the zone of *Tropites subbullatus* on Brock Mountain, 3 miles east of Madison's ranch, Shasta County, Calif. Figures 1 and 2, collection of U. S. Geological Survey; Figures 3–19, collection of J. P. Smith.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE VI

FIGURE 1. *Trachyceras (Protrachyceras) lecontei* Hyatt and Smith (pp. 78–79). Showing perfect surface ornamentation.
FIGURES 2–14. *Trachyceras (Protrachyceras) madisonense* Smith, n. sp. (pp. 80–81).

2, 3. Type.
4, 5. Immature specimen.
6. Septa of the same specimen.
7. Adolescent specimen.
8. Septa of the same specimen.
9, 10. Adolescent specimen; diameter 20 millimeters.
11. Septa of the same specimen.
12–14. Late larval stage; diameter 11 millimeters.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, *Trachyceras* subzone of the *Tropites subbullatus* zone of Brock Mountain, 3 miles east of Madison's ranch, Shasta County, Calif. Figure 1, collection of U. S. Geological Survey; Figures 2–14, collection of J. P. Smith.

PLATE VII

FIGURES 1–4. *Trachyceras* (*Protrachyceras*) *storrsi* Smith, n. sp. (p. 81).

1. Type.
2. A smaller specimen.
3. Immature stage.
4. Adolescent specimen.

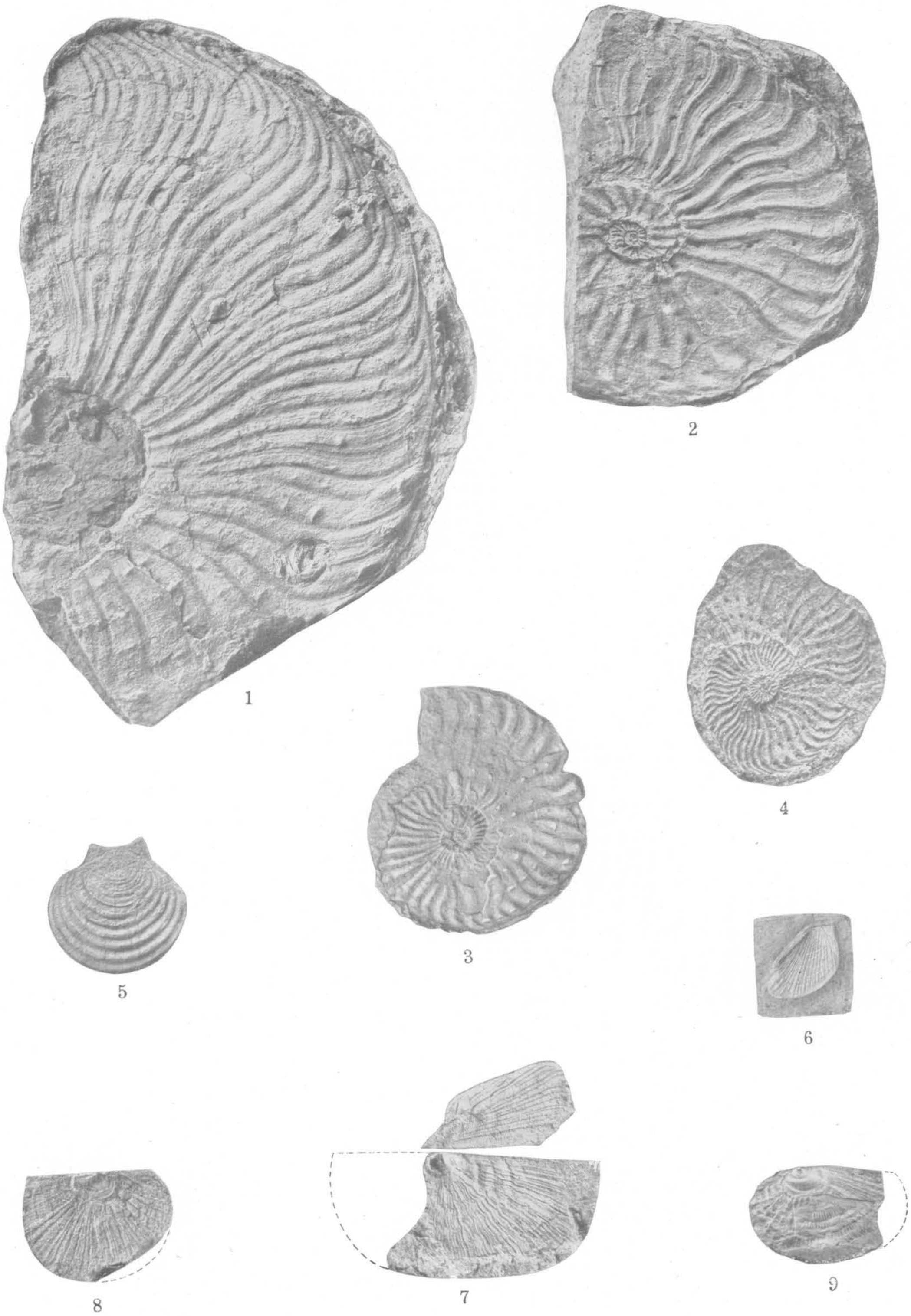
FIGURE 5. *Pecten* (*Entolium*) *pittensis* Smith, n. sp. (p. 121). Type.

FIGURE 6. *Lima kimballi* Smith, n. sp. (p. 122). Type.

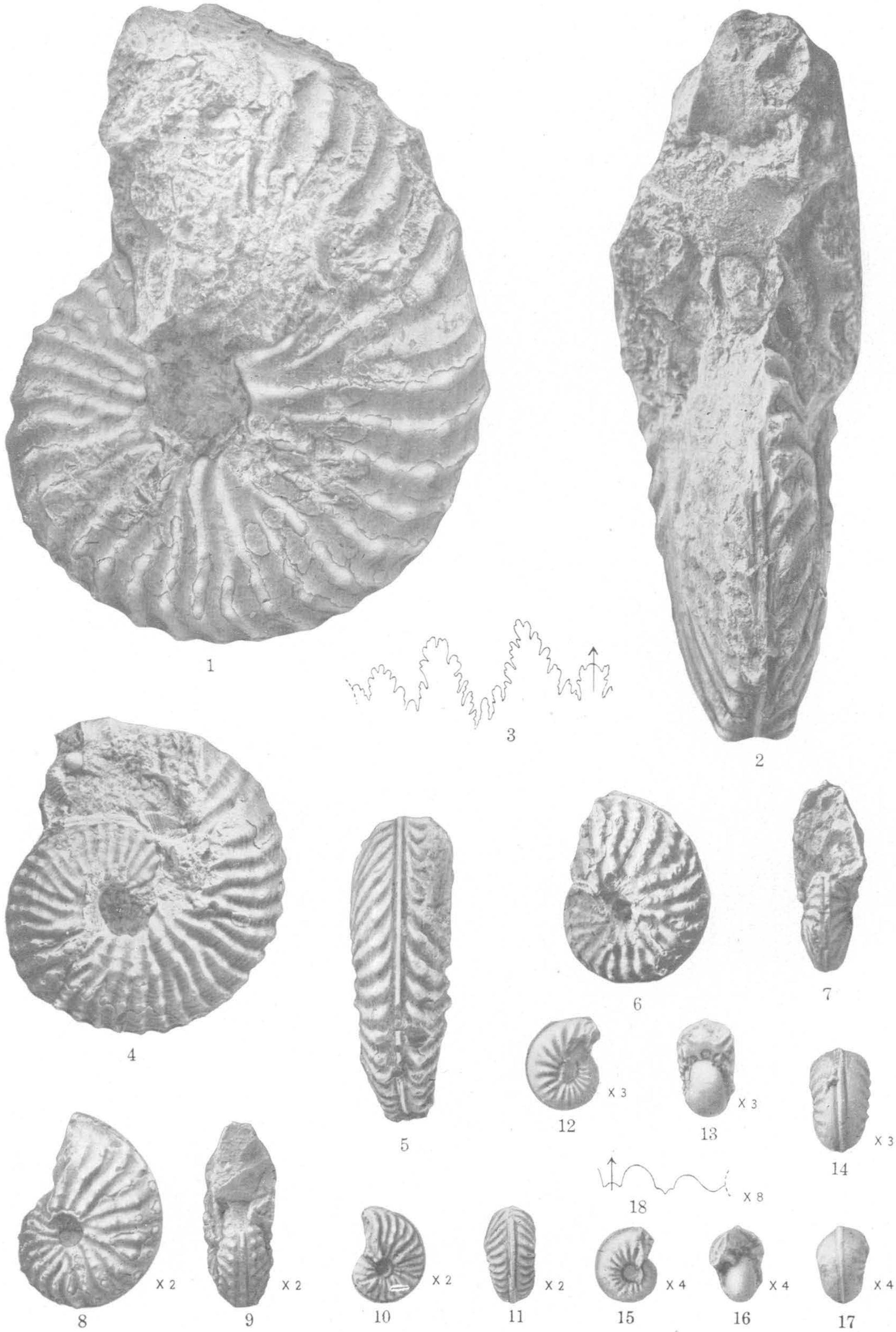
FIGURES 7–10. *Halobia rugosa* Gümbel (p. 117).

7. Pair of valves showing sculpture.
8. Showing shape and sculpture.
9. Left valve.
10. Right valve, showing larval shell.

All specimens figured on this plate came from the Upper Triassic *Halobia rugosa* zone of the Pit shale on Brock Mountain, Shasta County, Calif. Collection of J. P. Smith.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE VIII

FIGURES 1–18. *Discotropites mojsvarensis* Smith, n. sp. (p. 42).

1–3. Type.

4, 5. Immature specimen.

6, 7. Late adolescent stage.

8, 9. Early adolescent stage; diameter 15 millimeters.

10, 11. Transitional from larval to adolescent stage; diameter 8 millimeters.

12–14. Late larval stage; diameter 5 millimeters.

15–18. Larval stage; diameter 3 millimeters.

All specimens figured on this plate came from the *Juvavites* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone of Bear Cove, Brock Mountain, Shasta County, Calif. Collection of U. S. Geological Survey.

PLATE IX

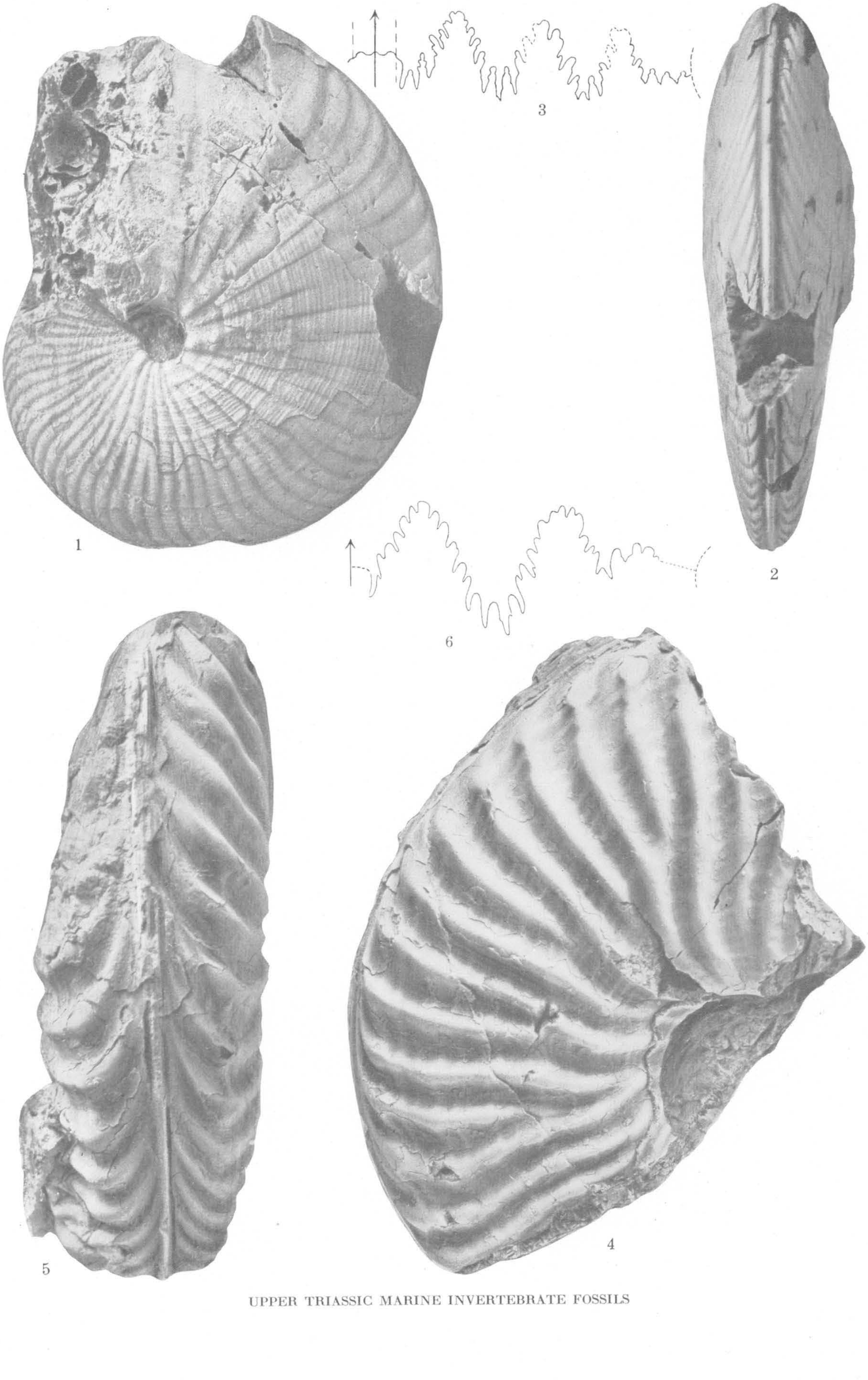
FIGURES 1–3. *Discotropites theron* Mojsisovics (pp. 40–41).

1, 2. Mature shell.

3. Septa of the same specimen.

FIGURES 4–6. *Discotropites davisi* Smith, n. sp. (pp. 42–43). Type, shell and septa.

All specimens figured on this plate came from the *Juvavites* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone at the north end and west side of Brock Mountain, Shasta County, Calif. Collection of U. S. Geological Survey.



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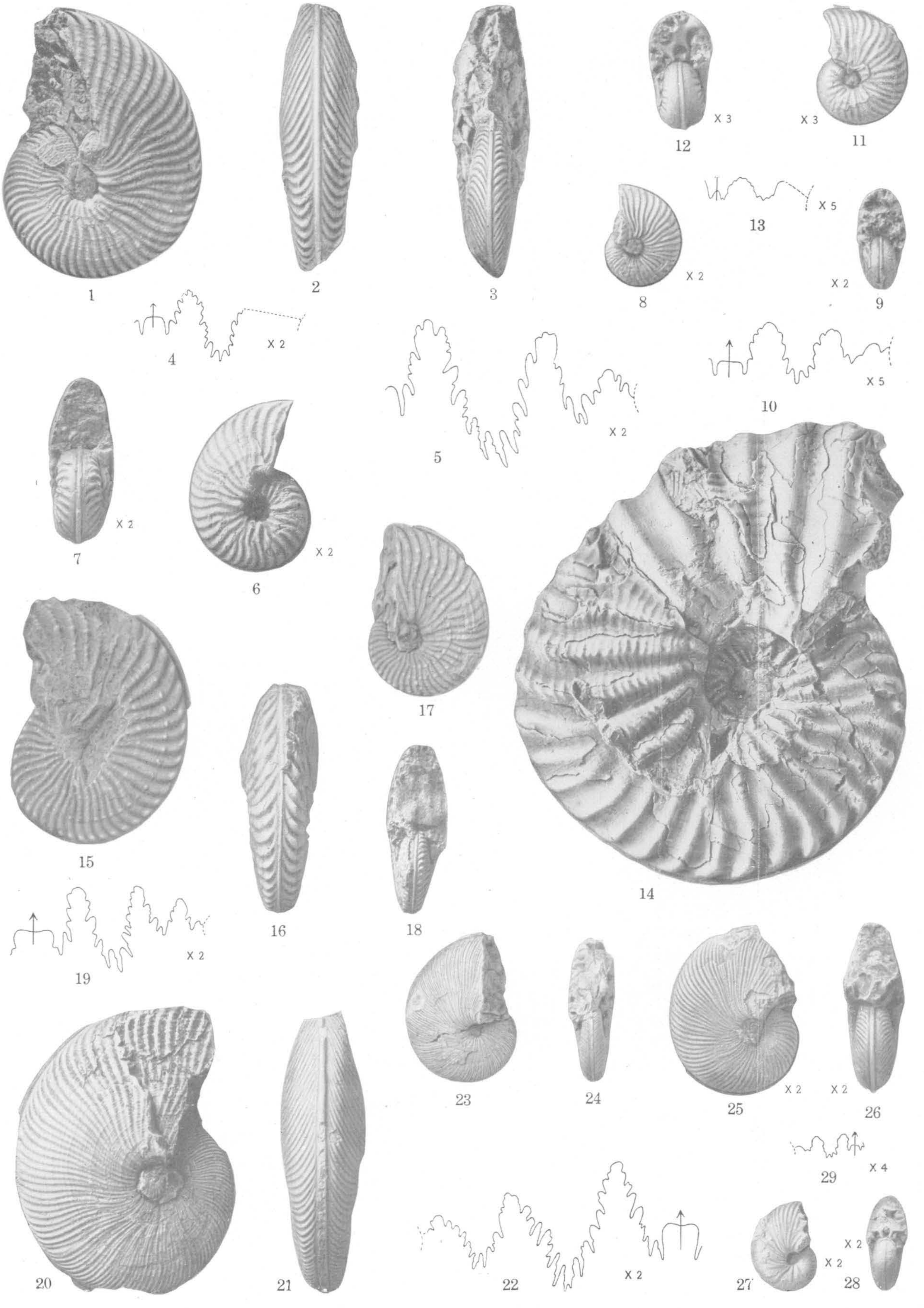


UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE X

FIGURES 1–13. *Discotropites gemmellaroi* Smith, n. sp. (p. 41).

1–4. Type.
5. Septa of another specimen.
6, 7. Adolescent specimen; diameter 15 millimeters.
8–10. Early adolescent stage; diameter 9 millimeters.
11–13. Early adolescent stage; diameter 7 millimeters.

FIGURE 14. *Discotropites davisi* Smith, n. sp. (pp. 42–43). Mature specimen, younger than the type.

FIGURES 15–19. *Discotropites sengeli* Mojsisovics (p. 42).

15, 16. Adult specimen.
17, 18. Younger specimen, showing septa.
19. Septa of the same specimen.

FIGURES 20–29. *Discotropites lineatus* Smith, n. sp. (p. 41).

20, 21. Type.
22. Septa of another specimen.
23, 24. Late adolescènt stage.
25, 26. Shell.
27–29. Shell.

All specimens figured on this plate came from the *Juvavites* subzone of the *Tropites subbullatus* zone of the Upper Triassic Hosselkus limestone at the north end of Brock Mountain, Shasta County, Calif. Collection of U. S. Geological Survey.

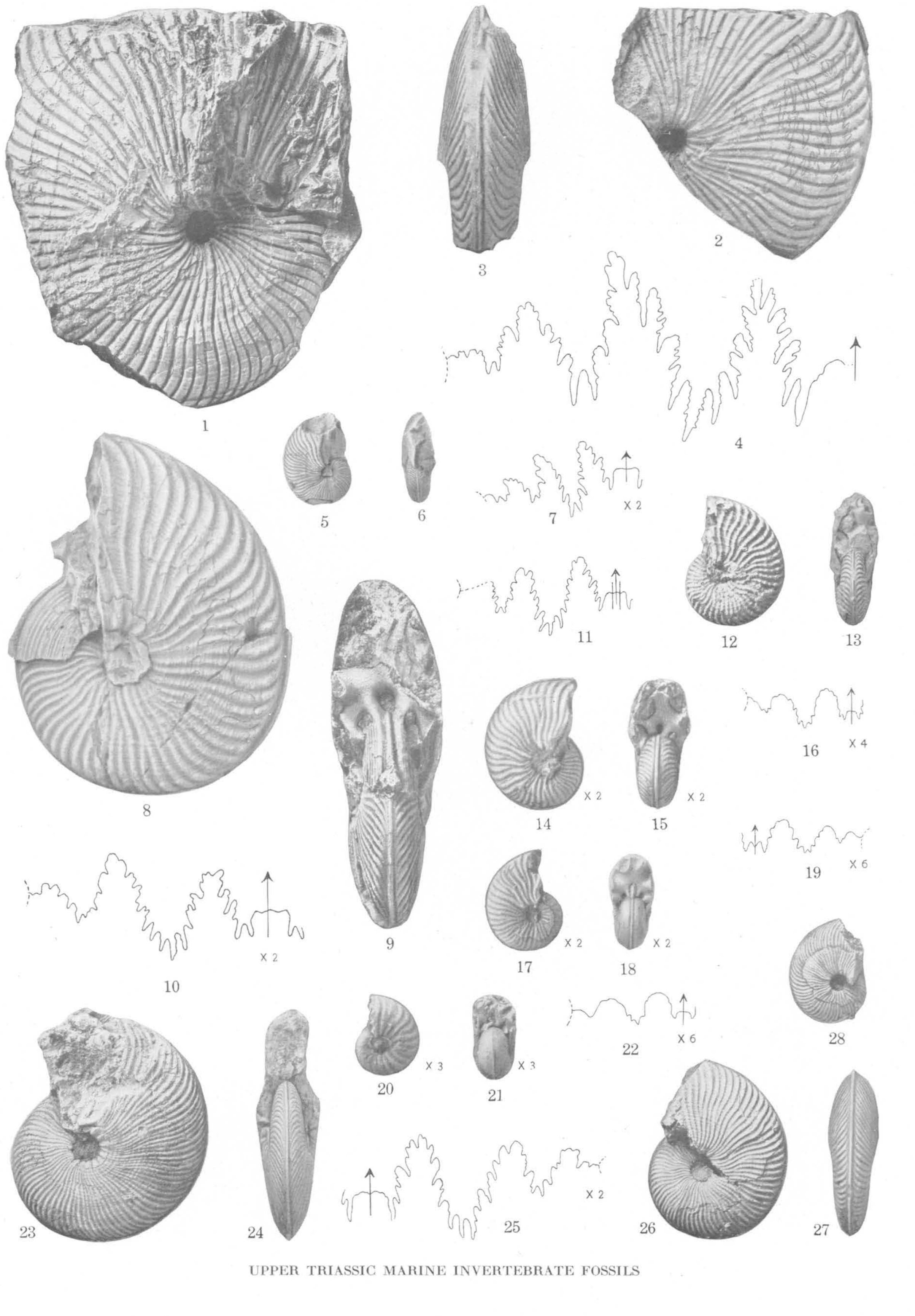
PLATE XI

FIGURES 1–7. *Discotropites empedoclis* Gemmellaro (p. 41).
1. Adult specimen.
2–4. Showing septa.
5–7. Adolescent stage.

FIGURES 8–22. *Discotropites laurae* Mojsisovics (p. 42).
8–10. Adult shell.
11. Septa of another specimen.
12, 13. Early mature stage.
14–16. Adolescent stage.
17–19. Adolescent stage; diameter 8.5 millimeters.
20–22. Late larval stage; diameter 5 millimeters.

FIGURES 23–28. *Discotropites formosus* Smith, n. sp. (p. 40).
23–25. Type.
26, 27. Smaller specimen.
28. Early mature stage.

All specimens figured on this plate came from the *Tropites subbullatus* zone of the Upper Triassic Hosselkus limestone of Shasta County, Calif. Figures 1–7 from the *Juvavites* subzone, North Fork of Squaw Creek, 3 miles north of Kelly's ranch; collection of U. S. Geological Survey. Figures 8–22 from the *Juvavites* subzone, north end of Brock Mountain; collection of U. S. Geological Survey. Figures 23–28 from the *Trachyceras* subzone south end of Brock Mountain; collection of J. P. Smith.



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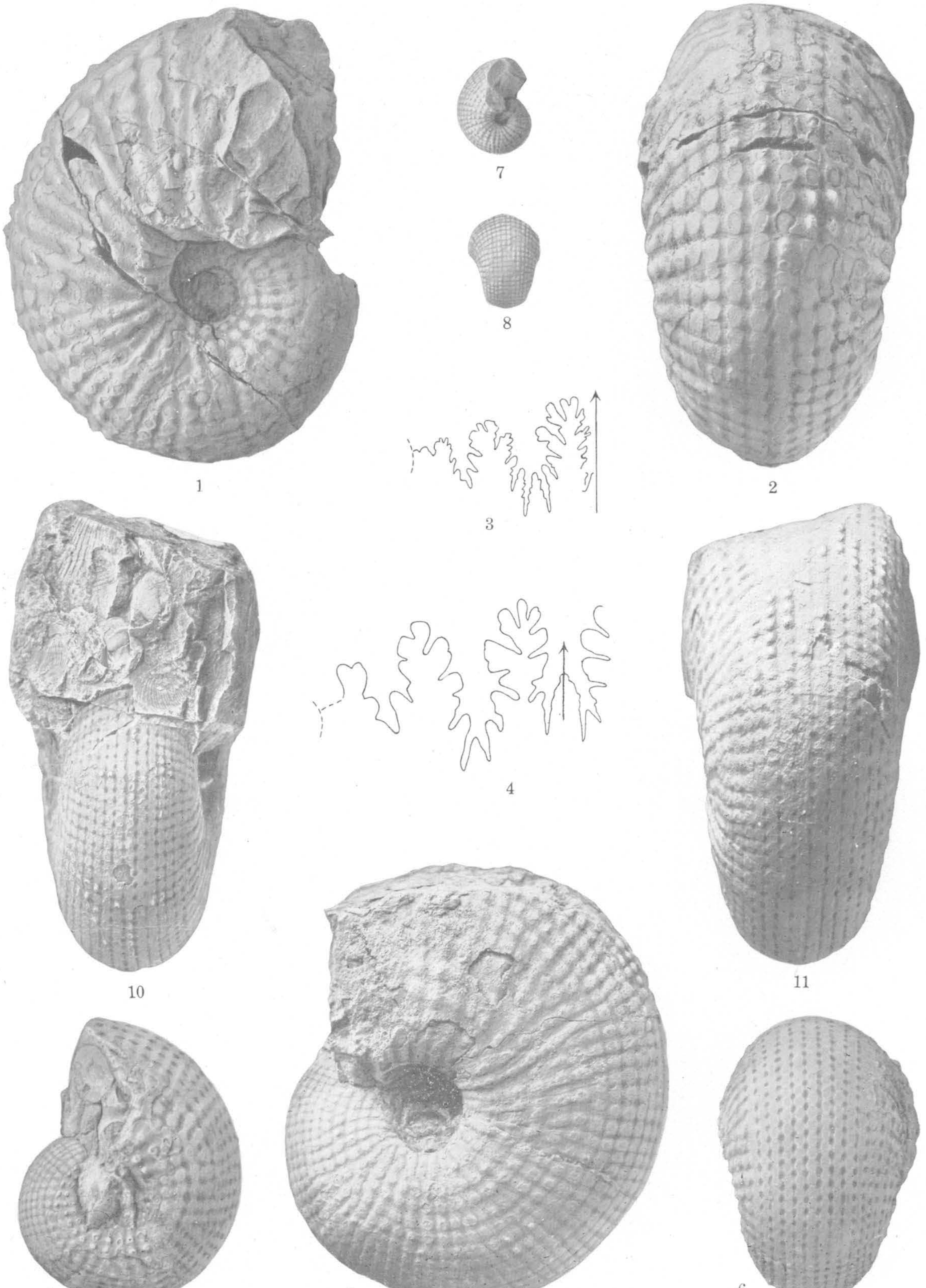


UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XII

FIGURES 1–8. *Sagenites (Trachysagenites) erinaceus* Dittmar (p. 60).

1–3. Mature shell.

4. Septa of another specimen.

5, 6. Early mature stage.

7, 8. Late adolescent stage.

FIGURES 9–11. *Sagenites (Trachysagenites) shastensis* Smith, n. sp. (p. 62). Type.

All specimens figured on this plate came from the *Tropites subbullatus* zone of the Upper Triassic Hosselkus limestone of Brock Mountain, Shasta County, Calif. Figures 1–4 from the *Juvavites* subzone; collection of U. S. Geological Survey. Figures 5–11 from the *Trachyceras* subzone; collection of J. P. Smith.

PLATE XIII

FIGURES 1–10. *Gonionotites hyatti* Smith, n. sp. (p. 59).

1–3. Type.

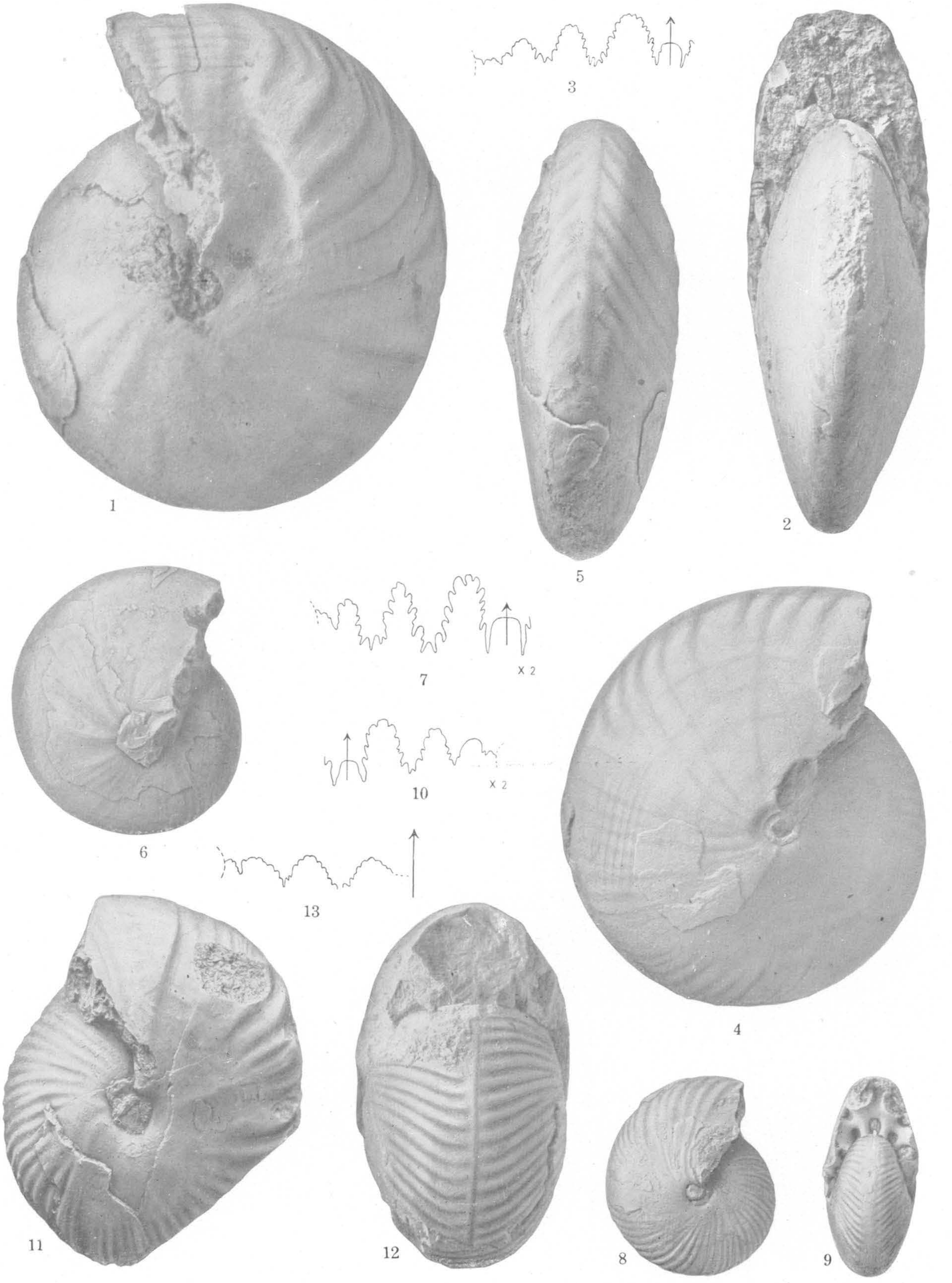
4, 5. View showing obsolescence of sculpture.

6, 7. View showing vestiges of "*Juvavites*" sculpture.

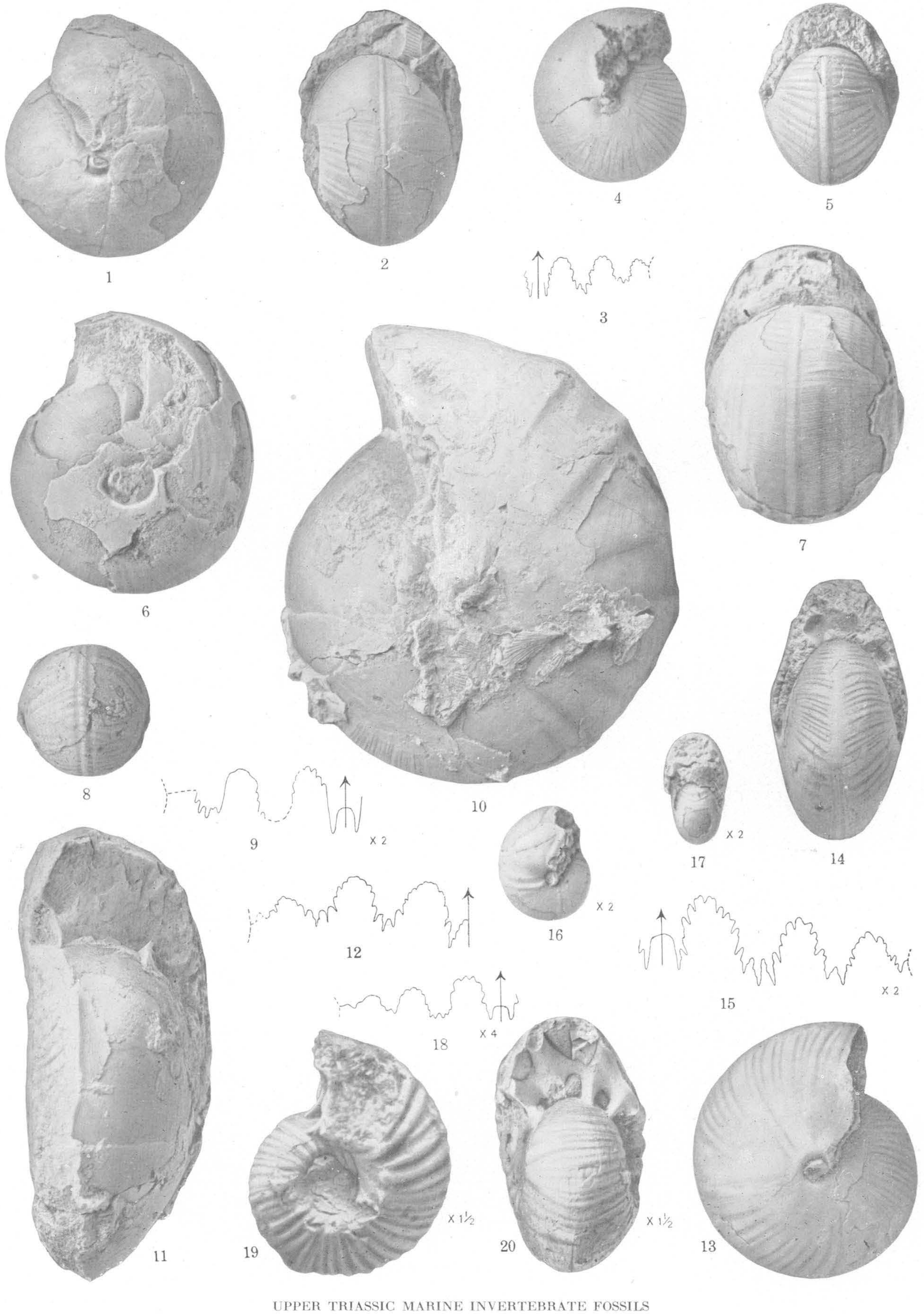
8–10. Adolescent stage.

FIGURES 11–13. *Jovites pacificus* Smith, n. sp. (p. 53). Type.

All specimens figured on this plate came from the *Juvavites* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone of Shasta County, Calif. Collection of U. S. Geological Survey. Figures 1–10 from Bear Cove, Brock Mountain. Figures 11–13 from North Fork of Squaw Creek, 3 miles north of Kelly's ranch.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XIV

FIGURES 1–5. *Jovites (Bacchites) bacchus* Mojsisovics (p. 53).
- 1–3. Adult specimen.
- 4, 5. Younger specimen, showing vestiges of sculpture.

FIGURES 6–9. *Jovites (Bacchites) sphaericus* Smith, n. sp. (p. 54).
- 6, 7. Type.
- 8, 9. A younger specimen, showing septa.

FIGURES 10–12. *Jovites (Bacchites) pinguis* Smith, n. sp. (p. 53). Type.

FIGURES 13–18. *Goniotites northi* Smith, n. sp. (p. 59).
- 13–15. Type. Septa × 2.
- 16–18. Young specimen; diameter 10 millimeters.

FIGURES 19, 20. *Sagenites dickersoni* Smith, n. sp. (p. 60). Type.

The originals of Figures 1–18 are from the *Trachyceras* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone at the south end of Brock Mountain, on the divide between Squaw Creek and Pit River Shasta County, Calif. Figures 1–9, collection of J. P. Smith; Figures 10–18, collection of U. S. Geological Survey. The originals of Figures 19, 20 are from the *Juvavites* subzone of the same zone of the Hosselkus limestone at Bear Cove, north end of Brock Mountain; collection of U. S. Geological Survey.

PLATE XV

FIGURES 1–8. *Juvavites* (*Anatomites*) *obsoletus* Smith, n. sp. (p. 58).

1, 2. Type.

3–5. Younger specimen.

6–8. Adolescent stage.

FIGURES 9–15. *Juvavites* (*Anatomites*) *mendenhalli* Smith, n. sp. (p. 57).

9, 10. Type.

11–13. Early mature stage.

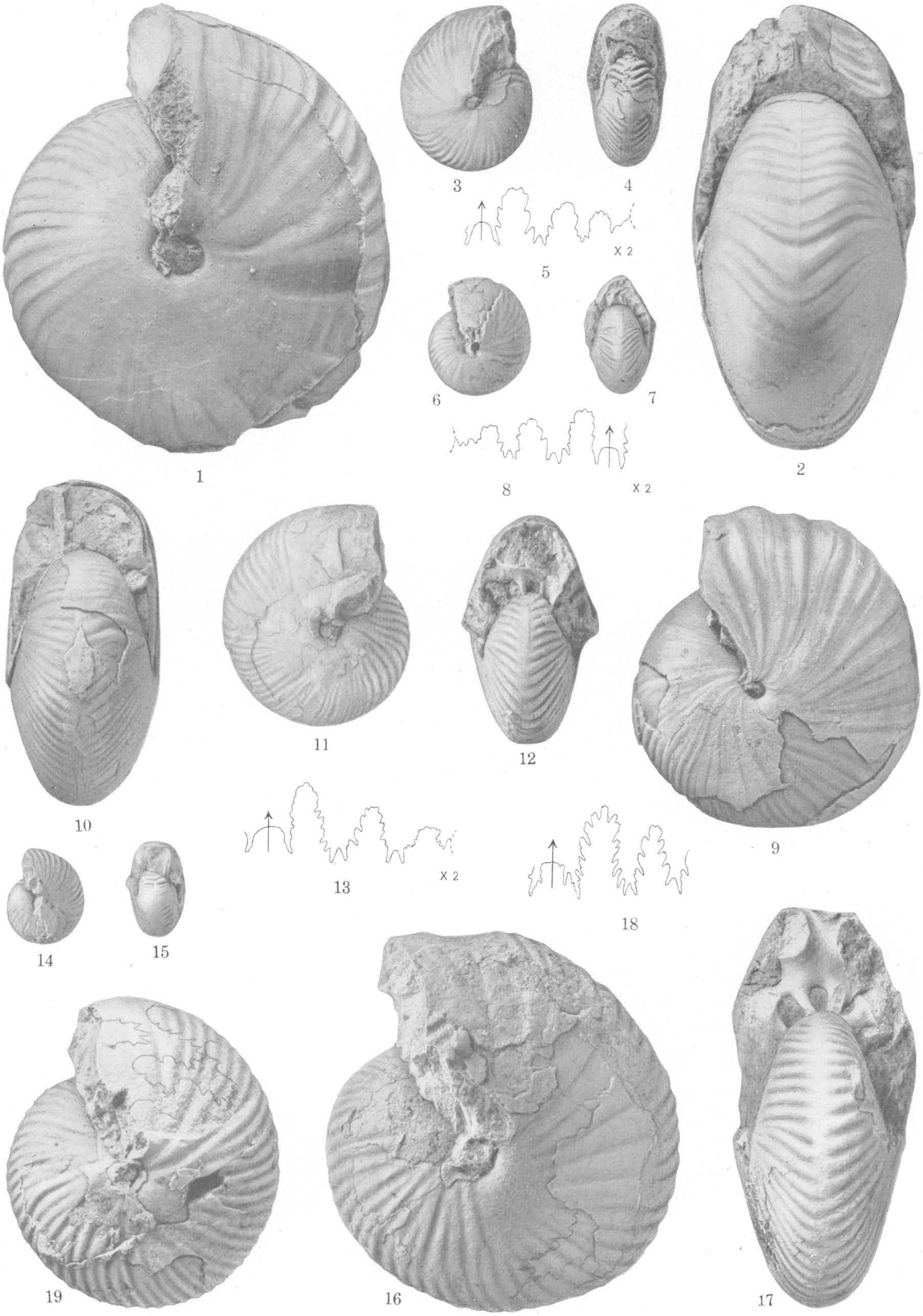
14, 15. Adolescent stage.

FIGURES 16–19. *Juvavites knowltoni* Smith, n. sp. (p. 55).

16–18. Type.

19. Early mature stage.

All specimens figured on this plate came from the *Juvavites* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone of Bear Cove, Brock Mountain, Shasta County, Calif. Collection of U. S. Geological Survey.



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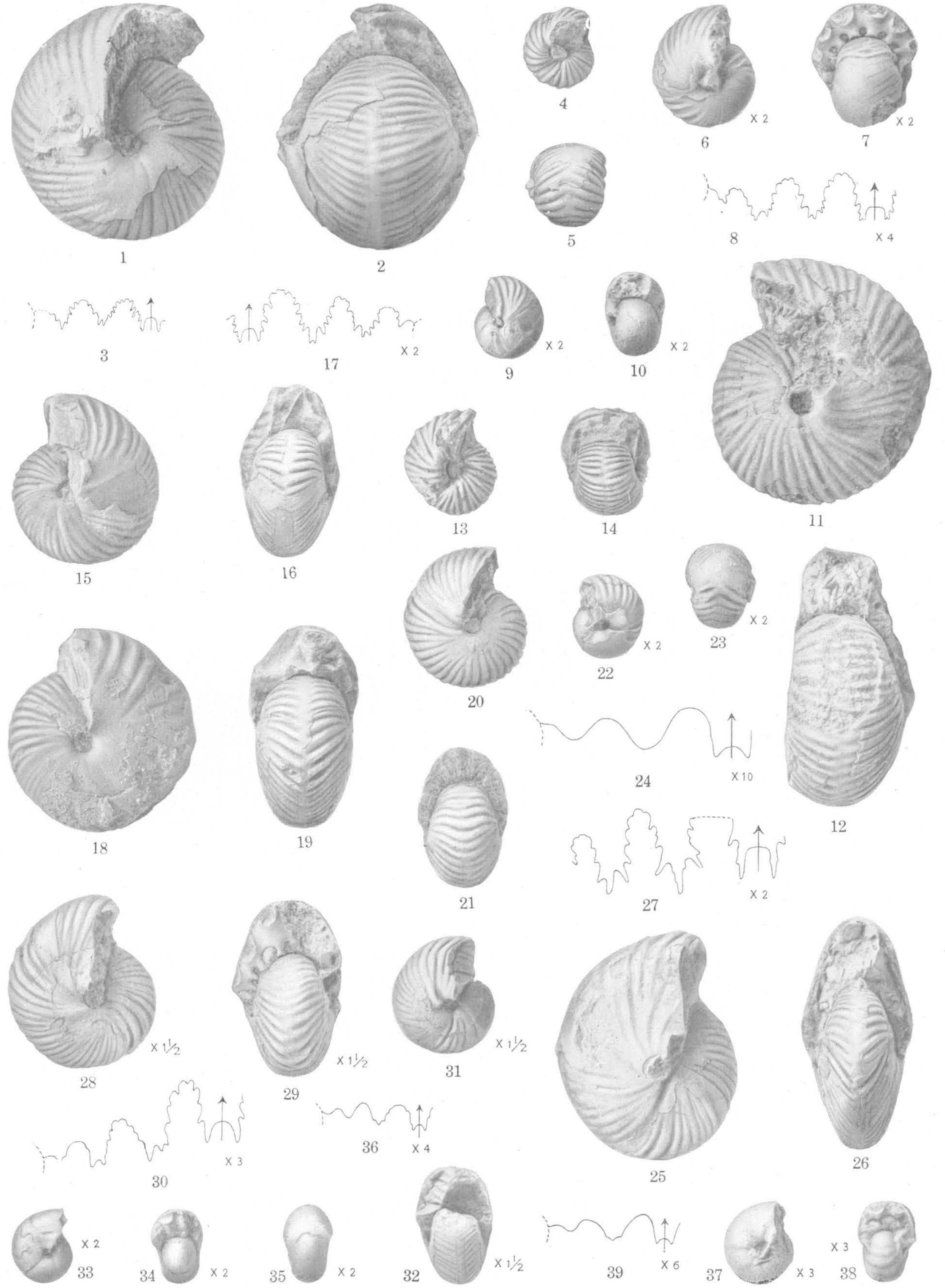

UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XVI

FIGURES 1–10. *Juvavites* (*Anatomites*) *strongi* Smith, n. sp. (p. 58).

1–3. Type.

4, 5. Adolescent specimen.

6–8. Adolescent stage; diameter 11 millimeters.

9, 10. Adolescent stage; diameter 7.5 millimeters.

FIGURES 11–14. *Juvavites* (*Anatomites*) *edgari* Mojsisovics (p. 56).

11, 12. Typical specimen.

13, 14. Adolescent stage.

FIGURES 15–24. *Juvavites* (*Anatomites*) *brockensis* Smith, n. sp. (p. 56).

15–17. Type.

18, 19. Mature specimen.

20, 21. Early mature stage.

22, 23. Adolescent stage.

24. Septa 10 of specimen; diameter 5 millimeters; larval stage.

FIGURES 25–39. *Juvavites* (*Anatomites*) *subintermittens* Hyatt and Smith (pp. 58–59).

25–27. Mature specimen.

28–30. Shell and septa.

31, 32. Adolescent stage.

33–36. Transition from goniatite to ammonite stage; diameter 6.5 millimeters.

37–39. Larval stage, like *Gastrioceras;* diameter 5 millimeters.

All specimens figured on this plate came from the *Juvavites* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone at the north end of Brock Mountain, Shasta County, Calif. Collection of U. S. Geological Survey.

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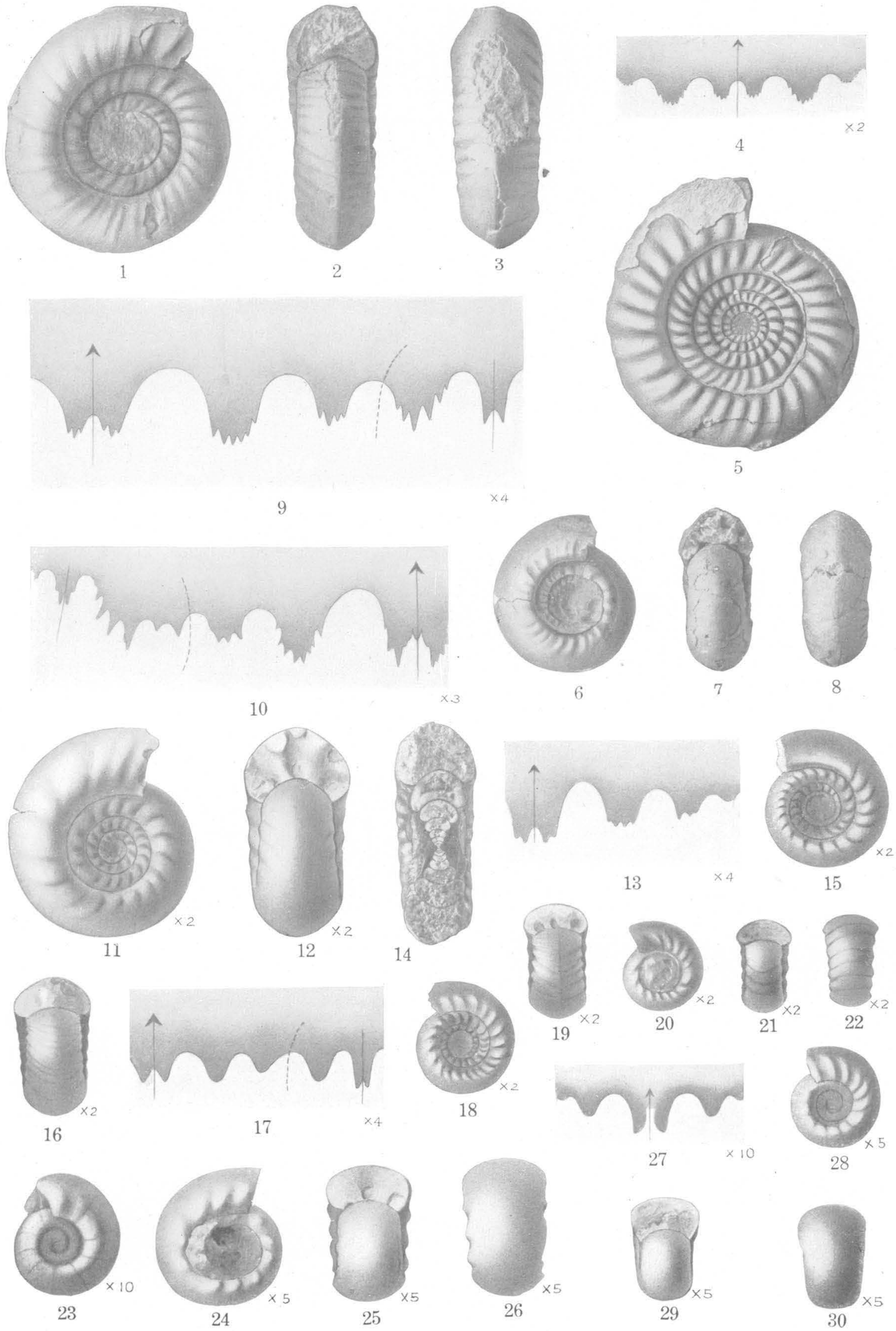
PLATE XVII

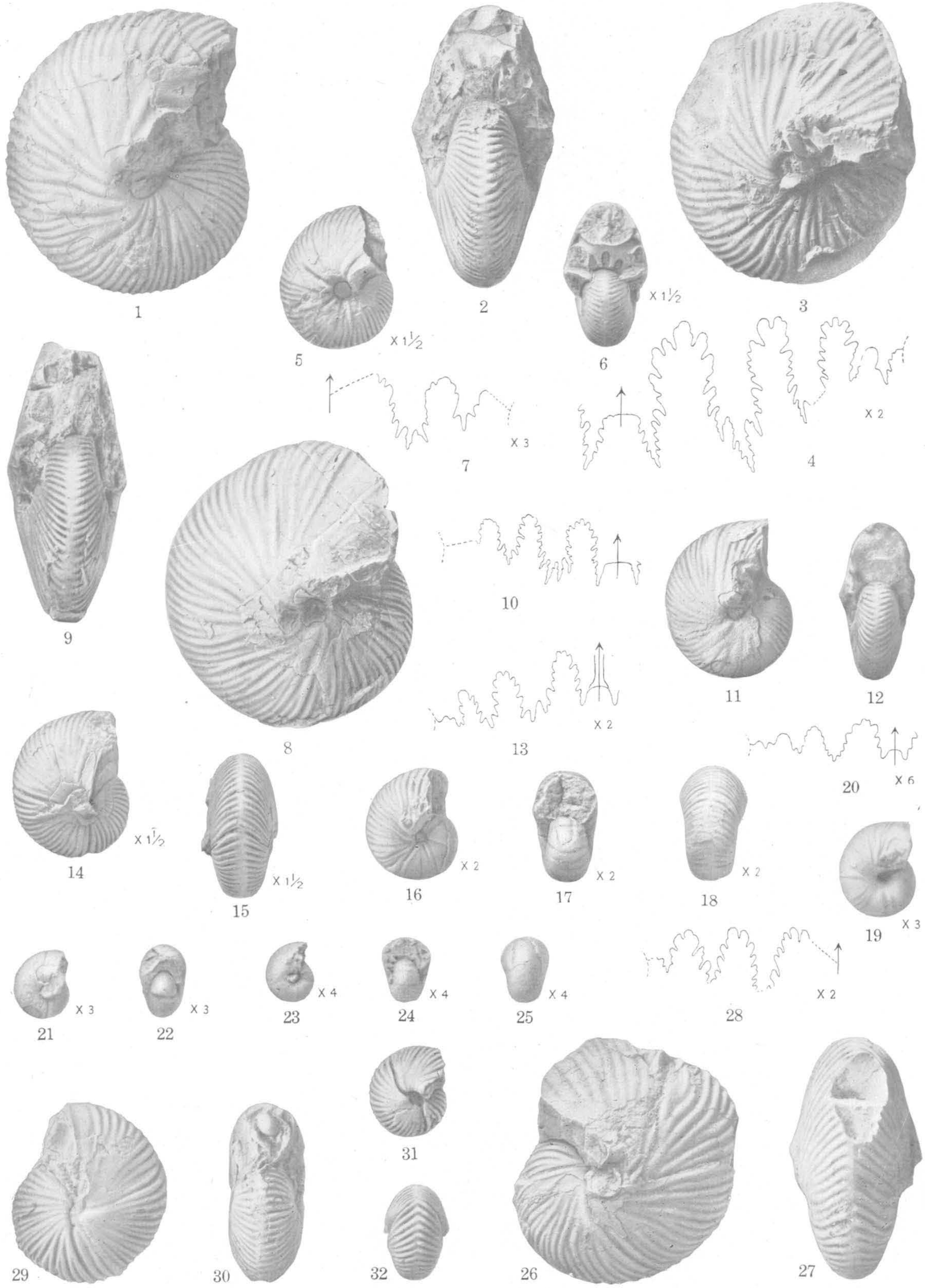
FIGURES 1–30. *Tropigastrites trojanus* Smith. Middle Triassic *Daonella* zone, Fossil Hill, south fork of American Canyon; West Humboldt Range, Nev.

1–3. Side, front, and rear of the type.
4. Septa of the type.
5. Side view of another specimen, to show the sculpture.
6–8. Side, front, and rear of a specimen in the early adult stage; diameter 27.5 millimeters.
9. Septa of the above specimen, at diameter 24 millimeters.
10. Septa of the same specimen, at diameter 31 millimeters.
11, 12. Side and front views, late adolescent stage; diameter 19 millimeters.
13. Septa of the above specimen.
14. Cross section, early adult stage.
15, 16. Adolescent stage; diameter 12 millimeters.
17. Septa of the above specimen; diameter 10 millimeters.
18, 19. Inner coil of the above specimen, adolescent stage; diameter 10 millimeters, side and front.
20–22. Side, front, and rear, early adolescent stage; diameter 8 millimeters.
23. Side view, larval stage; diameter 2 millimeters.
24–26. End of larval stage, corresponding to *Gastrioceras;* diameter 4.5 millimeters.
27. Septa of the same.
28–30. Larval stage; diameter 3.5 millimeters.

All specimens figured on this plate were collected by J. P. Smith. Collection of U. S. Geological Survey. These figures are introduced here for comparison with young stages of Upper Triassic ammonites.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XVIII

FIGURES 1–7. *Juvavites subinterruptus* Mojsisovics (p. 55).
1, 2. Typical specimen.
3, 4. Another specimen.
5–7. Adolescent stage.
FIGURES 8–25. *Juvavites kellyi* Smith, n. sp. (p. 55).
8–10. Type.
11–13. Smaller specimen.
14, 15. Adolescent stage.
16–18. Adolescent stage; diameter 9 millimeters.
19, 20. Larval stage; diameter 5 millimeters.
21, 22. Larval stage; diameter 4 millimeters.
23–25. Larval stage; diameter 3 millimeters; corresponding to group of *Gastrioceras globulosum*.
FIGURES 26–32. *Juvavites* (*Anatomites*) *adalberti* Mojsisovics (p. 56).
26–28. Mature specimen.
29, 30. Early mature stage.
31, 32. Late adolescent stage.

All specimens figured on this plate came from the *Juvavites* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif. Collection of U. S. Geological Survey.

PLATE XIX

FIGURES 1–5. *Juvavites* (*Anatomites*) *externiplicatus* Mojsisovics (p. 57).
1–3. Adult stage; shell natural size, septa ×2.
4, 5. Adolescent stage.

FIGURES 6–13. *Juvavites* (*Anatomites*) *intermittens* Mojsisovics (p. 57).
6, 7. Mature stage.
8–10. Early mature stage.
11–13. Adolescent stage.

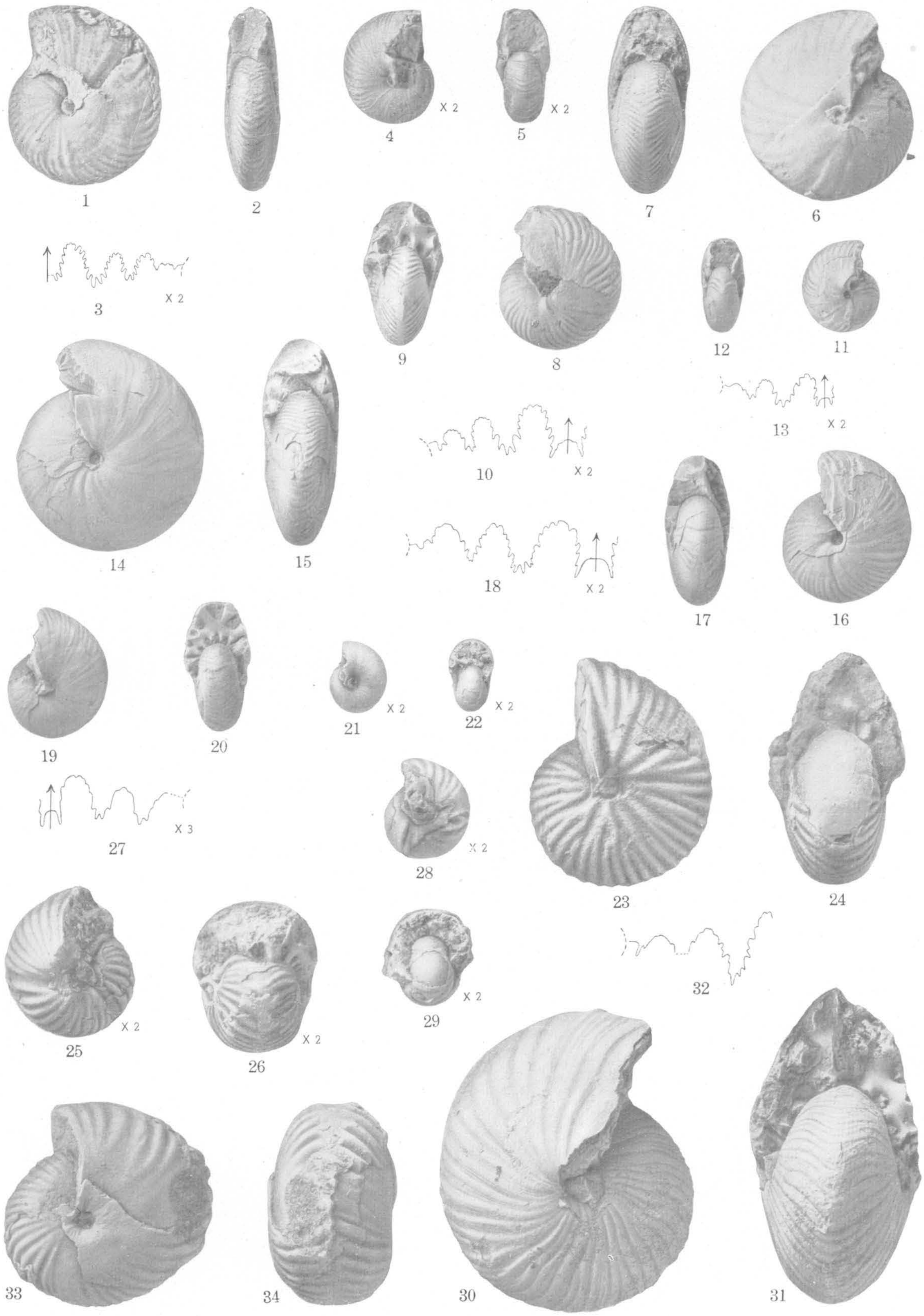
FIGURES 14–22. *Juvavites* (*Anatomites*) *konninckii* Mojsisovics (p. 57).
14, 15. Mature specimen.
16, 17. Younger stage.
18. Septa of another specimen.
19, 20. Adolescent stage.
21, 22. Late larval stage.

FIGURES 23–29. *Juvavites* (*Anatomites*) *damesi* Mojsisovics (p. 56).
23, 24. Mature stage.
25–27. Early mature stage.
28, 29. Adolescent stage.

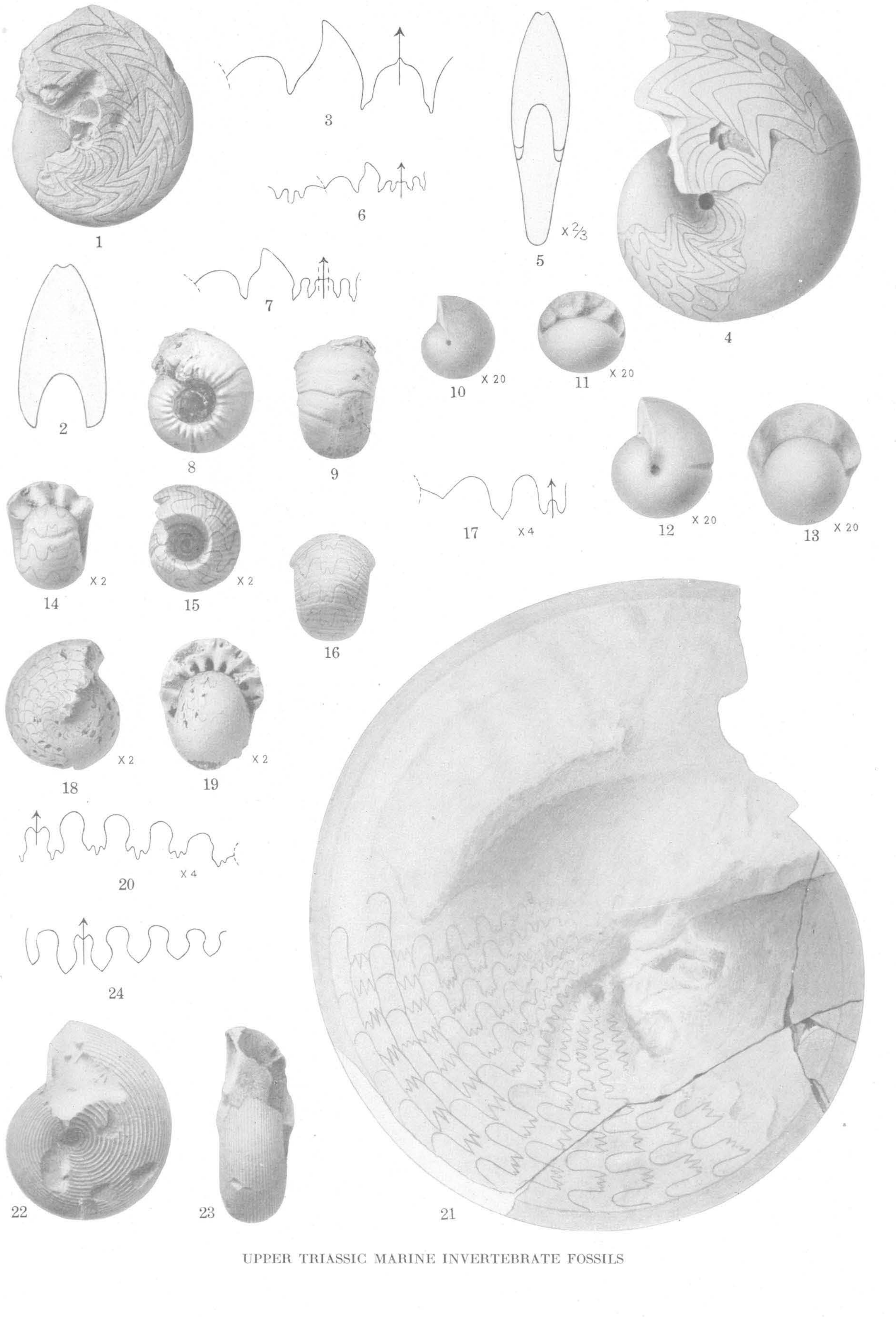
FIGURES 30–32. *Juvavites* (*Anatomites*) *shastensis* Smith, n. sp. (p. 58). Type specimen.

FIGURES 33, 34. *Juvavites* (*Anatomites*) *septentrionalis* Smith, n. sp. (p. 58). Type.

All specimens figured on this plate came from the *Juvavites* subzone of the Upper Triassic zone of *Tropites subbullatus*. Collection of U. S. Geological Survey. Figures 1–13 from the Hosselkus limestone, North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.; Figures 14–29 from Hosselkus limestone at Bear Cove, Brock Mountain, Shasta County, Calif.; Figures 30–32 from Hosselkus limestone on west side of Brock Mountain 1 mile north of the quarry; Figures 33, 34 from Nikolai Creek, Nizina district, Alaska, locality No. 6312, U. S. Geol. Survey.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XX

FIGURES 1–3. *Gonioloboceras welleri* Smith. Type, refigured. Cisco group (Pennsylvanian), Graham, Tex.
FIGURES 4–7. *Texites texanus* Smith. Type, refigured. Cisco group (Pennsylvanian), Graham, Tex.
FIGURES 8–13. *Gastrioceras listeri* Martin. Typical specimen, Middle Coal Measures, Manchester, England. Larval stages.
FIGURES 14–17. *Gastrioceras welleri* Smith. Typical specimen, from the "Upper Coal Measures" (Pennsylvanian) at Howard, Kans.
FIGURES 18–20. *Stacheoceras ganti* Smith. "Upper Coal measures" (Pennsylvanian) at Howard, Kans.
FIGURE 21. *Prodromites gorbyi* Miller. Typical specimen. Chouteau limestone (Mississippian), Pettis County, Mo.
FIGURES 22–24. *Agathiceras ciscoense* Smith. Type, refigured. Cisco group (Pennsylvanian), Graham, Young County, Tex.

Figures 1–7 and 21–24 are from U. S. Geol. Survey Mon. 42, the Carboniferous ammonoids of America. These figures are introduced here for comparison with young stages of Upper Triassic ammonites.

PLATE XXI

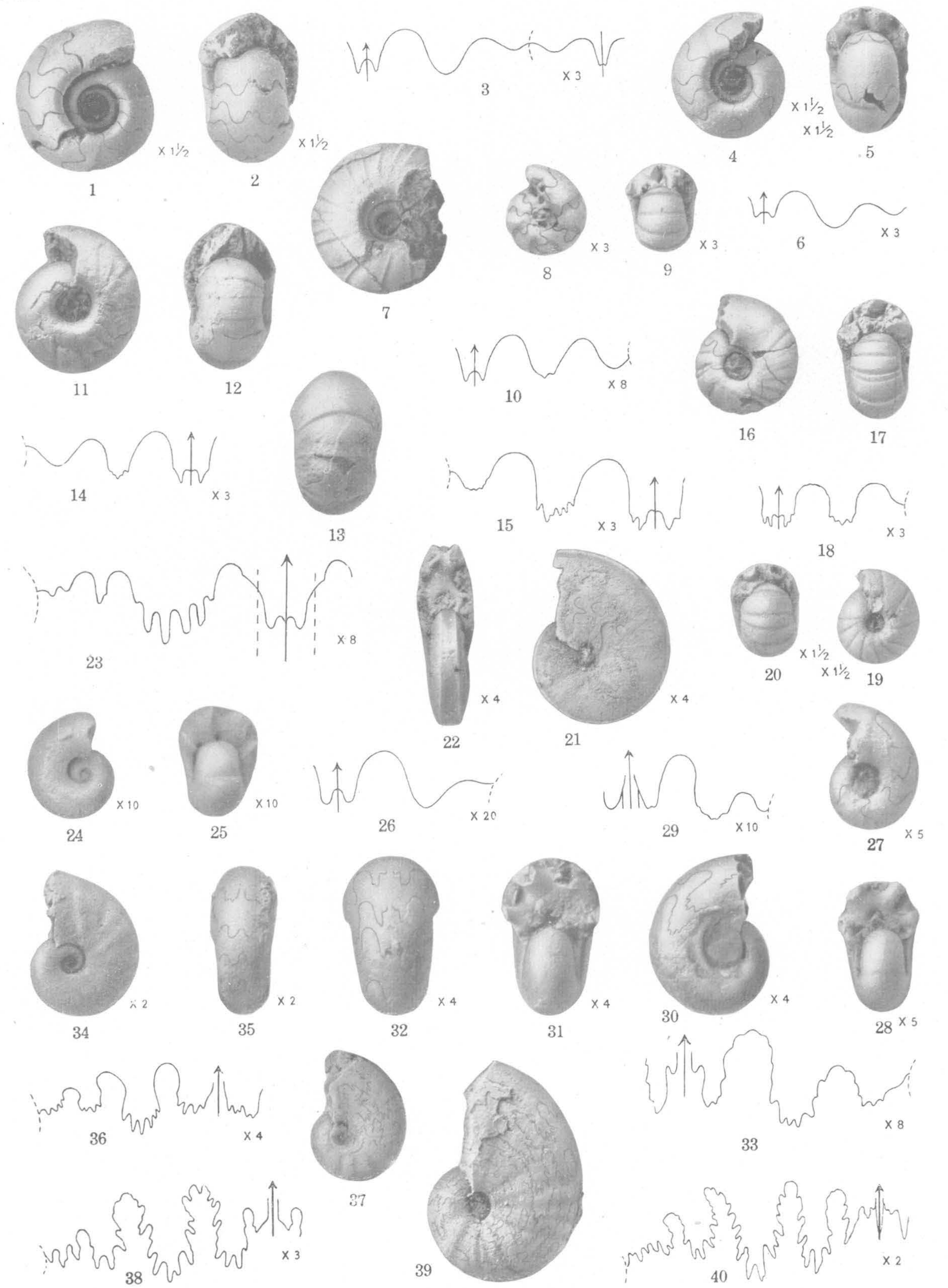
FIGURES 1–10. *Juvenites kraffti* Smith, n. sp. (pp. 23–24).
- 1–3. Type.
- 4–6. Same specimen, with one-half of the whorl removed.
- 7. Old-age form, showing sculpture and septa.
- 8–10. Adolescent stage; diameter 5 millimeters.

FIGURES 11–20. *Thermalites thermarum* Smith, n. sp. (p. 24).
- 11–14. Type.
- 15. Septa of another specimen.
- 16–18. Adult specimen, showing typical sculpture.
- 19, 20. Early mature stage; diameter 10 millimeters.

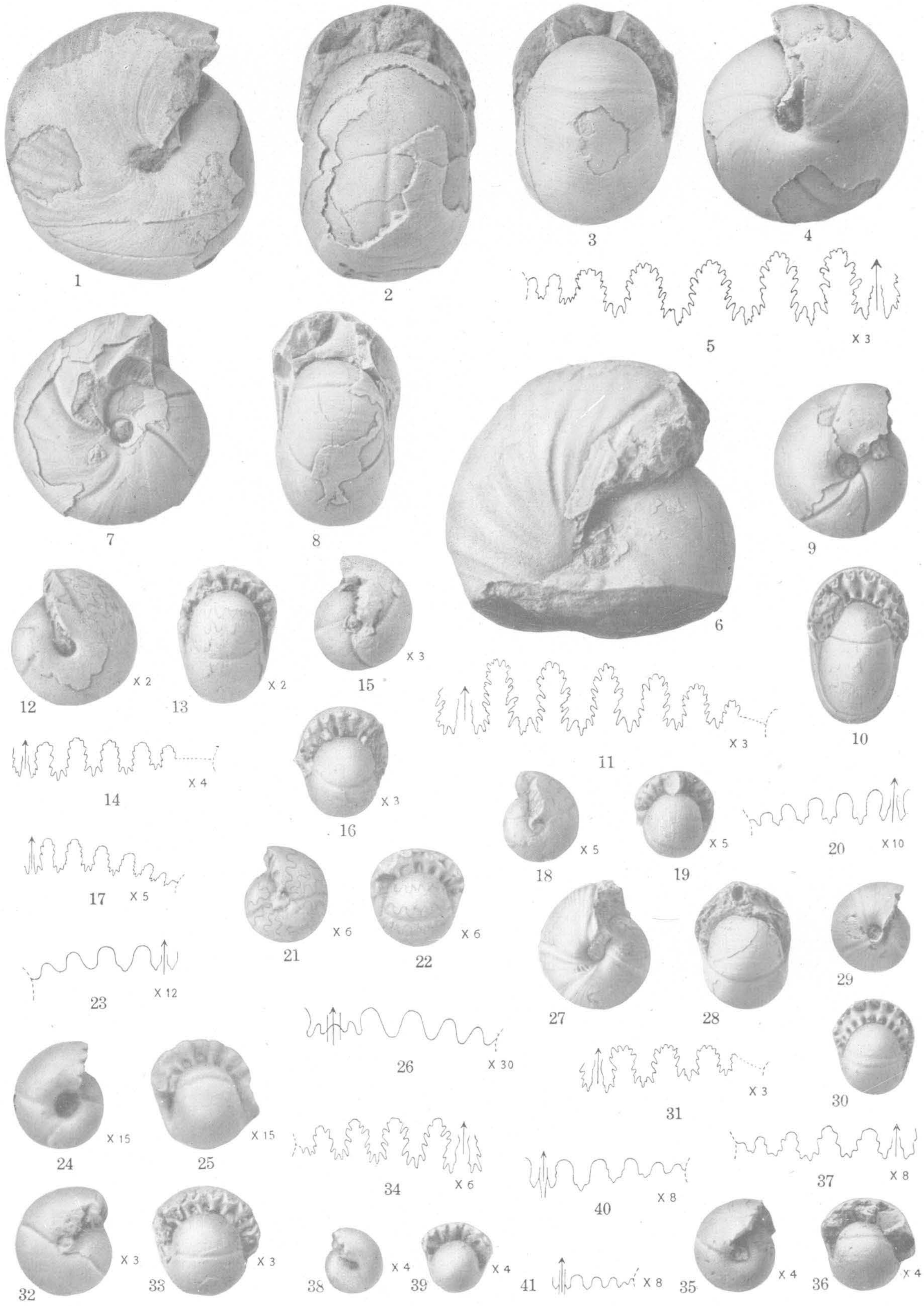
FIGURES 21–23. *Lanceolites compactus* Hyatt and Smith. Adolescent stage; diameter 8 millimeters.

FIGURES 24–40. *Ussuria waageni* Hyatt and Smith.
- 24–26. Larval stage, corresponding to *Manticoceras* to *Dimorphoceras* to *Thalassoceras;* diameter 1.8 millimeters.
- 27–29. Larval stage, transitional from *Manticoceras* to *Dimorphoceras;* diameter 4.4 millimeters.
- 30–33. Early adolescent stage, transitional from *Dimorphoceras* to *Thalassoceras;* diameter 6.5 millimeters.
- 34–36. Adolescent stage, diameter 12 millimeters; resembling *Thalassoceras.*
- 37, 38. Early mature stage, showing beginning of adventitious lobes.
- 39, 40. Early mature stage, showing adventitious lobes.

All specimens figured on this plate came from the Lower Triassic *Meekoceras* zone of southeastern Idaho. Collection of U. S. Geological Survey. These figures are introduced here for comparison with young stages of Upper Triassic ammonites.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XXII

FIGURES 1–6. *Arcestes* (*Proarcestes*) *whitneyi* Smith, n. sp. (p. 69).

1, 2. Type.

3, 4. Showing outer shell nearly perfect.

5. Septa, from another specimen of equal size.

6. Old-age form, showing the aperture.

FIGURES 7–26. *Arcestes* (*Proarcestes*) *shastensis* Smith, n. sp. (p. 69).

7, 8. Type.

9–11. Cotype.

12–14. Adolescent stage.

15–17. Adolescent stage, diameter 6.5 millimeters; resembling *Megaphyllites*.

18–20. Adolescent stage, diameter 3 millimeters; transitional from *Stacheoceras* to *Popanoceras*.

21–23. Late larval stage, diameter 2.25 millimeters; *Stacheoceras* stage.

24–26. Larval stage, diameter 1.3 millimeters; transitional from *Gastrioceras* to *Adrianites* stage.

FIGURES 27–41. *Arcestes* (*Proarcestes*) *traski* Smith, n. sp. (p. 69).

27–28. Type.

29, 30. Early mature stage.

31. Septa of another specimen.

32–34. Adolescent stage; diameter 6.5 millimeters.

35–37. Larval stage, diameter 4 millimeters; corresponding to *Popanoceras*.

38–41. Larval stage, transitional from *Adrianites* to *Stacheoceras;* diameter 3 millimeters.

Figures 1–26 are from the upper or *Juvavites* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.; collection of U. S. Geological Survey. Figures 27–41 are from the lower or *Trachyceras* subzone of the zone of *Tropites subbullatus* in the Hosselkus limestone at the old stone quarry on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch, Shasta County, Calif.; collection of J. P. Smith.

PLATE XXIII

FIGURES 1–11. *Arcestes* (*Proarcestes*) *carpenteri* Smith, n. sp. (p. 68).

1, 2. Type.

3–5. Smaller specimen.

6, 7. Adolescent specimen; diameter 8.5 millimeters.

8–11. Diameter 3.3 millimeters; septa in Figure 10 from larger part of shell at diameter 3 millimeters; septa in Figure 11 from the younger part of the shell, diameter 1.5 millimeters, showing transition from *Adrianites* to *Stacheoceras* to *Waagenoceras*-like lobes.

FIGURES 12–23. *Arcestes* (*Proarcestes*) *pacificus* Hyatt and Smith (pp. 68–69).

12, 13. Mature specimen with shell.

14–16. Mature specimen with shell removed.

17–19. Adolescent stage; diameter 10 millimeters.

20–23. Larval stage; diameter 3 millimeters.

Figure 22, septa at diameter 3 millimeters; Figure 23, septa at diameter 2 millimeters, showing *Adrianites* stage and transition from *Stacheoceras* to *Popanoceras* or *Waagenoceras*-like septa.

FIGURES 24–33. *Arcestes* (*Proarcestes*) *winnemae* Smith, n. sp. (pp. 69–70).

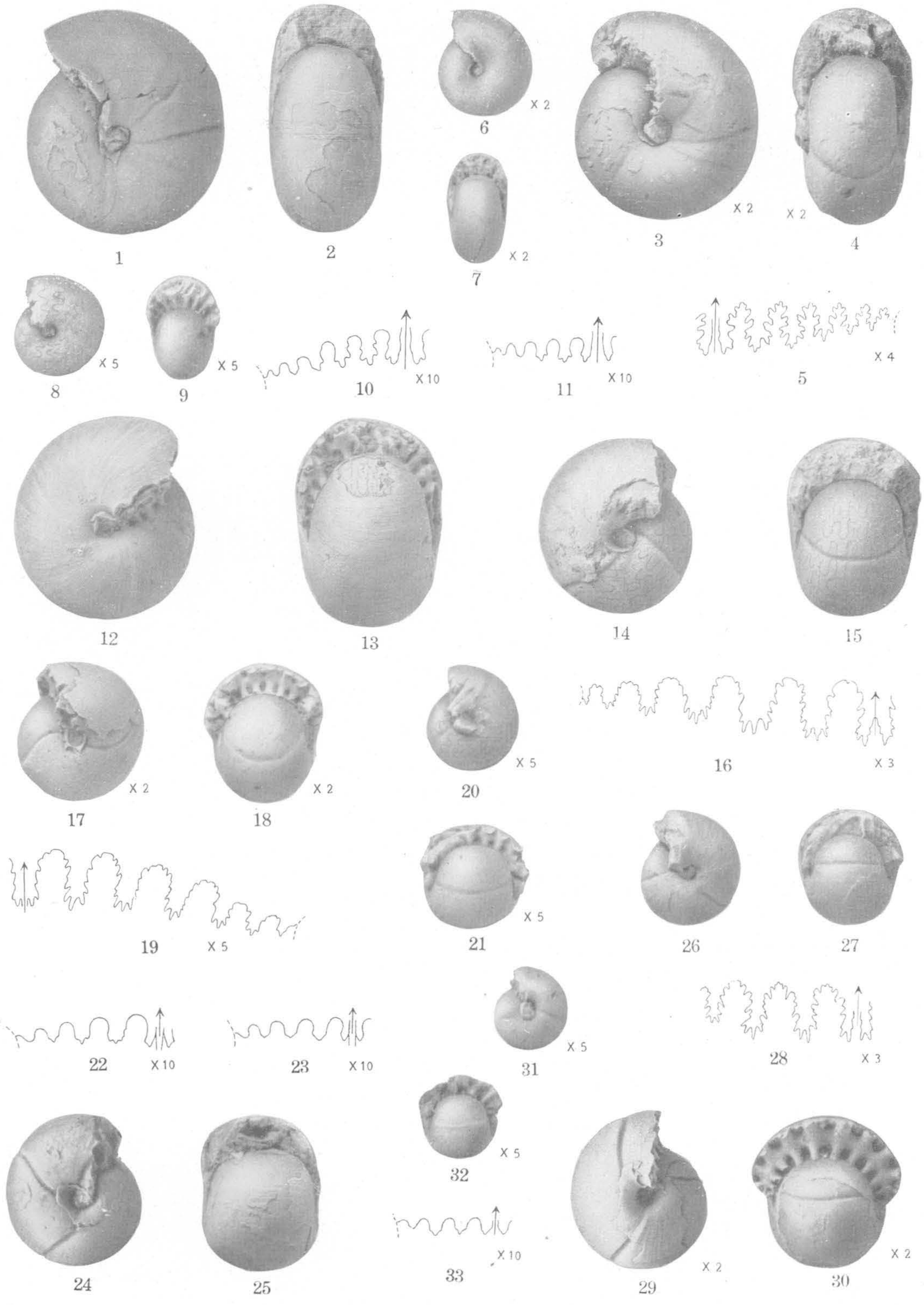
24, 25. Type.

26–28. Cotype.

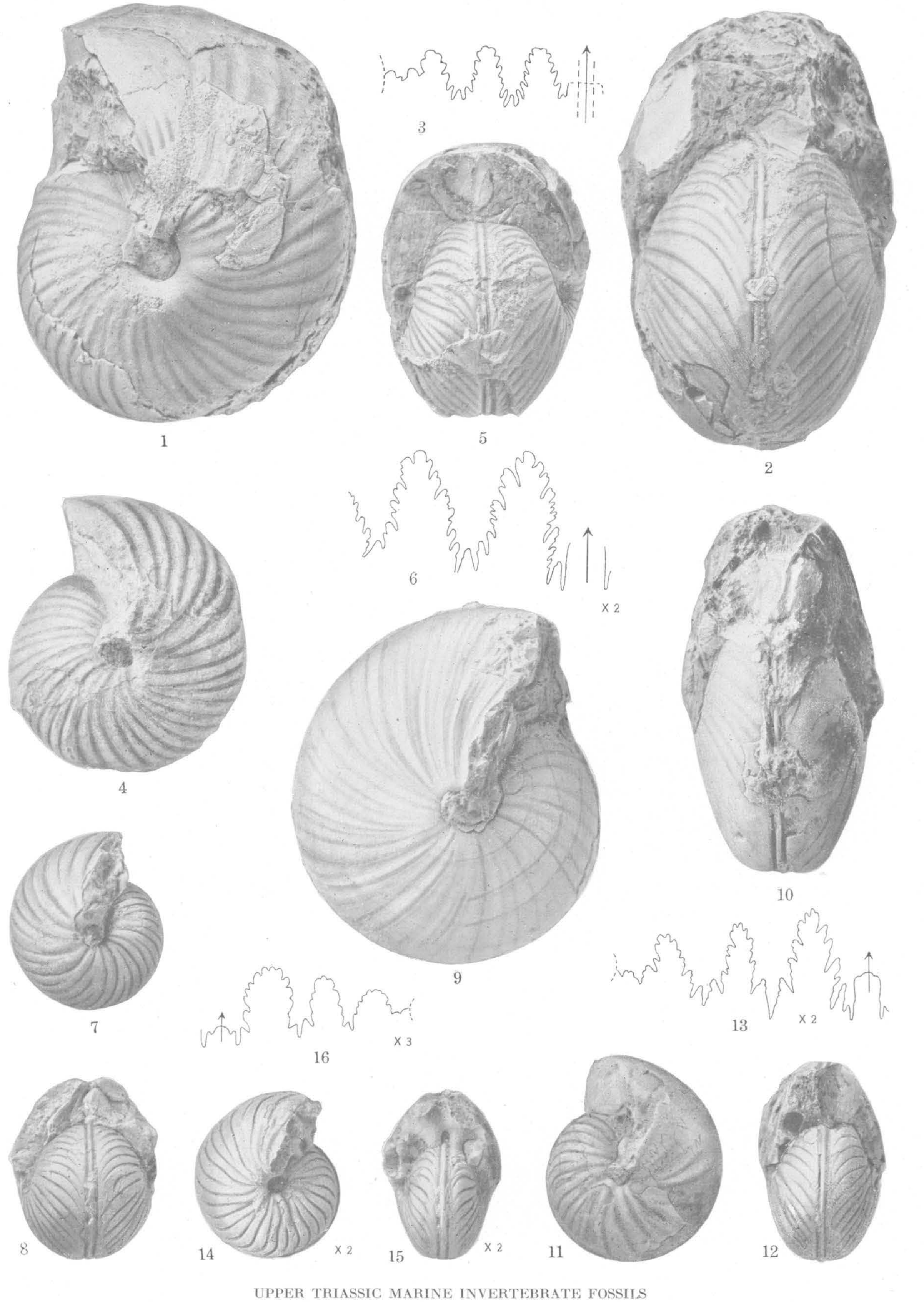
29, 30. Early mature stage; diameter 13 millimeters.

31–33. Larval stage; diameter 2.5 millimeters.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, zone of *Tropites subbullatus*, of Shasta County, Calif. Figures 1–23 from the *Juvavites* subzone on the North Fork of Squaw Creek; collection of U. S. Geological Survey. Figures 24–33 from the *Trachyceras* subzone at south end of Brock Mountain; collection of J. P. Smith.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XXIV

FIGURES 1–8. *Paratropites antiselli* Smith, n. sp. (p. 43).

1–3. Type.

4–6. Cotype, shell natural size.

7, 8. Early mature stage.

FIGURES 9–13. *Paratropites gabbi* Smith, n. sp. (p. 44).

9, 10. Type.

11–13. Early mature stage, showing septa.

FIGURES 14–16. *Paratropites sellai* Mojsisovics (p. 45). Early mature stage.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, *Trachyceras* subzone of the zone of *Tropites subbullatus* of Brock Mountain, Shasta County, Calif. Figures 1–13 from the old quarry at the south end of Brock Mountain, on the divide between Squaw Creek and Pit River; collection of J. P. Smith. Figures 14–16 from the divide, 1 mile north of the quarry; collection of U. S. Geological Survey.

PLATE XXV

FIGURES 1, 2. *Paratropites dittmari* Mojsisovics (p. 44). Refigured (originally in California Acad. Sci. Proc., 3d ser., Geology, vol. 1, pl. 47, fig. 1, 1904).

FIGURES 3–9. *Paratropites arnoldi* Smith, n. sp. (p. 44).

3–6. Type.

7–9. Early mature stage.

FIGURES 10–13. *Paratropites gracilis* Smith, n. sp. (pp. 44–45). Type.

FIGURES 14, 15. *Paratropites (Gymnotropites) rotundus* Smith, n. sp. (p. 47). Type.

FIGURES 16–20. *Paratropites (Gymnotropites) laevis* Smith, n. sp. (p. 46).

16–18. Type.

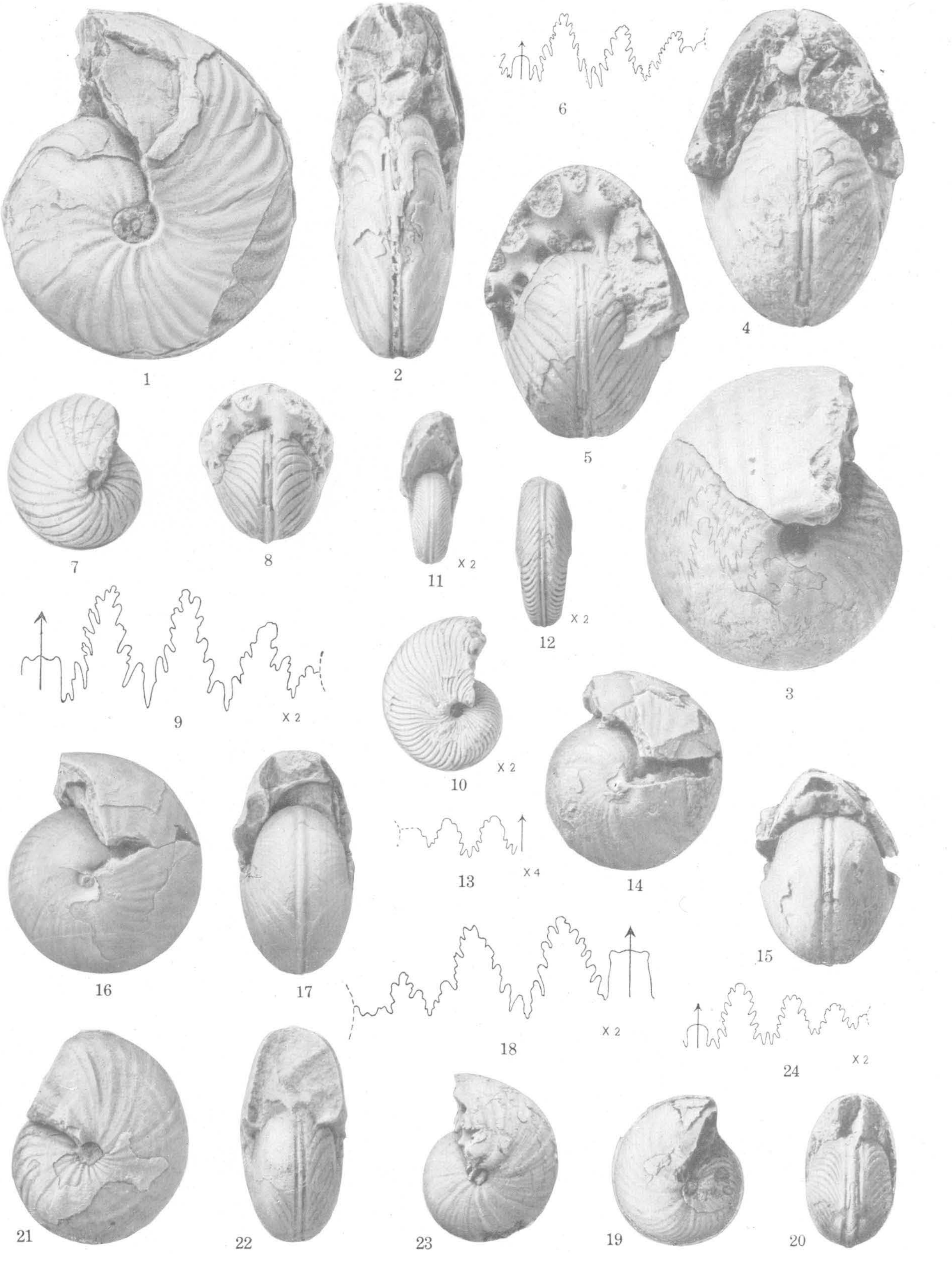
19, 20. Early mature stage, showing vestigial sculpture.

FIGURES 21–24. *Paratropites (Gymnotropites) yatesi* Smith, n. sp. (p. 47).

21, 22. Type.

23, 24. Shell and septa.

All specimens figured on this plate came from the *Trachyceras* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone of Brock Mountain, on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch, Shasta County, Calif. Figures 1–15, 21–24, collection of J. P. Smith; Figures 16–20, collection of U. S. Geological Survey.



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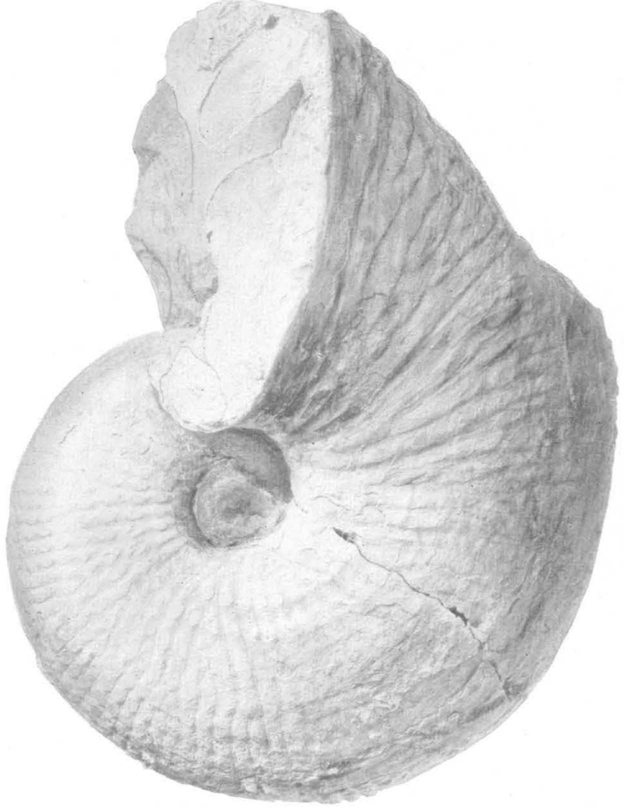

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UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XXVI

FIGURES 1, 2. *Sagenites herbichi* Mojsisovics (p. 60). Side and front views of a large specimen, showing the decrease of the spines and increase of the radial ribs in old age. From Upper Triassic Hosselkus limestone, in the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of U. S. National Museum.

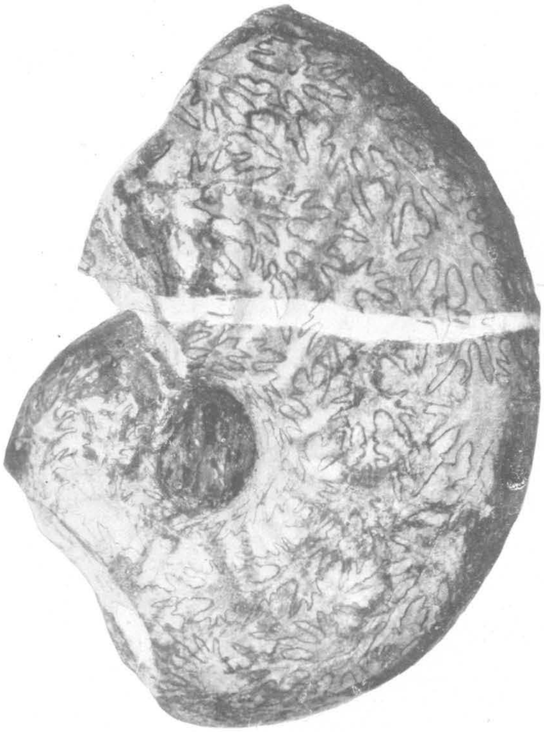
PLATE XXVII

FIGURES 1–4. *Sagenites herbichi* Mojsisovics (p. 60).

1, 2. Side view and septa of a specimen with the shell removed to show the smooth cast.

3, 4. Side and front views, showing the shell at maturity.

From Upper Triassic Hosselkus limestone, in the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



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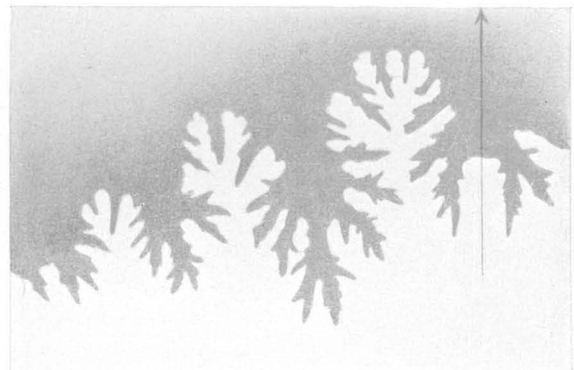

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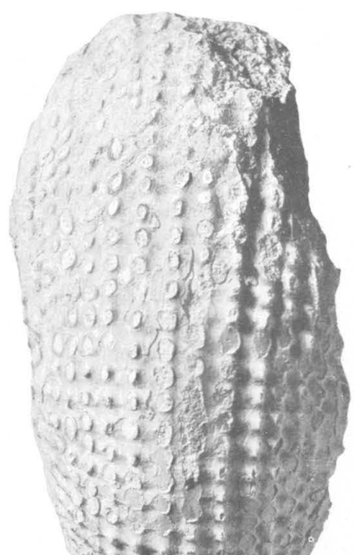

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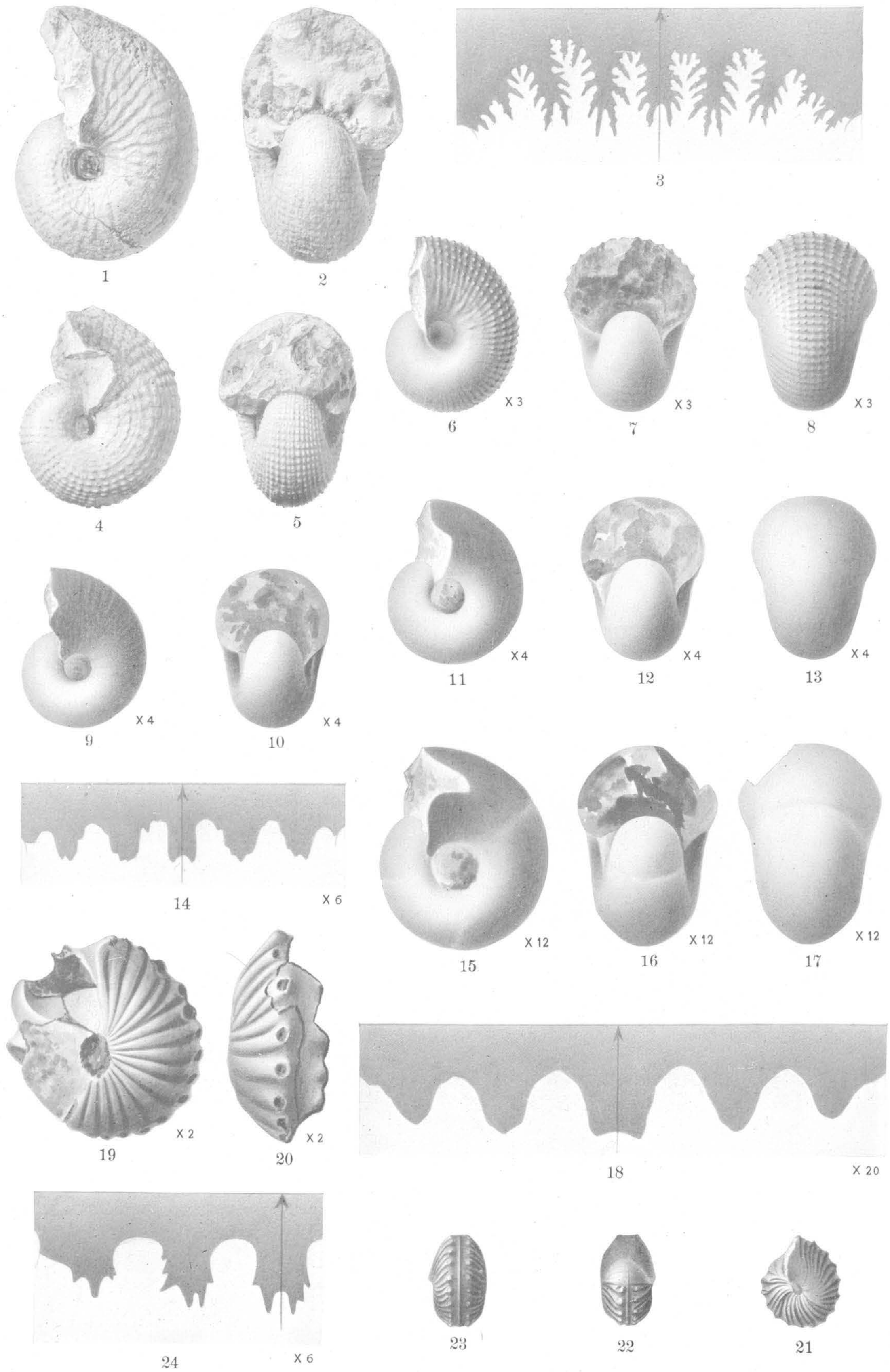
UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XXVIII

FIGURES 1–18. *Sagenites herbichi* Mojsisovics (p. 60).

1–3. Side and front views and septa of an immature specimen; diameter 45 millimeters.

4, 5. Side and front views of an immature specimen, showing the shell at this stage; diameter 34 millimeters.

6–8. Side, front, and rear views of an adolescent specimen, showing the beginning of the sculpture; diameter 9.5 millimeters.

9, 10. Side and front views of a smaller adolescent specimen; diameter 6.5 millimeters.

11–14. Side, front, and rear views and septa, showing the transition from goniatite to ammonite; diameter 4.8 millimeters.

15–18. Side, front, and rear views and septa, larval stage, corresponding to the goniatite ancestor of *Sagenites*; diameter 2.4 millimeters.

From Upper Triassic Hosselkus limestone, in the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

FIGURES 19–24. *Homerites semiglobosus* Hauer (p. 52).

19, 20. Side and rear views.

21–23. Side, front, and rear views.

24. Septa of same specimens.

From Upper Triassic Hosselkus limestone, in *Juvavites* subzone of *Tropites subbullatus* zone, California. Figures 19, 20 from divide between Squaw Creek and Pit River; Figures 21–24 from west bank of North Fork of Squaw Creek 3 miles north of Kelly's ranch, Shasta County, Calif. Collection of J. P. Smith.

PLATE XXIX

FIGURES 1, 2. *Halorites americanus* Hyatt (p. 52). Copied from Palaeontology of California, vol. 1, pl. 3, figs. 21, 21a. From Upper Triassic beds of Noric age, in the Swearinger slate (above the Hosselkus limestone), near Genesee, Plumas County, Calif.

FIGURES 3–21. *Leconteiceras californicum* Hyatt and Smith (p. 66).

3–6. Side, front, and rear views and septa of the type specimen.

7. Side view of another specimen, showing the constriction near the aperture.

8. Cross section.

9. Septa, drawn from a broken whorl.

10, 11. Views from side and above of specimens, showing contraction of body chamber at the aperture.

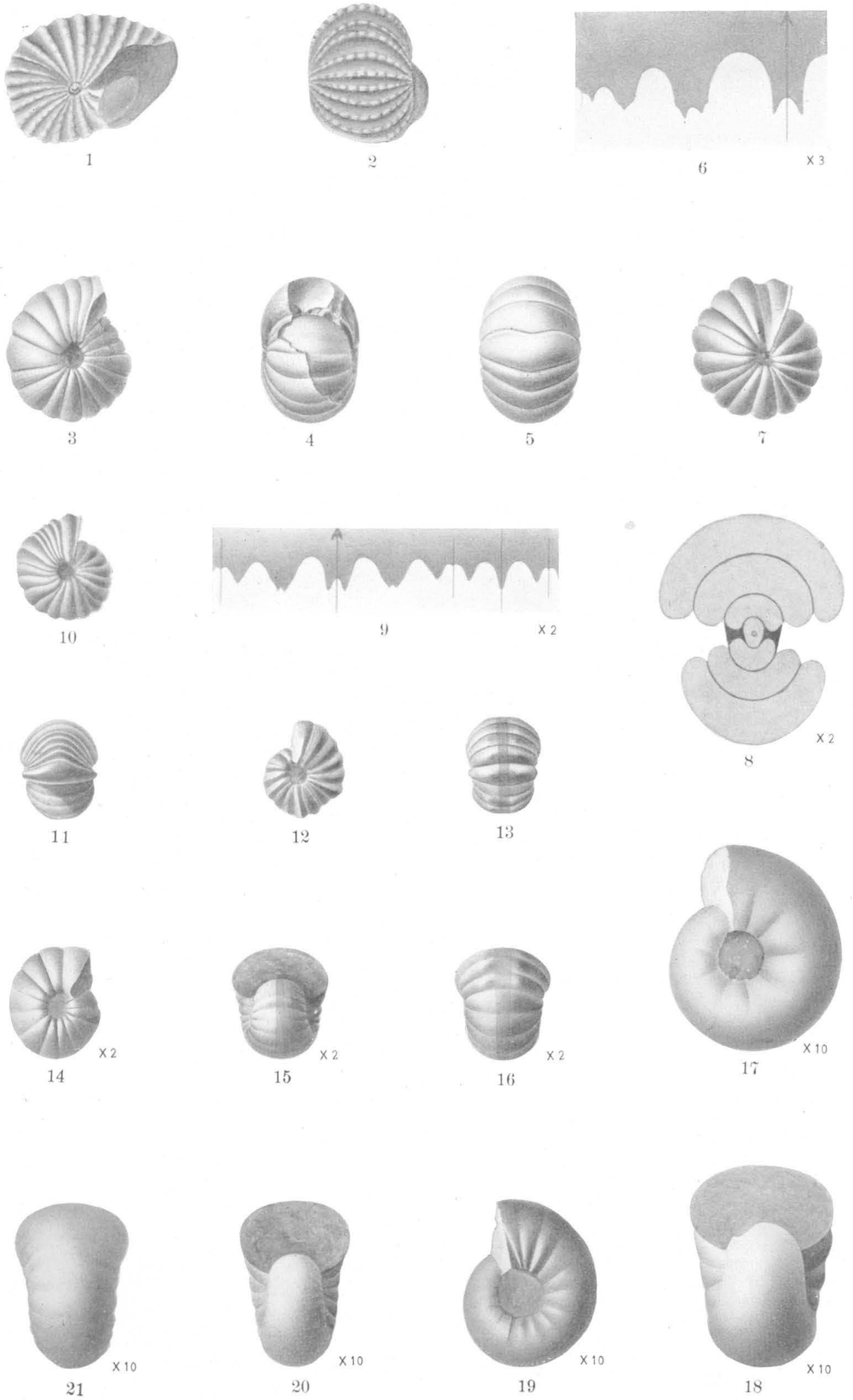
12, 13. Side and rear views of specimen with outer shell removed, showing the ventral rows of knots on the cast.

14–16. Side, front, and rear views of an adolescent specimen, showing the beginning of the knots on the ribs; diameter 9 millimeters.

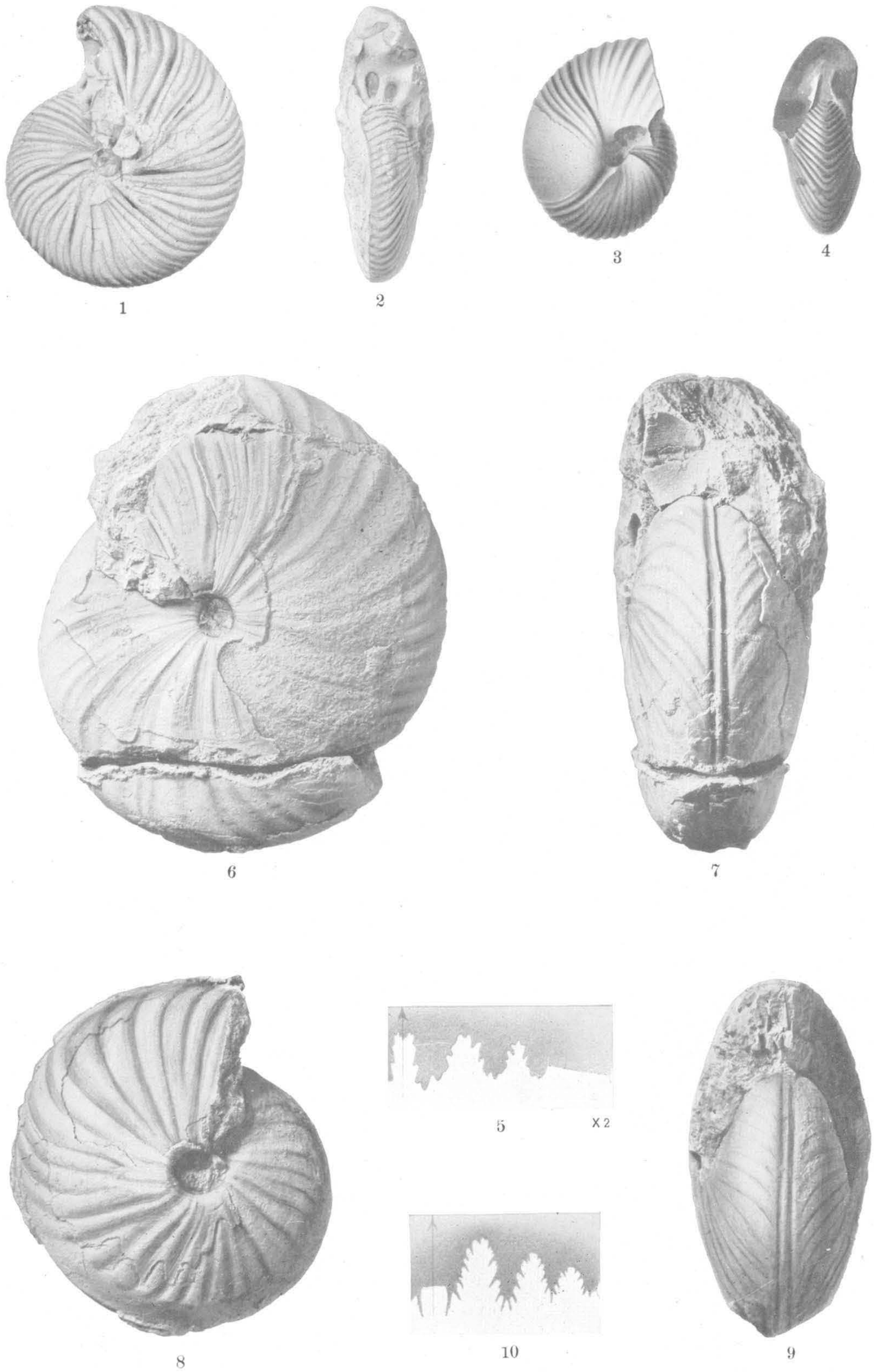
17, 18. Side and front views of larval specimen; diameter 2.9 millimeters.

19–21. Side, front, and rear views of larval specimen, to show the beginning of the umbilical ribs; diameter 2.5 millimeters.

From Upper Triassic Hosselkus limestone, *Trachyceras* subzone of the zone of *Tropites subbullatus*, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XXX

FIGURES 1, 2. *Juvavites subinterruptus* Mojsisovics (p. 55). Side and front views. From Upper Triassic Hosselkus limestone, in the *Tropites subbullatus* zone, *Juvavites* subzone, near Terrup Chetta, 6 miles north of Madison's ranch, on divide between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

FIGURES 3–5. *Juvavites Anatomites subintermittens* Hyatt and Smith (pp. 58–59). Side and front views and septa. From the same zone near Terrup Chetta, 6 miles north of Madison's ranch, on Squaw Creek, Shasta County, Calif. Collection of J. P. Smith.

FIGURES 6–10. *Paratropites sellai* Mojsisovics (p. 45). From the same zone 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

6, 7. Side and front views of an old specimen.

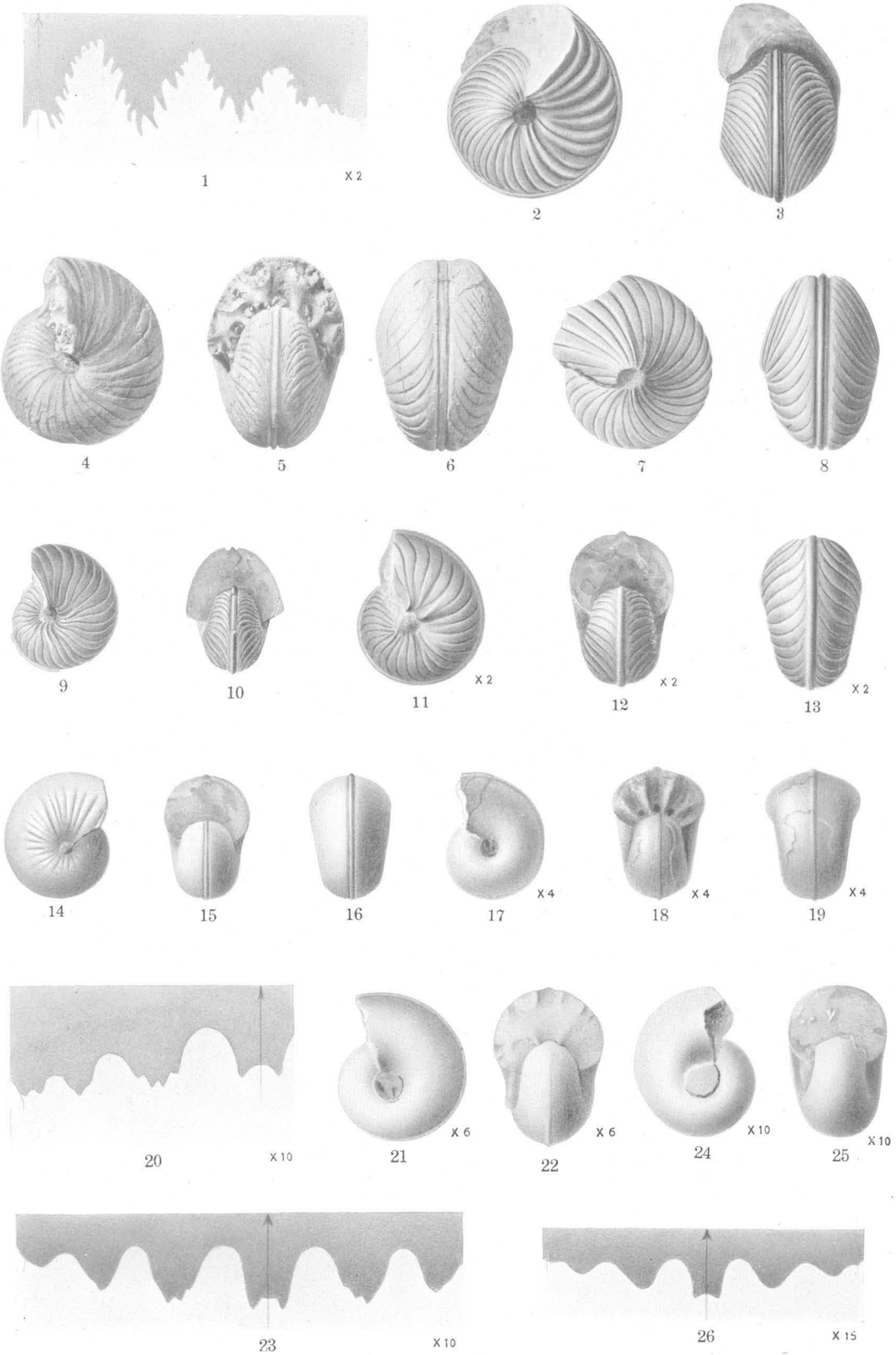
8–10. Side and front views and septa of a mature specimen.

PLATE XXXI

FIGURES 1–26. *Paratropites sellai* Mojsisovics (p. 45).

1. Septa of a mature specimen.
2, 3. Side and front views.
4–6. Side, front, and rear views.
7, 8. Side and rear views.
9, 10. Side and front views; diameter 21 millimeters.
11–13. Side, front, and rear views; diameter 12 millimeters.
14–16. Side, front, and rear views; diameter 7 millimeters.
17–20. Side, front, and rear views and septa; diameter, 4.93 millimeters.
21–23. Side and front views and septa; diameter 4 millimeters.
24–26. Side and front views and septa; diameter 2.3 millimeters.

From Upper Triassic Hosselkus limestone in the zone of *Tropites subbullatus, Trachyceras* subzone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



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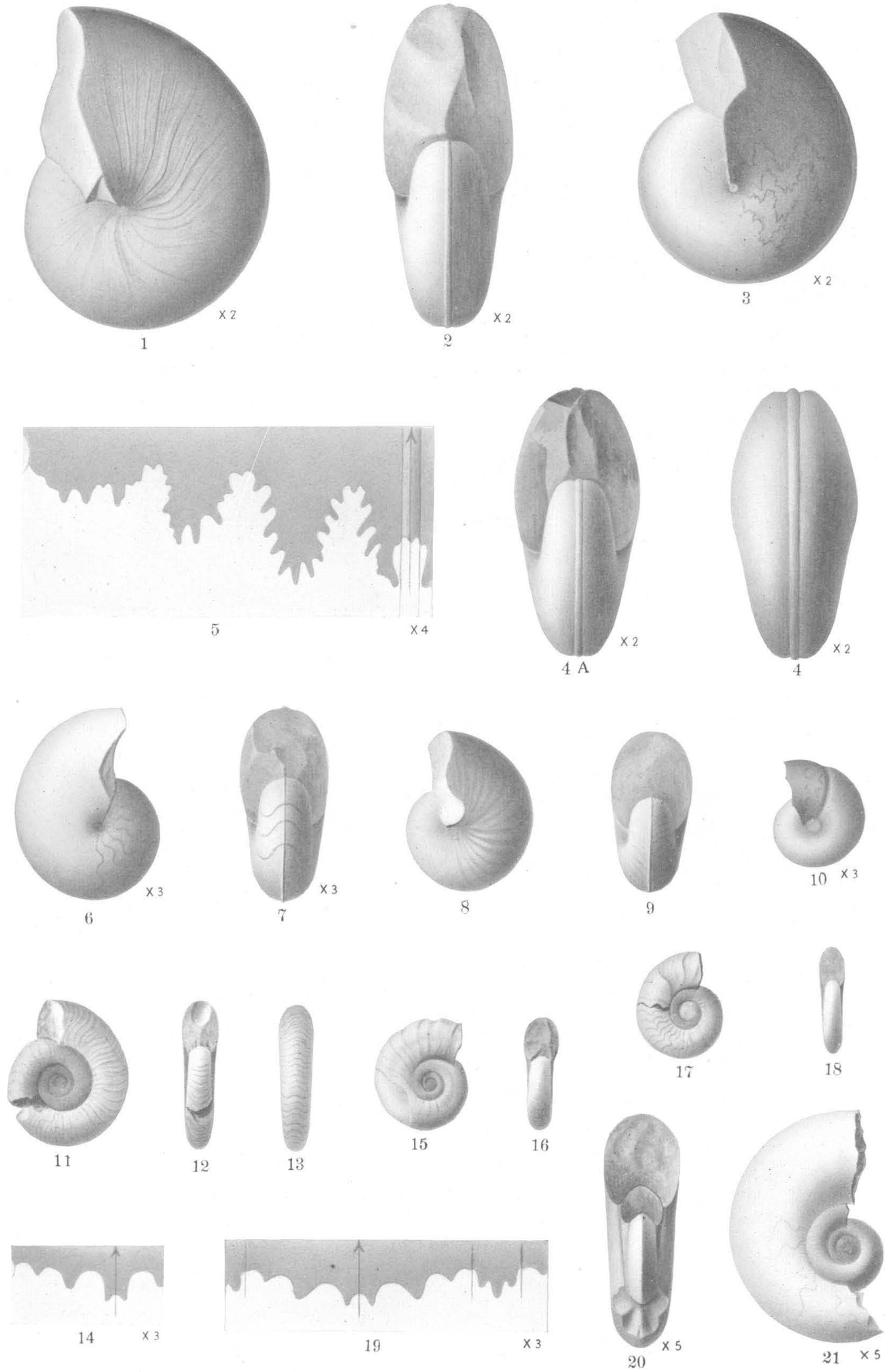


UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XXXII

FIGURES 1–10. *Paratropites* (*Gymnotropites*) *americanus* Hyatt and Smith (p. 46).

1, 2. Side and front views of the type specimen.

3–5. Side, front, and rear views and septa.

6, 7. Side and front views; diameter 10 millimeters. (Septa not exact; they should show a divided ventral lobe.)

10. Side view; diameter 6.5 millimeters.

FIGURES 11–21. *Tornquistites evolutus* Hyatt and Smith (p. 50).

11–14. Side, front, and rear views and septa of the type specimen.

15, 16. Side and front views.

17–19. Side and front views and septa.

20, 21. Views showing the keel on the inner volutions; diameter, 7.5 millimeters; ×5.

All specimens figured on this plate came from Upper Triassic Hosselkus limestone, *Trachyceras* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

PLATE XXXIII

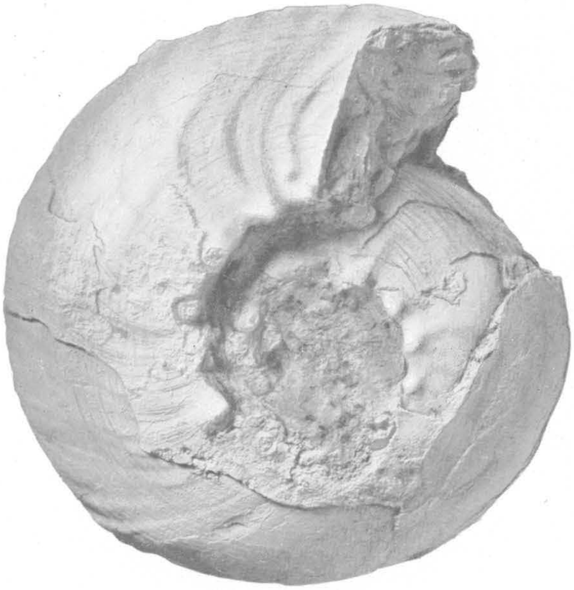
FIGURES 1–7. *Tropites armatus* Smith, n. sp. (p. 31).

1–3. Side, front, and rear views of the type specimen; diameter 83 millimeters.

4. Septa from another specimen.

5–7. Side, front, and rear views of an adult specimen.

From Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



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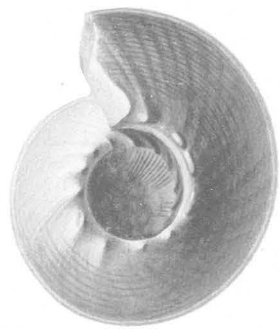

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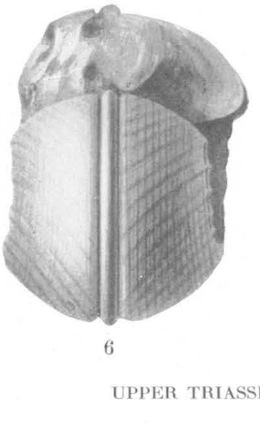

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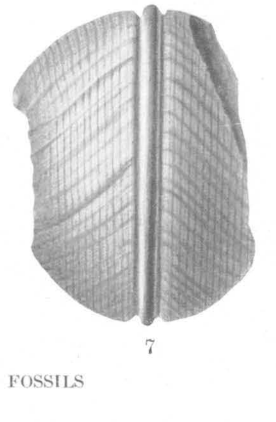

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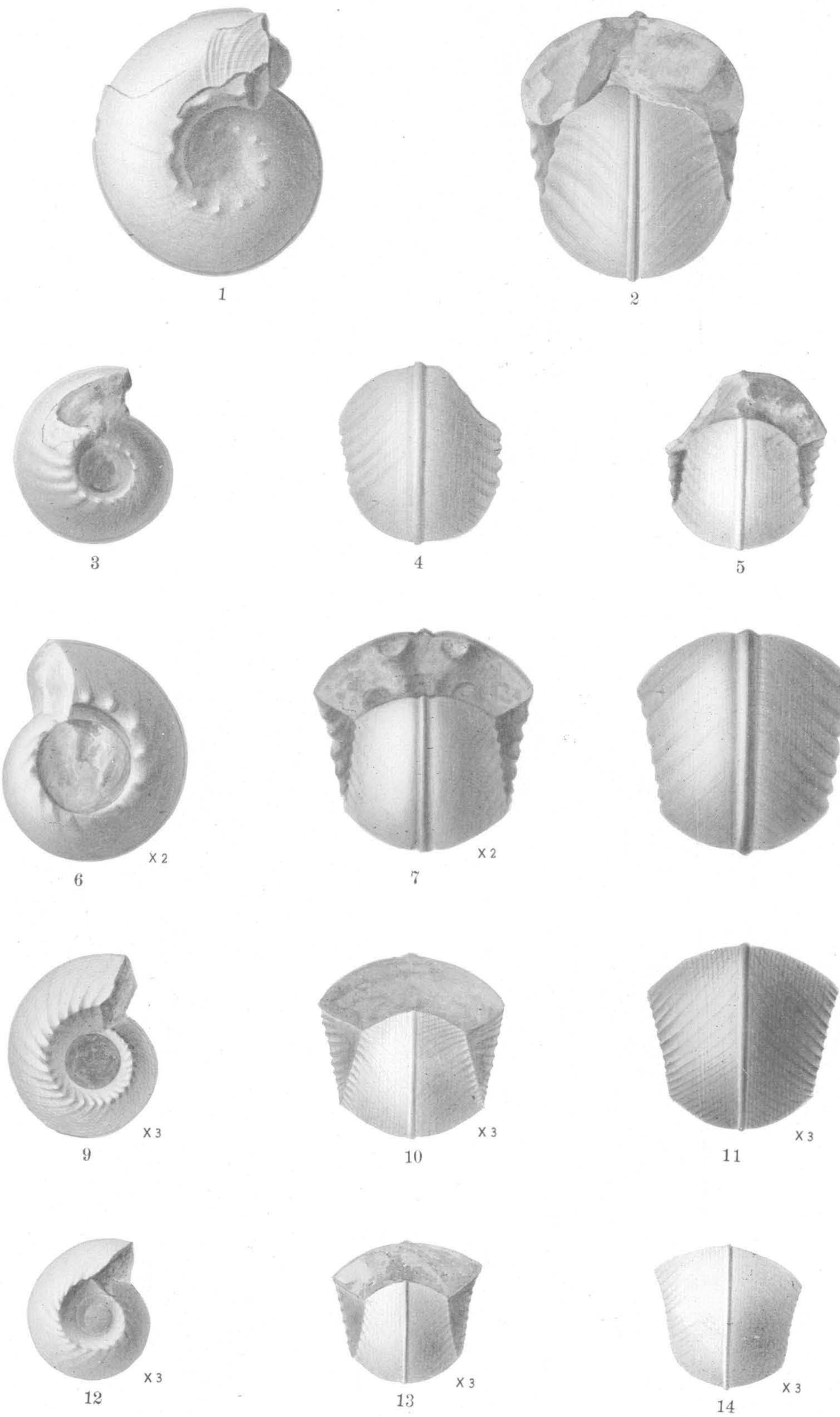
UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XXXIV

FIGURES 1–14. *Tropites subbullatus* Hauer (pp. 29–31).

1, 2. Side and front views of adult specimen.

3–5. Side, front, and rear views of an adolescent specimen; diameter 27 millimeters.

6–8. Side, front, and rear views, adolescent stage; diameter 17.5 millimeters.

9–11. Side, front, and rear views, adolescent stage; diameter 9.5 millimeters.

12–14. Side, front, and rear views, adolescent stage; diameter 7 millimeters.

From Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

PLATE XXXV

FIGURES 1–12. *Discotropites sandlingensis* Hauer (pp. 39–40).

1, 2. Side view and septa of a large specimen, showing the hollow keel.

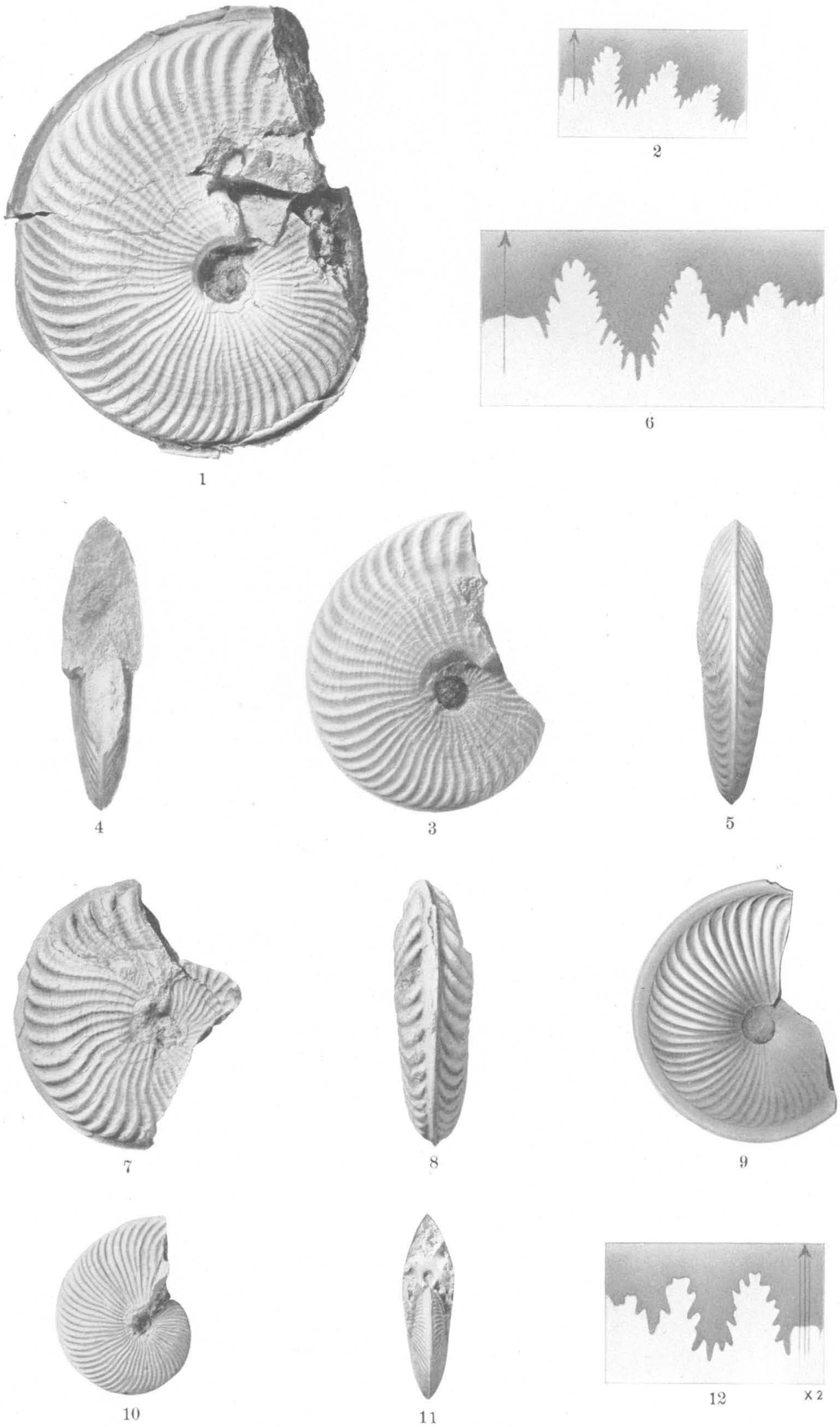
3–6. Side, front, and rear views and septa, with the outer shell removed, showing the low keel on the cast; diameter 48 millimeters.

7, 8. Side and front views, showing the coarse sculpture.

9. An artificial cast, showing the radial ribs, spiral lines, keel, and umbilical nodes.

10–12. Side and front views and septa; diameter 29.5 millimeters.

From Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the *Tropites subbullatus* zone. 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



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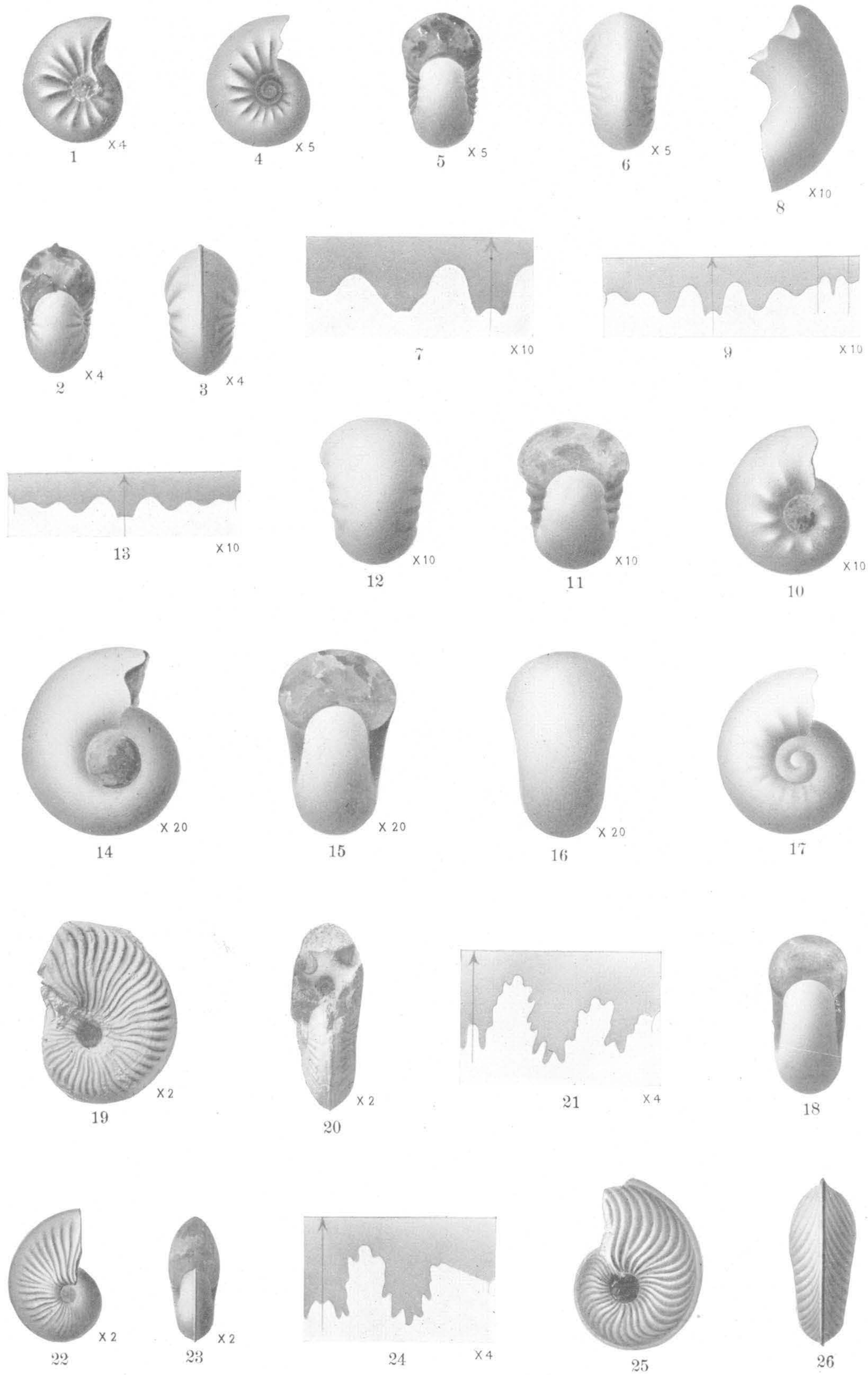


UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XXXVI

FIGURES 1–26. *Discotropites sandlingensis* Hauer (pp. 39–40).

1–3. Side, front, and rear views, showing the beginning of the lateral ribs; diameter 5.5 millimeters.
4–7. Side, front, and rear views and septa; diameter 4.25 millimeters.
8, 9. Fragment of whorl and septa; diameter 3.20 millimeters.
10–13. Side, front, and rear views and septa, larval stage; diameter 2.68 millimeters.
14–16. Side, front, and rear views, larval stage; diameter 1.50 millimeters.
17, 18. Side and front views, larval stage; diameter 1.36 millimeters.
19–21. Shell and septa; diameter 15.5 millimeters.
22–24. Shell and septa; diameter 10 millimeters.
25, 26. Outer shell and the keel; diameter 9 millimeters.

From Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

PLATE XXXVII

FIGURES 1–9. *Arcestes (Proarcestes) pacificus* Hyatt and Smith (pp. 68–69).

1–3. Side and front views and septa, *Stacheoceras* stage; diameter 2.97 millimeters.

4–6. Side and front views and septa, *Popanoceras* stage; diameter 2.16 millimeters.

7–9. Side and front views and septa, *Adrianites* stage; diameter 1.7 millimeters.

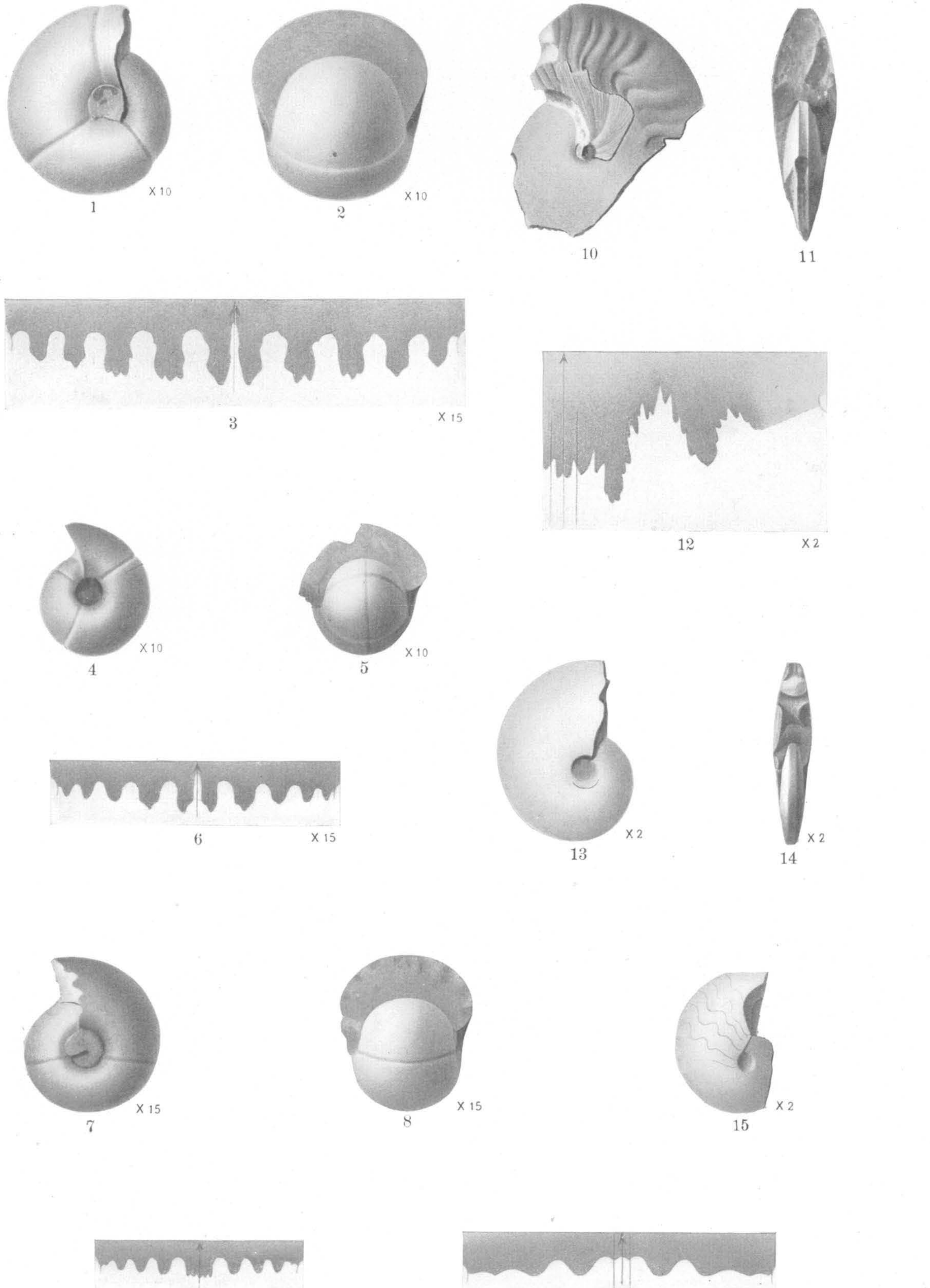
FIGURES 10–12. *Fremontites ashleyi* Hyatt and Smith (pp. 74–75). Side and front views and septa.

FIGURES 13–16. *Dieneria arthaberi* Hyatt and Smith (p. 76).

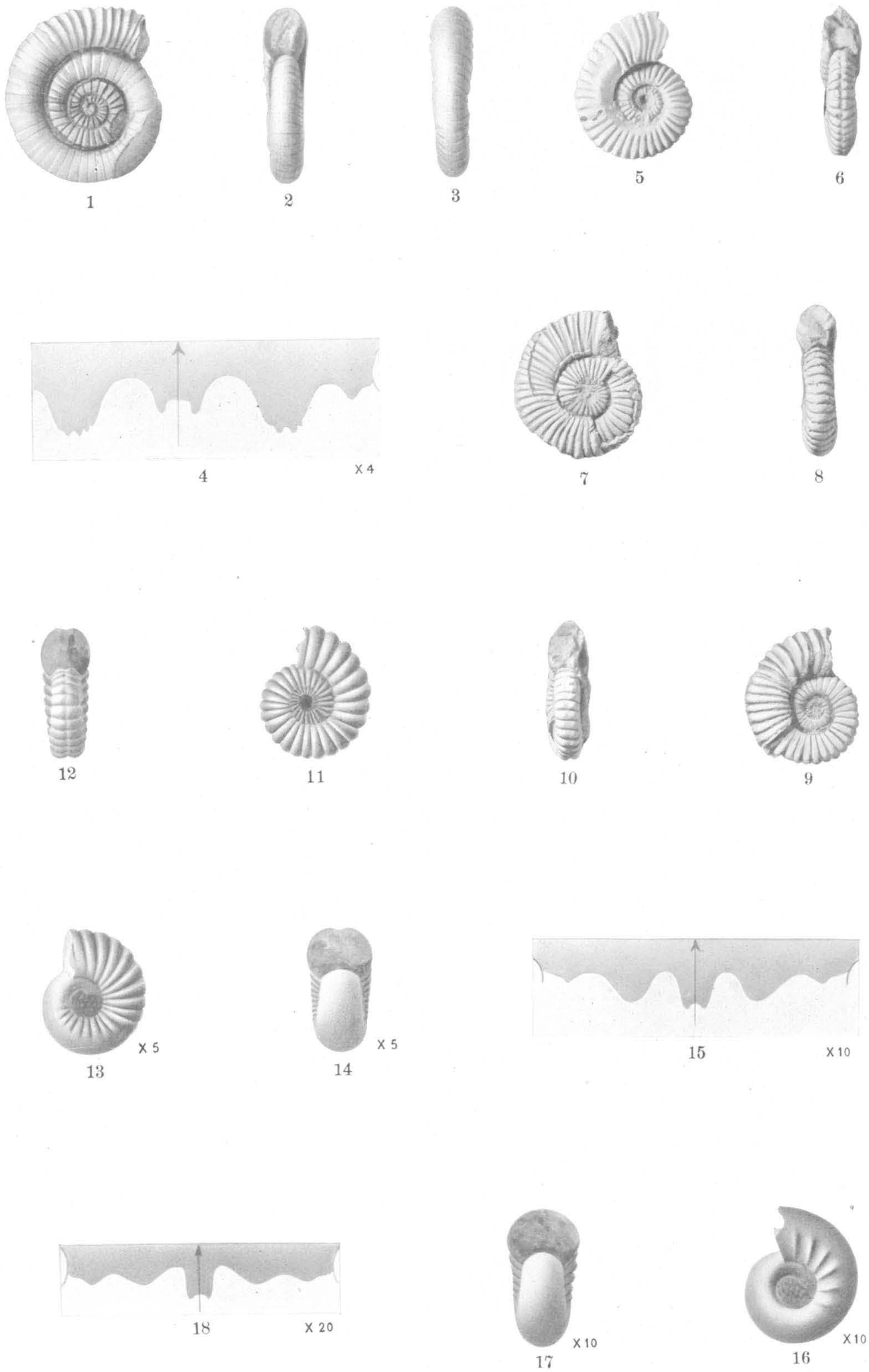
13, 14. Side and front views; diameter, 15 millimeters.

15, 16. Side view and septa, showing the goniatitic character.

All specimens figured on this plate came from Upper Triassic Hosselkus limestone, in the *Juvavites* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XXXVIII

FIGURES 1–18. *Polycyclus nodifer* Hyatt and Smith (p. 96).

1–4. Side, front, and rear views, and septa.

5, 6. Side and front views.

7, 8. Side and front views, showing the outer shell.

9, 10. Side and front views, showing both shell and cast.

11, 12. Side and front views; diameter 10 millimeters.

13–15. Side and front views and septa; adolescent stage; diameter 3.5 millimeters.

16–18. Side and front views and septa; larval stage; diameter 2 millimeters.

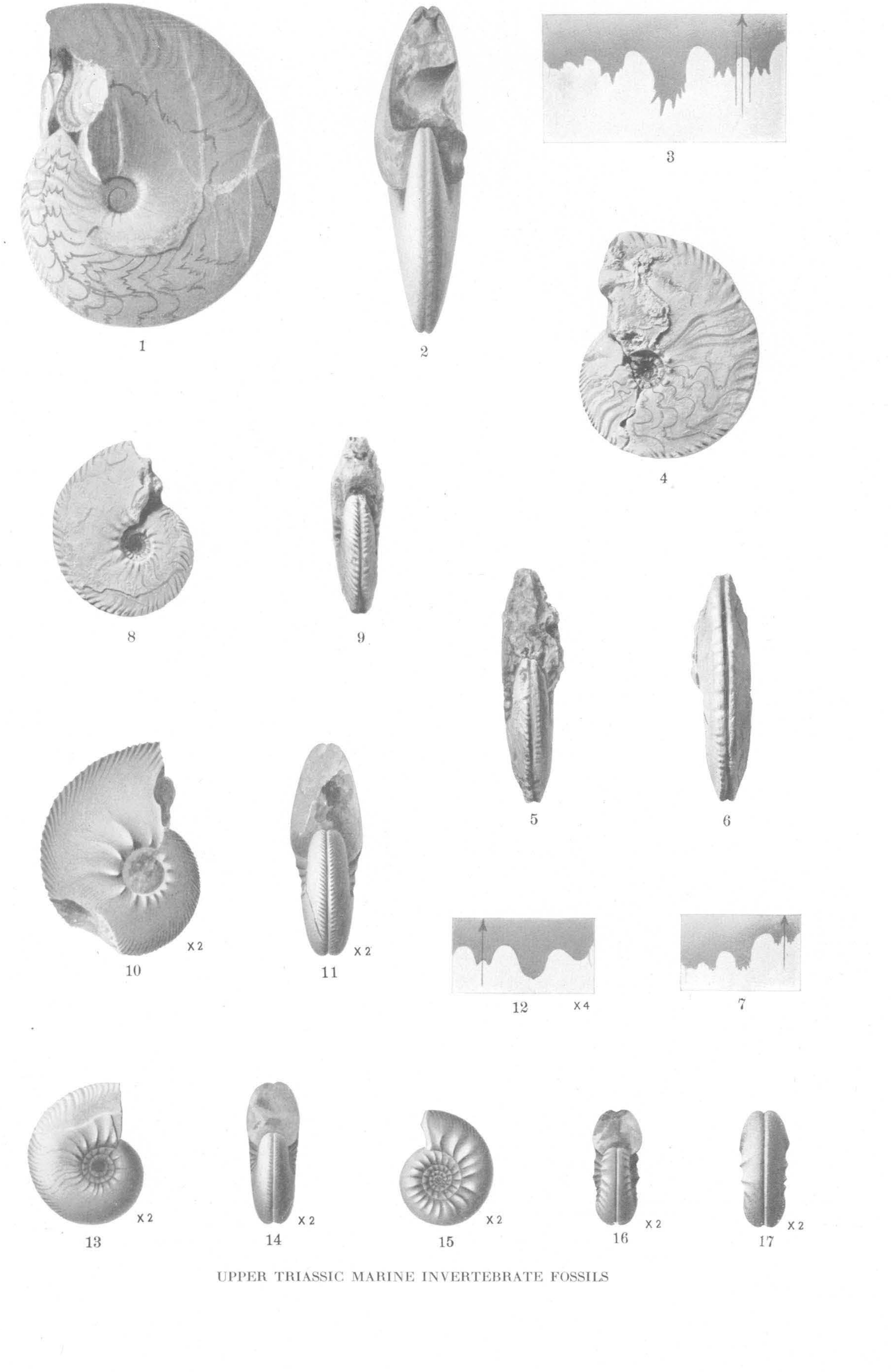
From Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

PLATE XXXIX

FIGURES 1–17. *Arpadites gabbi* Hyatt and Smith (p. 93–94).

1–3. Side and front views and septa.
4–7. Side, front, and rear views, and septa.
8, 9. Side and front views at early maturity.
10–12. Side and front views and septa; diameter 18.5 millimeters.
13, 14. Side and front views; diameter 12.5 millimeters.
15–17. Side, front, and rear views; end of adolescent stage; diameter 10 millimeters.

From Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Figures 1–3, collection of U. S. National Museum; Figures 4–17, collection of J. P. Smith.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

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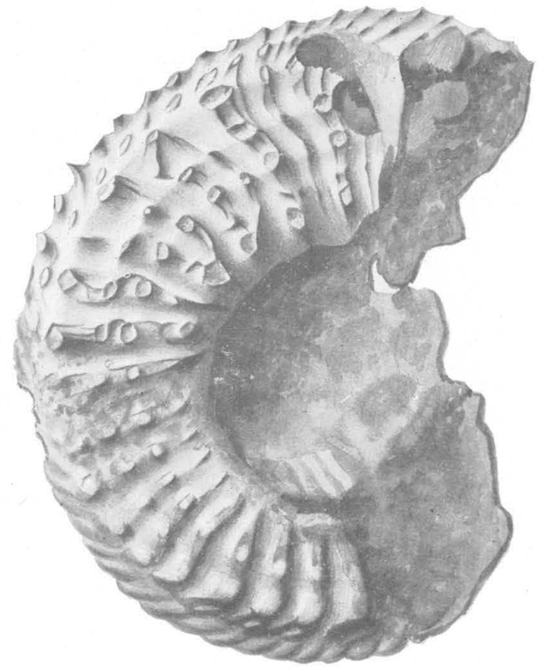

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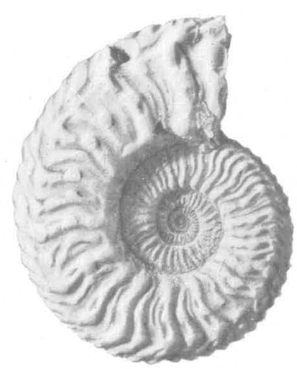

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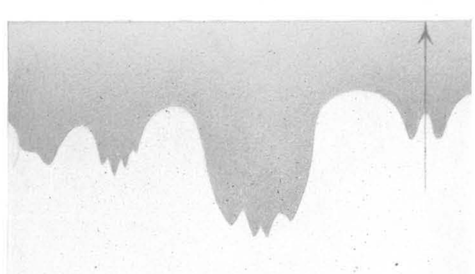

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UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XL

FIGURES 1–11. *Clionites* (*Traskites*) *fairbanksi* Hyatt and Smith (pp. 85–86).

1–4. Side, front, and rear views, and septa of the type specimen.

5. Side view of an old specimen, showing the rough sculpture in old age.

6–8. Side, front, and rear views; diameter 49 millimeters.

9–11. Side, front, and rear views; diameter 32 millimeters.

From Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Figures 1–4, collection of U. S. National Museum; Figures 5–11, collection of J. P. Smith.

PLATE XLI

FIGURES 1–14. *Clionites* (*Traskites*) *fairbanksi* Hyatt and Smith (pp. 85–86).

1, 2. Side and rear views; diameter 17.5 millimeters.

3–5. Side, front, and rear views; adolescent stage; diameter 14 millimeters.

6–8. Adolescent stage; diameter 10.20 millimeters.

9–11. Adolescent stage; diameter 7.5 millimeters.

12–14. Adolescent stage; corresponding to *Tirolites;* diameter 5.08 millimeters.

FIGURES 15–26. *Clionites* (*Stantonites*) *rugosus* Hyatt and Smith (pp. 89–90).

15–17. Side and front views, and septa of type specimen.

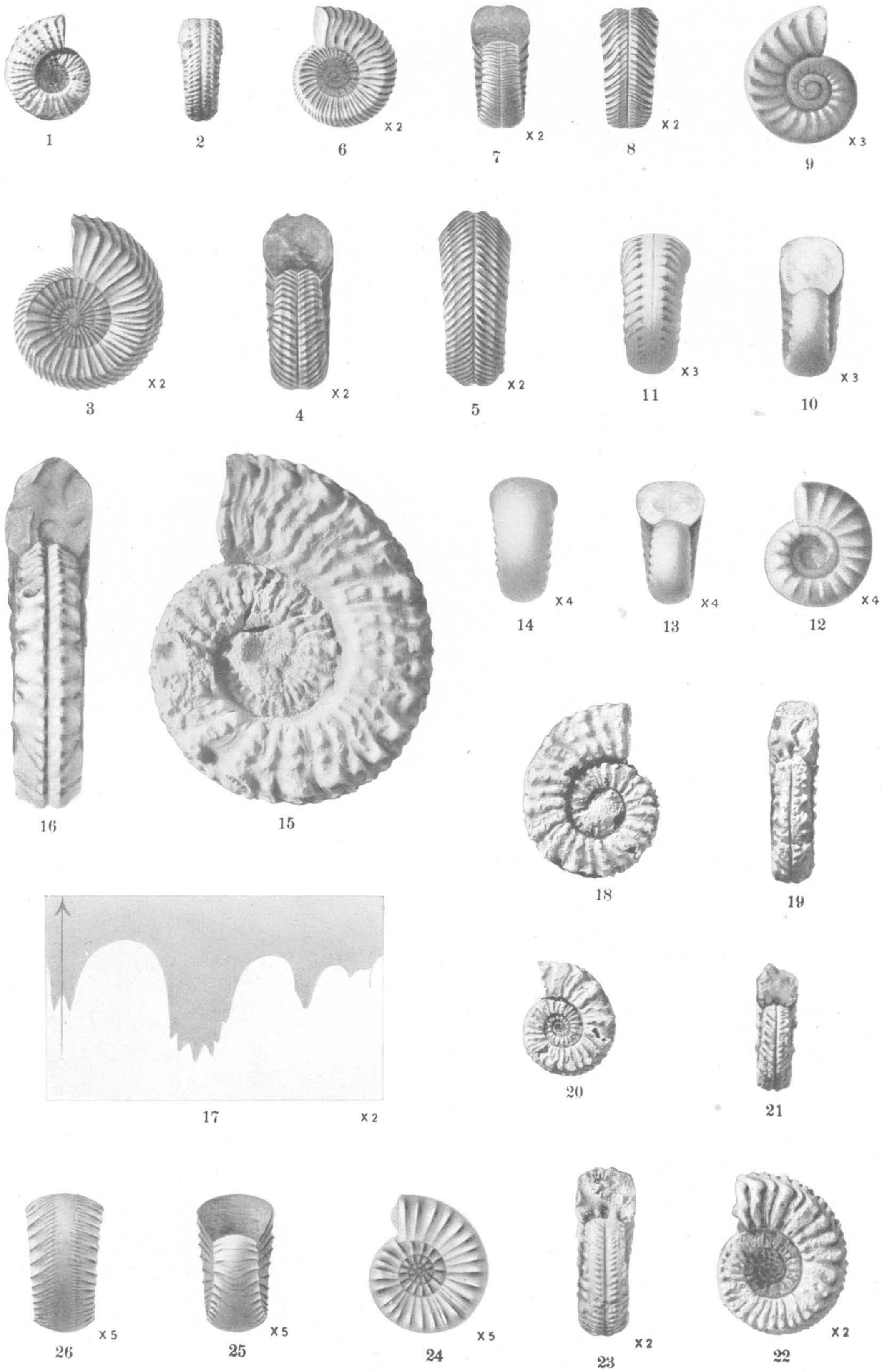
18, 19. Side and front views.

20, 21. Side and front views, adolescent specimen; diameter 20 millimeters.

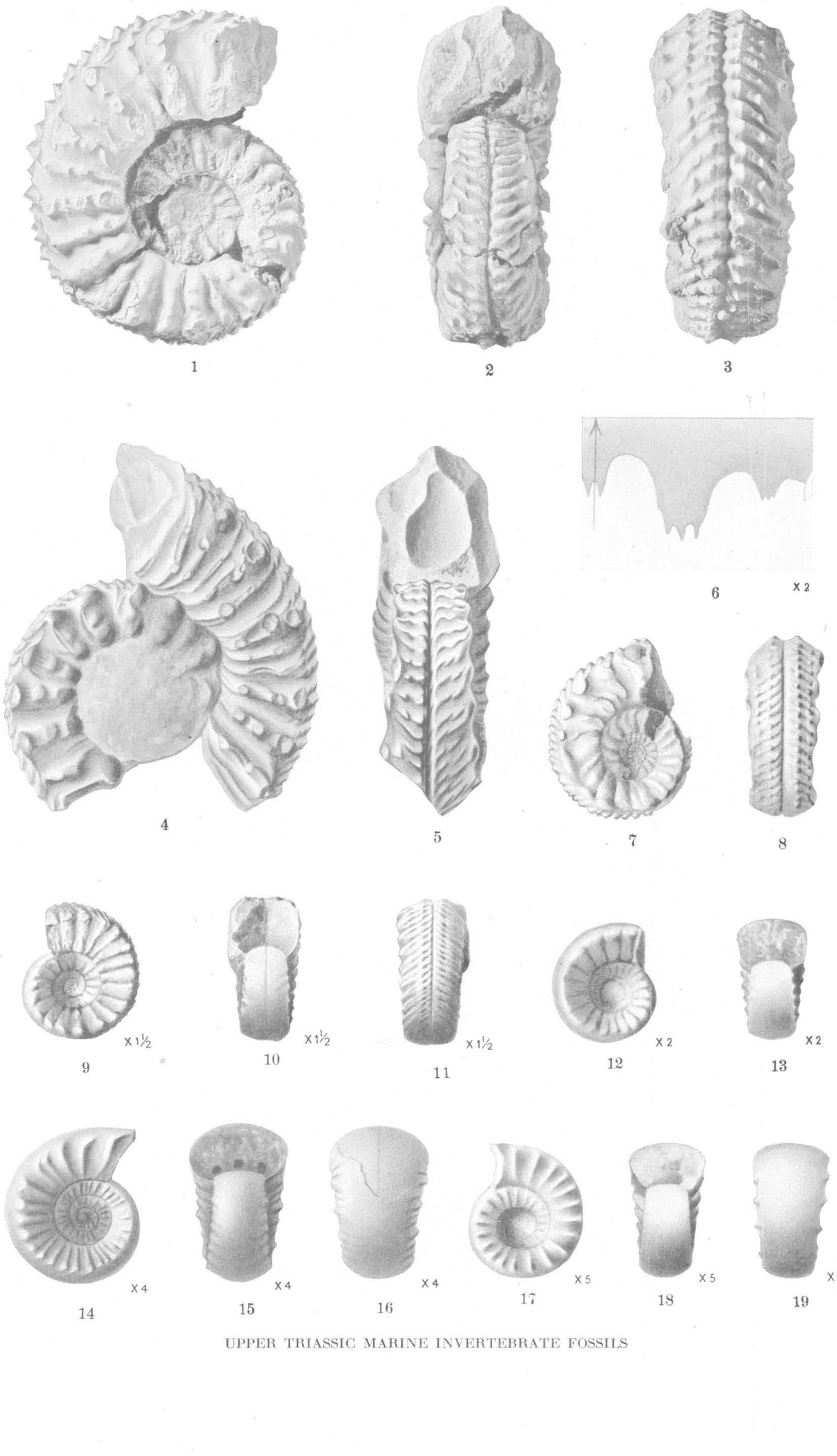
22, 23. Side and front views, adolescent stage; diameter 14 millimeters.

24–26. Side, front, and rear views, *Tirolites* stage; diameter 4.5 millimeters.

All specimens figured on this plate came from Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XLII

FIGURES 1–19. *Clionites (Traskites) robustus* Hyatt and Smith (p. 87).

1–3. Side, front, and rear views of the type specimen.

4–6. Side and front views and septa.

7, 8. Side and rear views. Transition from adolescence to maturity; diameter 31 millimeters.

9–11. Side, front, and rear views, adolescent stage; diameter 16 millimeters.

12, 13. Side and front views; adolescent stage corresponding to *Californites;* diameter 10 millimeters.

14–16. Side, front, and rear views; adolescent stage corresponding to *Tirolites;* diameter 6.5 millimeters.

17–19. Side, front, and rear views; *Tirolites* stage; diameter 4.5 millimeters.

From Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

PLATE XLIII

FIGURES 1–15. *Clionites (Shastites) compressus* Hyatt and Smith (pp. 88–89).

1–4. Side, front, and rear views, and septa, of type specimen.

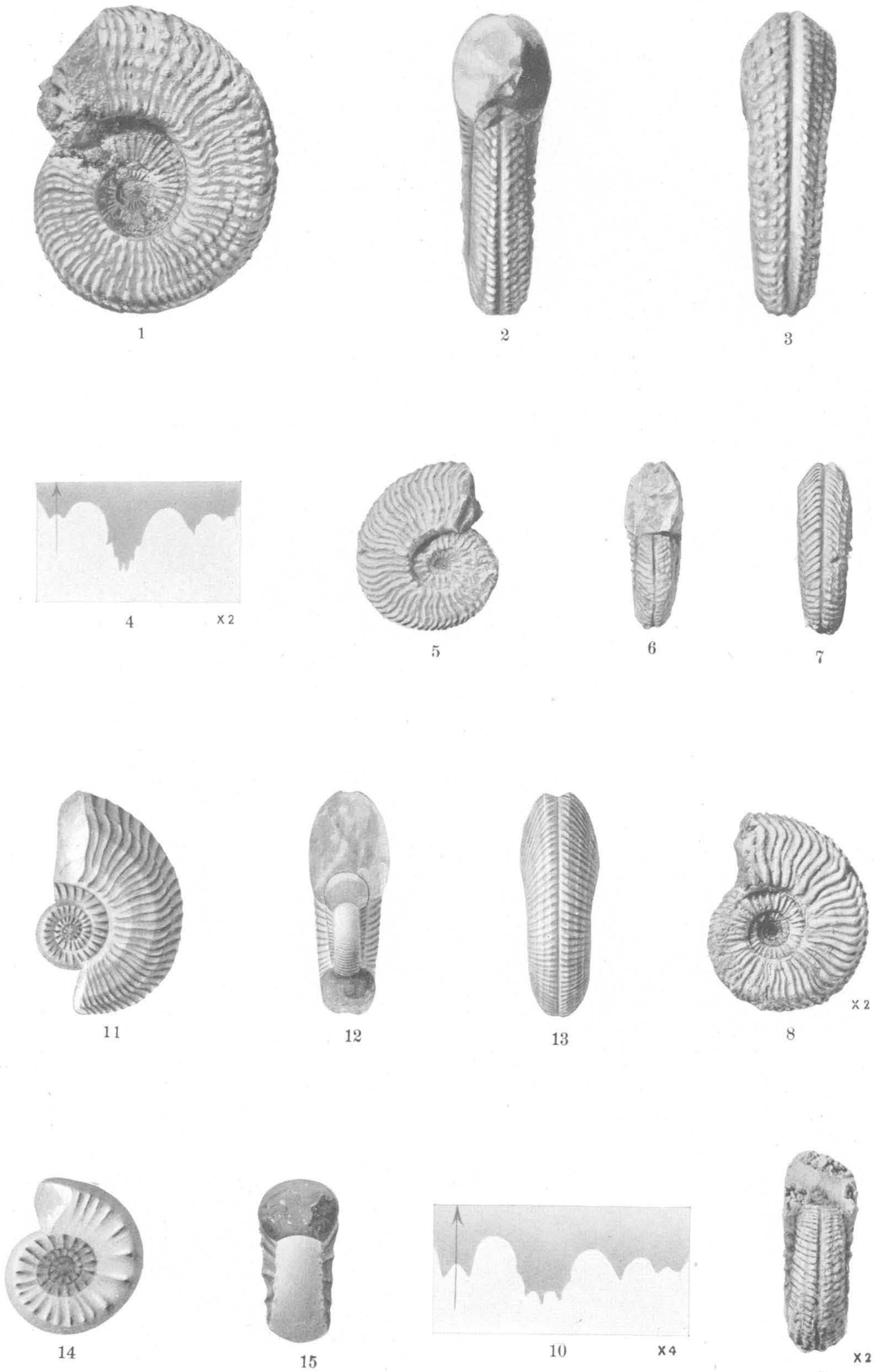
5–7. Side, front, and rear views; diameter 28 millimeters.

8–10. Side and front views; adolescent stage; diameter 16 millimeters.

11–13. Side, front, and rear views, adolescent stage; diameter 17 millimeters.

14, 15. Side and front views, adolescent stage corresponding to *Tirolites;* diameter 5 millimeters.

From Upper Triassic Hosselkus limestone, in *Trachyceras* subzone of *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

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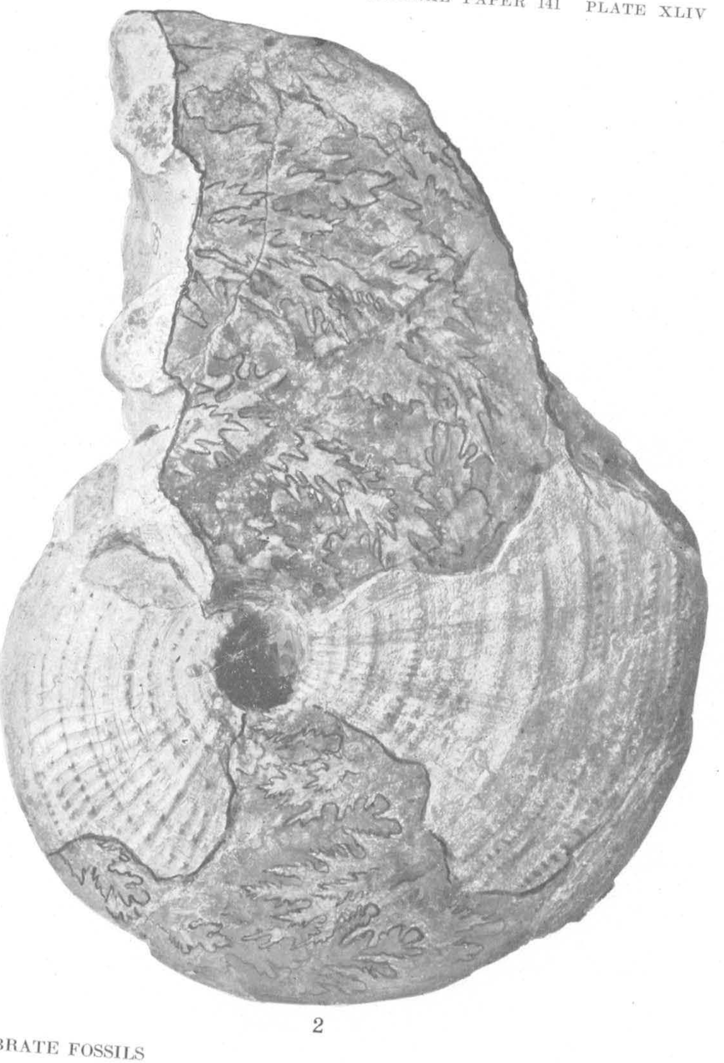

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UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XLIV

FIGURES 1, 2. *Trachyceras* (*Protrachyceras*) *lecontei* Hyatt and Smith (pp. 78–79). Right and left sides, showing on the right the surface sculpture and on the left the septa, type specimen. (See Pl. XLV, figs. 1, 2.) From Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

PLATE XLV

FIGURES 1–9. *Trachyceras* (*Protrachyceras*) *lecontei* Hyatt and Smith (p. 78–79).

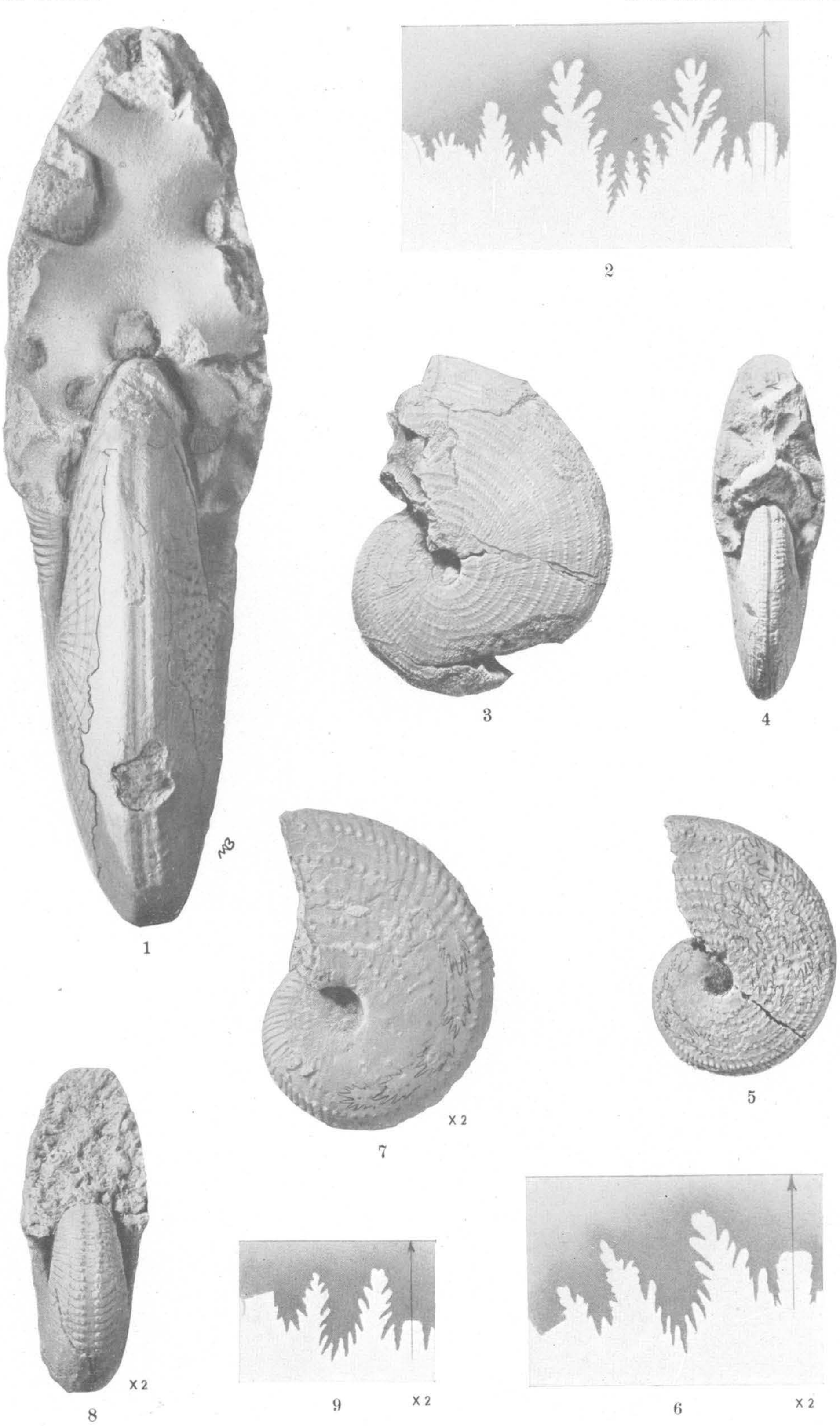
1, 2. Front view and septa of the same specimen shown in Plate XLIV, Figures 1, 2.

3, 4. Side and front views of a smaller specimen; diameter 53 millimeters.

5, 6. Side view, septa; diameter 42 millimeters.

7–9. Side and front view and septa; diameter 26 millimeters. (This specimen is the inner whorl of figs. 5, 6.)

From Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



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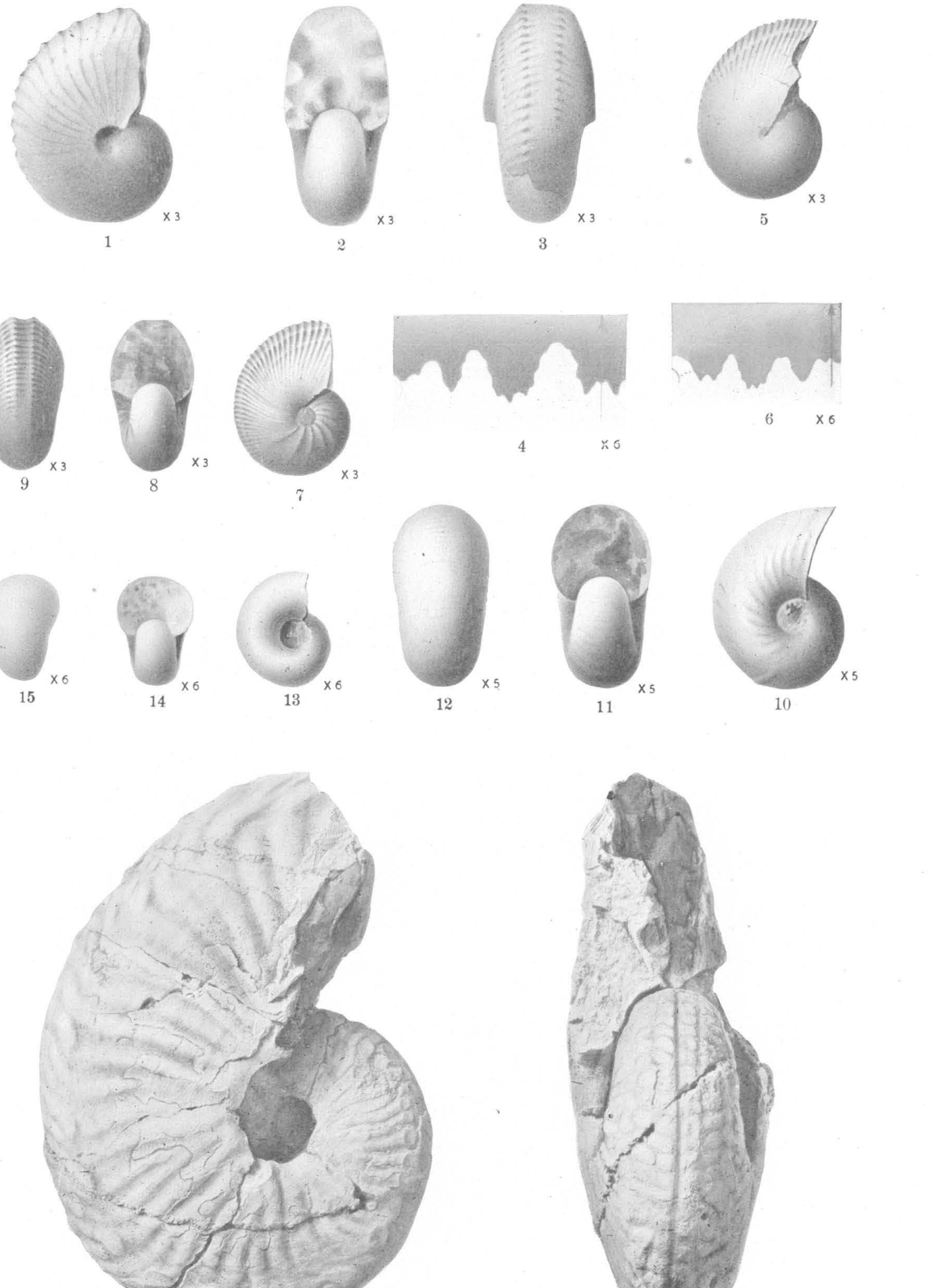


UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XLVI

FIGURES 1–15. *Trachyceras* (*Protrachyceras*) *lecontei* Hyatt and Smith (pp. 78–79).
1–4. Side, front, and rear views and septa; adolescent stage; diameter 12 millimeters.
5, 6. Side view and septa; adolescent stage; diameter 10 millimeters.
7–9. Side, front, and rear views, diameter 8 millimeters.
10–12. Side, front, and rear views; diameter 5.5 millimeters.
13–15. End of larval stage; side, front, and rear views; diameter 3 millimeters.
From Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

FIGURES 16, 17. *Sirenites lawsoni* Hyatt and Smith (p. 82). Side and front views of the type. (See also Pl. XLVII, figs. 1–3, for septa and inner whorl of the same specimen.) From same zone and locality as Figures 1–15. Collection of U. S. National Museum.

PLATE XLVII

FIGURES 1–9. *Sirenites lawsoni* Hyatt and Smith (p. 82).

1–4. Side, front, and rear views and septa; inner whorl of specimen shown on Plate XLVI, Figures 16, 17.

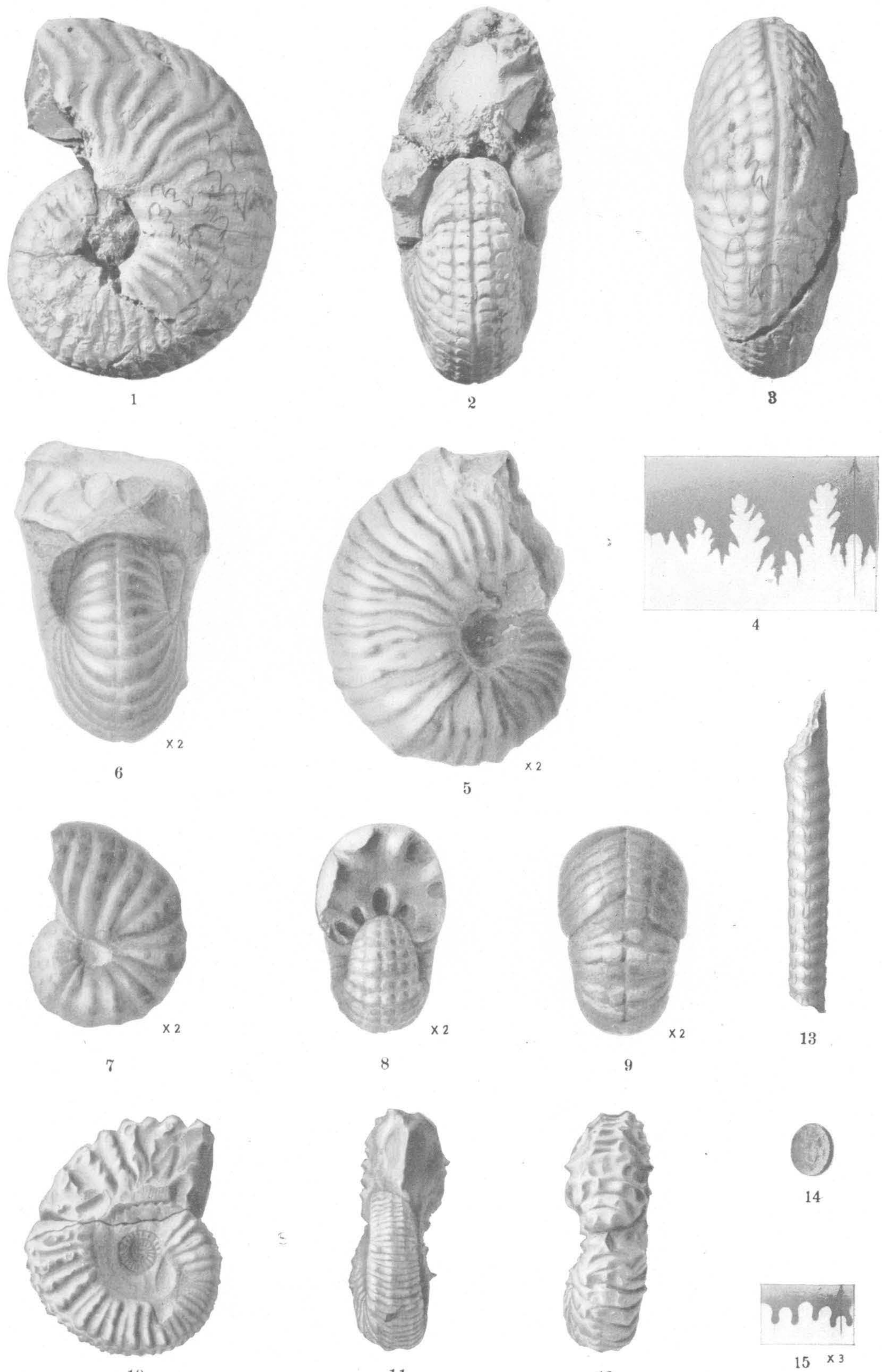
5, 6. Side and front views; adolescent stage; diameter 25 millimeters.

7–9. Side, front, and rear views; adolescent stage; diameter 17 millimeters.

From Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of U. S. National Museum.

FIGURES 10–12. *Sandlingites andersoni* Hyatt and Smith (p. 83). Side, front, and rear views. From same zone and locality as Figures 1–9. Collection of J. P. Smith.

FIGURES 13–15. *Rhabdoceras russelli* Hyatt (p. 99). Side view and cross section, and septa. From Upper Triassic *Pseudomonotis* zone, in Swearinger slate near Genesee, Plumas County, Calif. Collection of U. S. National Museum.



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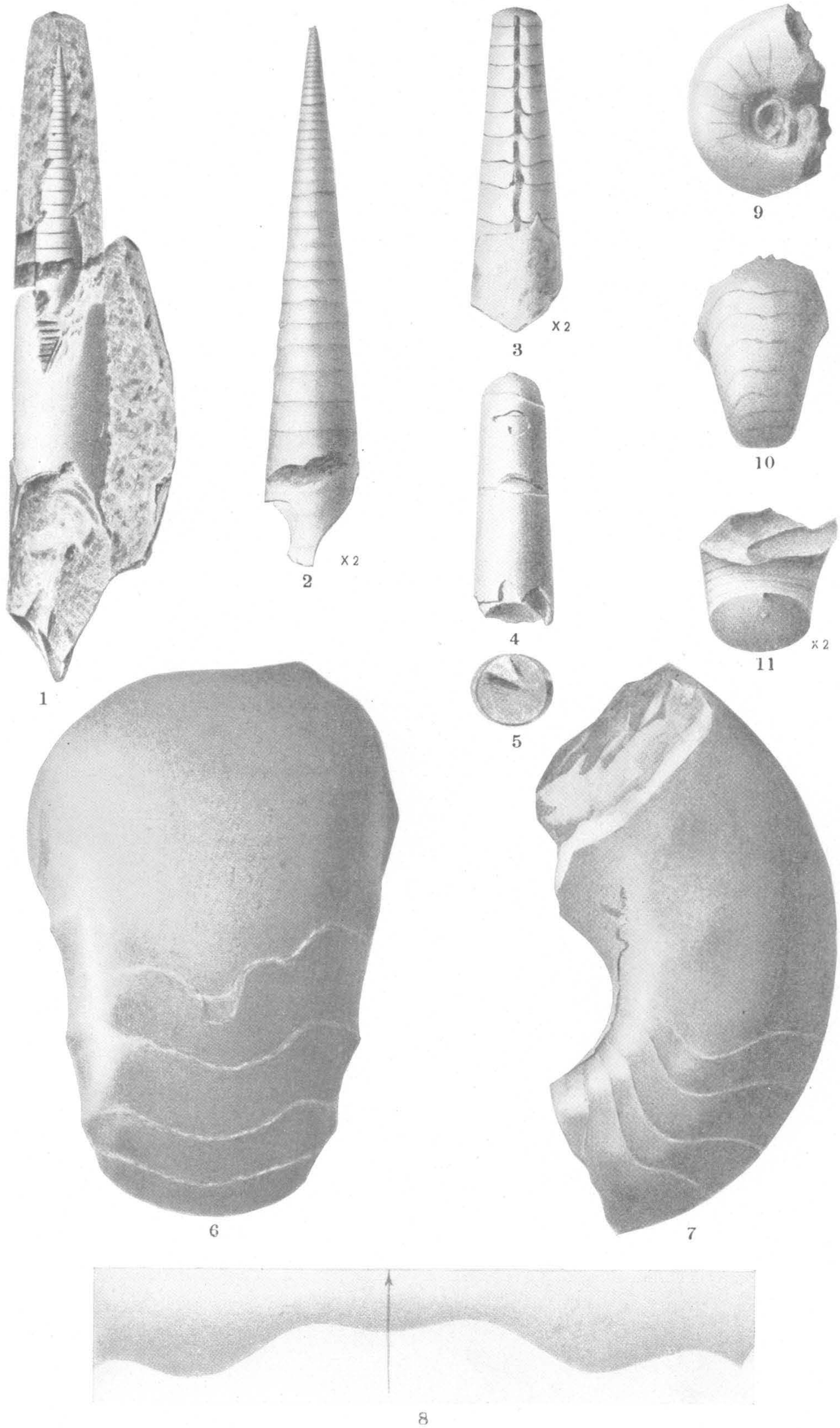

UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XLVIII

FIGURES 1–3. *Atractites philippii* Hyatt and Smith (p. 101).

1. Specimen showing phragmocone and guard.
2. Phragmocone of the same specimen.
3. Phragmocone of another specimen from Bear Mountain, Shasta County, showing the external siphuncle.

FIGURES 4, 5. *Orthoceras shastense* Hyatt and Smith (p. 102). Side view and cross section.

FIGURES 6–11. *Mojsvaroceras turneri* Hyatt and Smith (p. 106).

6–8. Side and rear views and septa.

9, 10. Side and rear views, adolescent stage.

11. Small fragment of inner whorl of the last specimen, showing the internal lobe and the siphuncle.

All specimens figured on this plate came from Upper Triassic Hosselkus limestone, in the *Juvavites* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

PLATE XLIX

FIGURES 1–3. *Proclydonautilus triadicus* Mojsisovics (pp. 102–103). Side and front views and septa. From Upper Triassic Hosselkus limestone, in both subzones of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

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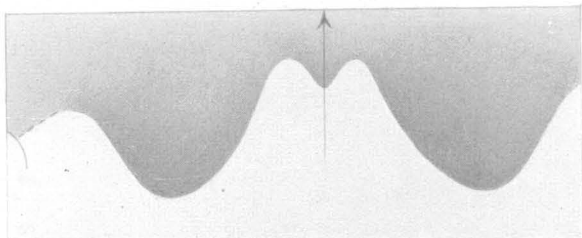

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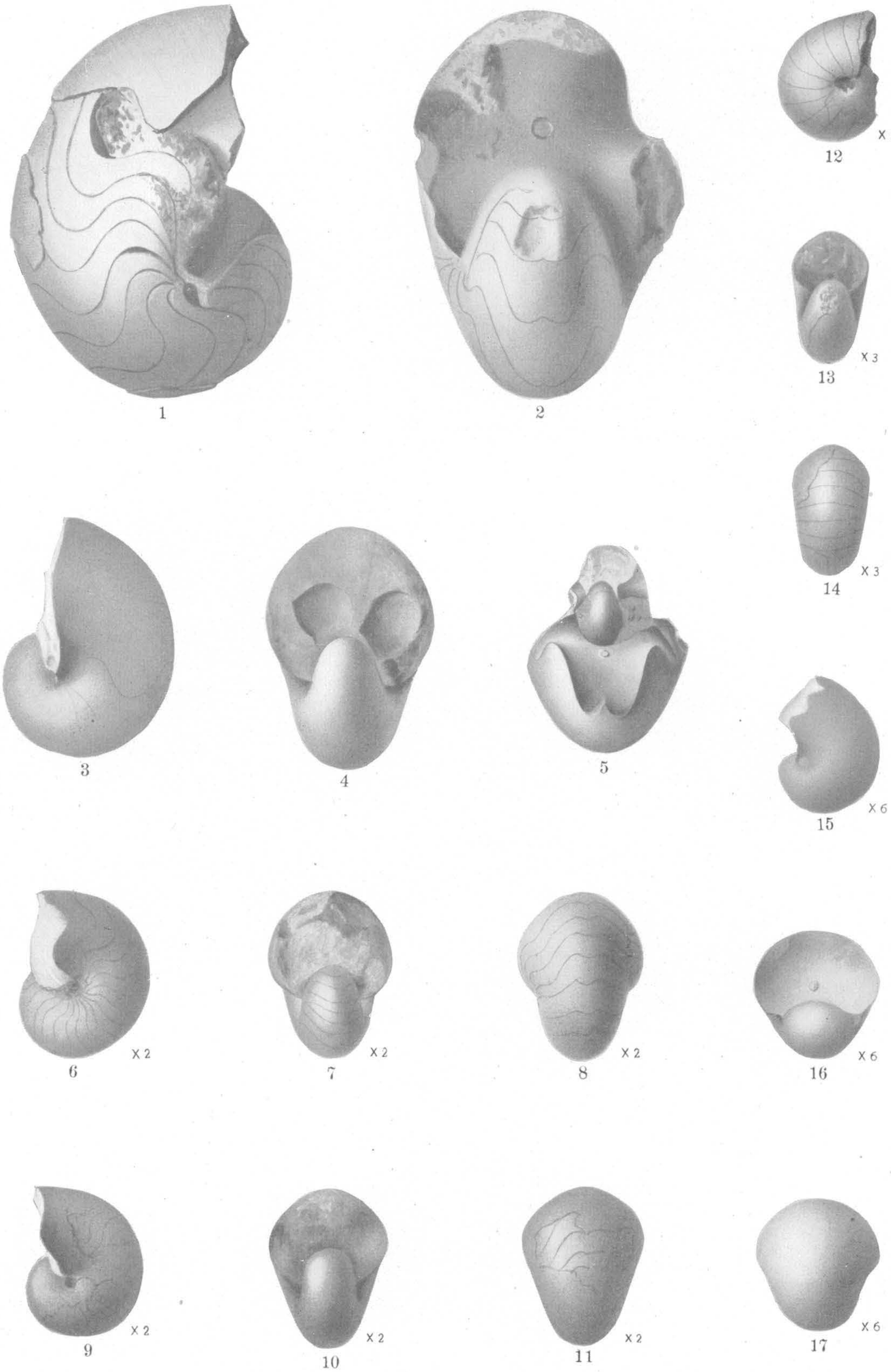


UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE L

FIGURES 1–17. *Proclydonautilus triadicus* Hyatt and Smith (pp. 102–103).

1, 2. Side and front views.

3–5. Side and front views of an immature specimen, and a rear view of the inner whorls, shown by removing part of the outer whorl.

6–8. Side, front, and rear views; adolescent stage; diameter 13 millimeters.

9–11. Side, front, and rear views; adolescent stage; diameter 12 millimeters.

12–14. Side, front, and rear views; adolescent stage, corresponding to *Coloceras;* diameter, 7 millimeters.

15–17. Side, front, and rear views; larval stage; diameter, 3 millimeters.

From Upper Triassic Hosselkus limestone, in both subzones of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

PLATE LI

Cosmonautilus dilleri Hyatt and Smith (p. 104). Side view; diameter 200 millimeters. (See also Pl. LII for front view of the same specimen.) From Upper Triassic Hosselkus limestone, in the *Juvavites* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

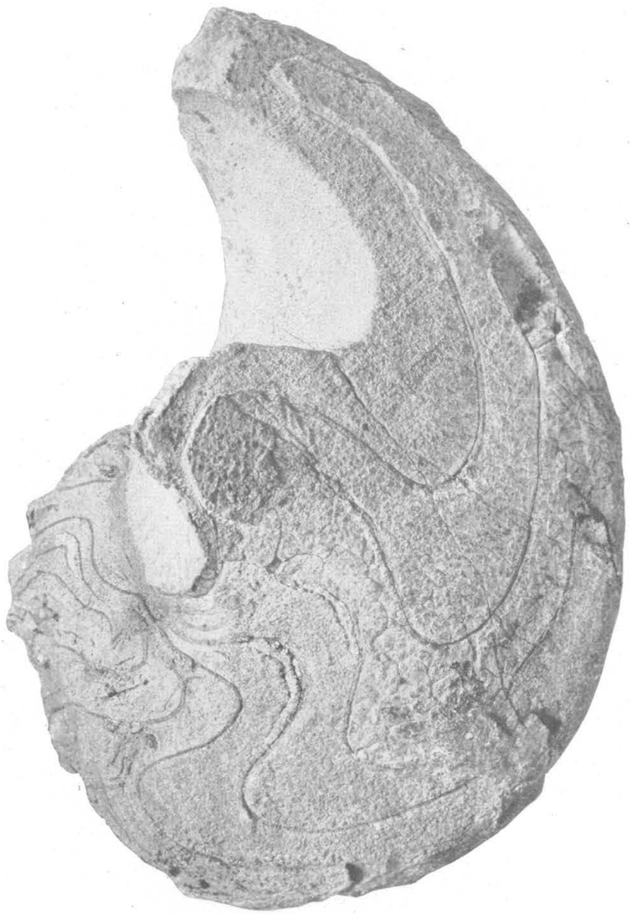
UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LII

Cosmonautilus dilleri Hyatt and Smith (p. 104). Front view; diameter 200 millimeters. (See Pl. LI for side view.) From Upper Triassic Hosselkus limestone, in the *Juvavites* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

PLATE LIII

FIGURES 1, 2. *Cosmonautilus dilleri* Hyatt and Smith (p. 104). Side and front views; diameter 125 millimeters. (See Pl. LIV, figs. 1, 2, for rear view and septa.) From Upper Triassic Hosselkus limestone, in the *Juvavites* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



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UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

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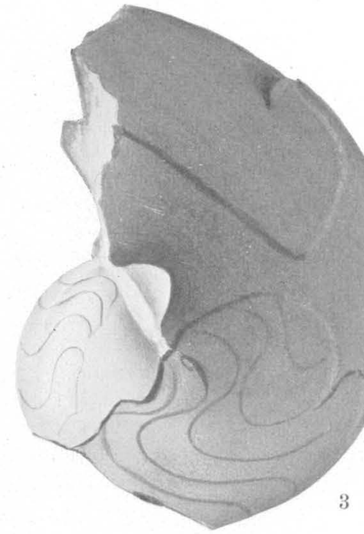

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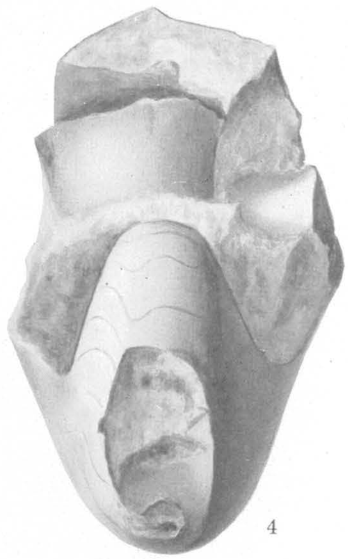

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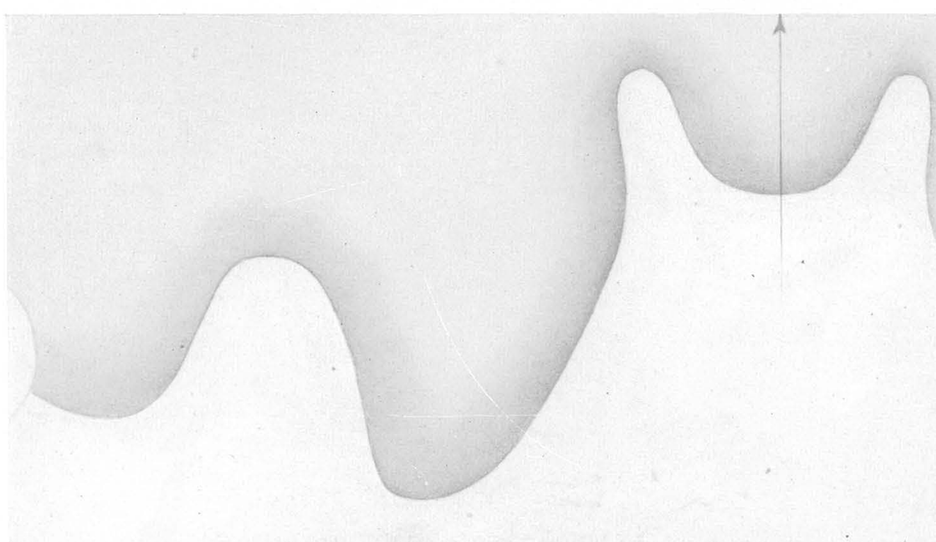

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UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LIV

FIGURES 1–4. *Cosmonautilus dilleri* Hyatt and Smith (p. 104).

1, 2. Rear view and septa of specimen shown on Plate LIII, Figures 1, 2.

3, 4. Side and front views, showing transition from adolescence to maturity; diameter, 70 millimeters.

From Upper Triassic Hosselkus limestone, in the *Juvavites* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

PLATE LV

FIGURES 1–11. *Cosmonautilus dilleri* Hyatt and Smith (p. 104).

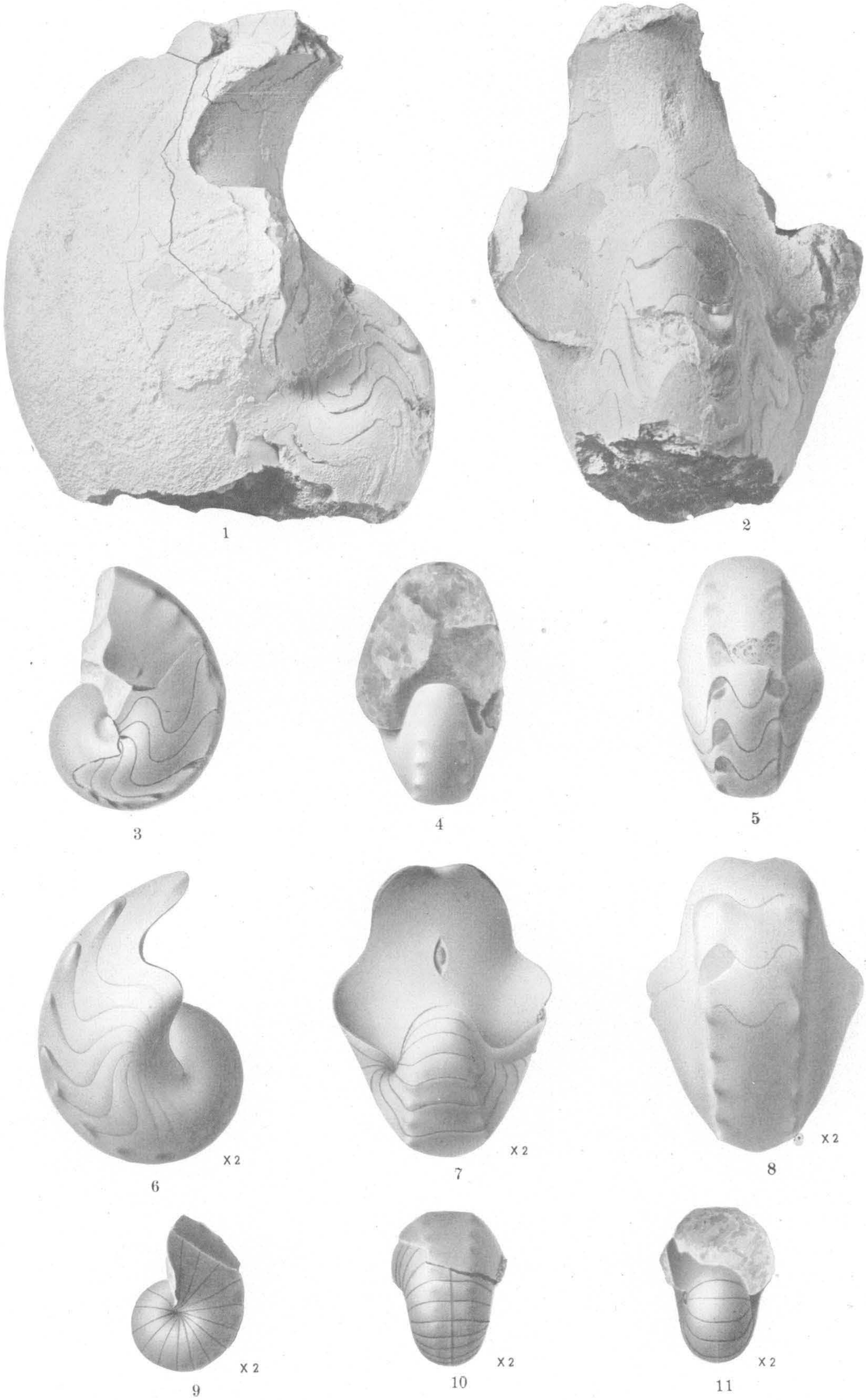
1, 2. Side and front views, early adult stage; diameter 95 millimeters.

3–5. Side, front, and rear views, adolescent stage; diameter 40 millimeters.

6–8. Side, front, and rear views; adolescent stage; diameter 24 millimeters.

9–11. Side, front, and rear views; larval stage; diameter 13 millimeters.

From Upper Triassic Hosselkus limestone, in the *Juvavites* subzone of the *Tropites subbullatus* zone, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



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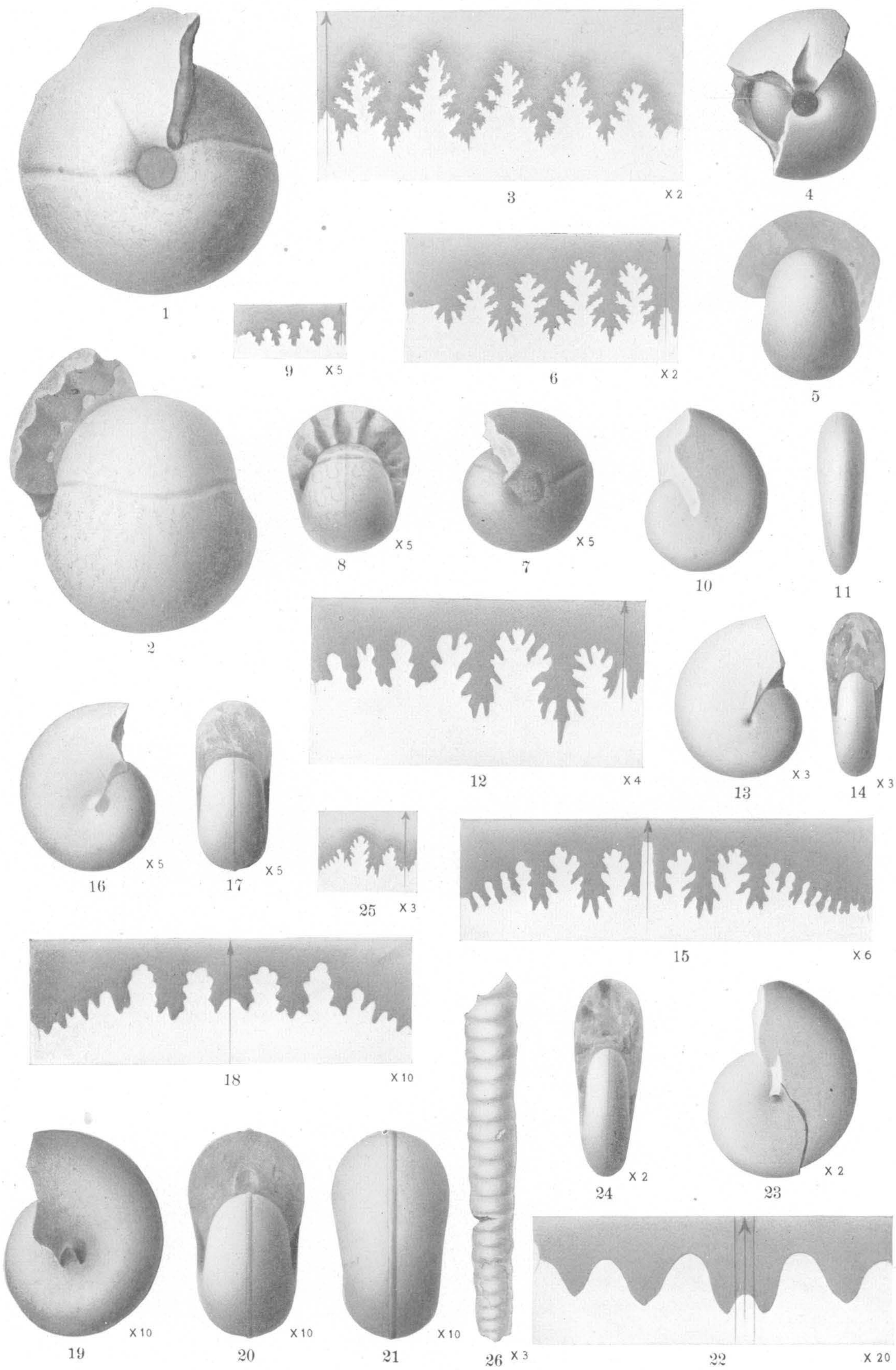


UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LVI

FIGURES 1–9. *Arcestes andersoni* Hyatt and Smith (p. 68).

1–3. Right side, front, and septa of the type specimen.

4–6. Right side, front, and septa, ×2, of a smaller specimen.

7–9. Side, front, and septa of a young specimen; diameter, 5 millimeters.

From Upper Triassic *Pseudomonotis* zone of the Star Peak formation in Muttleberry Canyon, 8 miles southeast of Lovelock, West Humboldt Range, Nev. Figures 1–3, collection of F. M. Anderson, Berkeley, Calif.; Figures 4–9, collection of J. P. Smith.

FIGURES 10–25. *Placites humboldtensis* Hyatt and Smith (p. 77).

10–12. Left side, rear, and septa; somewhat weathered.

13–15. Right side, front, and septa; diameter 9 millimeters.

16–18. Left side, front, and septa; early adolescent stage; diameter 5.5 millimeters.

19–22. Left side, front, rear, and septa; larval stage, showing the siphuncle; diameter 3 millimeters.

23–25. Left side, front, and septa; diameter 15 millimeters.

From Upper Triassic *Pseudomonotis* zone of the Star Peak formation in Muttleberry Canyon, 8 miles southeast of Lovelock, West Humboldt Range, Nev. Collection of J. P. Smith.

FIGURE 26. *Rhabdoceras russelli* Hyatt (p. 99). Side view, 3. From Upper Triassic beds of Noric age in the Star Peak formation in Muttleberry Canyon, 8 miles southeast of Lovelock, West Humboldt Range, Nev. Collection of J. P. Smith.

PLATE LVII

FIGURES 1–11. *Paratropites* (*Gymnotropites*) *californicus* Smith, n. sp. (p. 46).
- 1, 2. Type.
- 3–5. Cotype, showing septa.
- 6–8. Adolescent stage; diameter 11 millimeters.
- 9–11. Larval stage; diameter 3.5 millimeters.

FIGURES 12–21. *Paratropites* (*Paulotropites*) *shastensis* Smith, n. sp. (p. 47).
- 12–14. Type.
- 15, 16. Early mature stage; diameter 24 millimeters.
- 17, 18. Same specimen with one-third of a whorl removed; diameter 18 millimeters.
- 19–21. Diameter 15 millimeters.

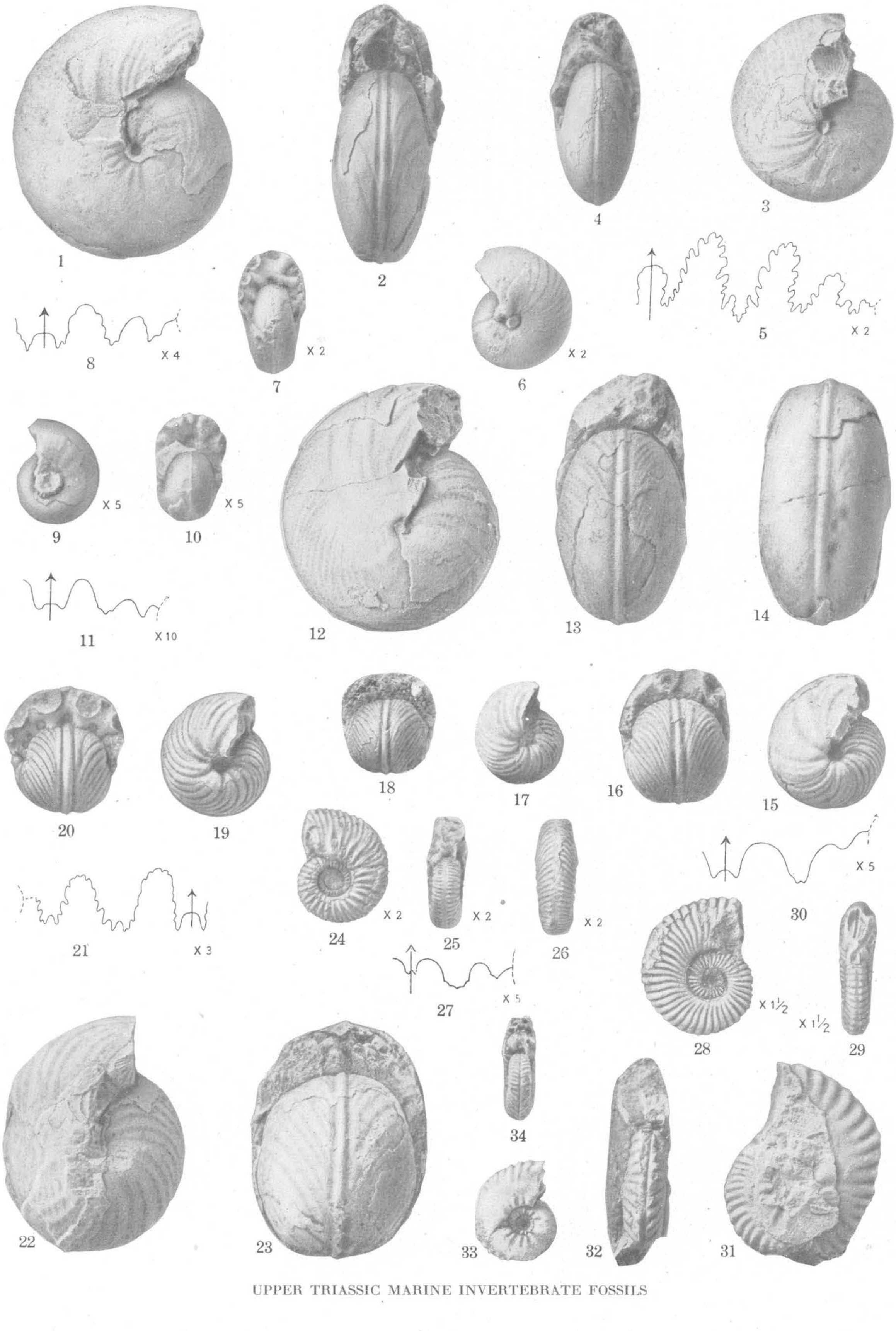
FIGURES 22, 23. *Paratropites* (*Paulotropites*) *colei* Smith, n. sp. (p. 47). Type.

FIGURES 24–27. *Sandlingites oribasus* Dittmar (p. 83). Typical specimen.

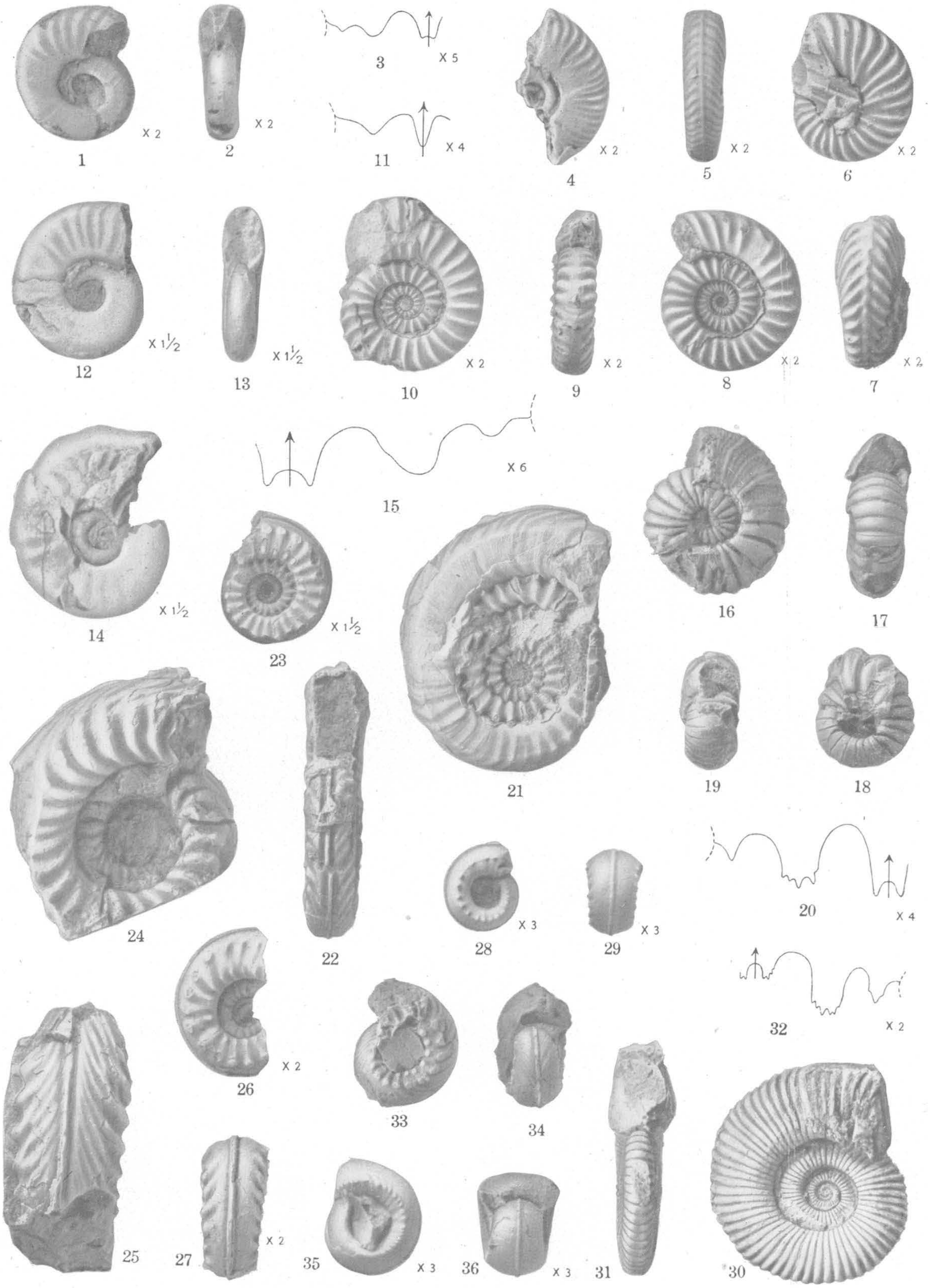
FIGURES 28–30. *Polycyclus henseli* Oppel (p. 97). Shell and septa.

FIGURES 31–34. *Arpadites kingi* Smith, n. sp. (p. 94).
- 31, 32. Type.
- 33, 34. Adolescent specimen; diameter 18 millimeters.

All specimens figured on this plate came from the lower or *Trachyceras* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone, at the old stone quarry on Brock Mountain, divide between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LVIII

FIGURES 1–5. *Tropiceltites caducus* Dittmar (p. 50).

1–3. Shell and septa.

4, 5. Another specimen, showing the sculpture.

FIGURES 6, 7. *Thisbites uhligi* Mojsisovics (p. 98).

FIGURES 8–11. *Celtites steindachneri* Mojsisovics (p. 51).

8, 9. Shell.

10, 11. Another specimen, showing septa.

FIGURES 12–15. *Tornquistites obolinus* Dittmar (pp. 50–51).

12, 13. Shell.

14, 15. Shell and septa.

FIGURES 16–20. *Leconteiceras occidentale* Smith, n. sp. (p. 66).

16, 17. Type.

18–20. Shell and septa.

FIGURES 21–23. *Anatropites hauchecornei* Mojsisovics (p. 49).

21, 22. Adult stage.

23. Adolescent stage; diameter 13 millimeters.

FIGURES 24–29. *Margarites jokelyi* Hauer (p. 48).

24, 25. Adult specimen.

26, 27. Adolescent stage; diameter 12 millimeters.

28, 29. Early adolescent stage; diameter 5 millimeters.

FIGURES 30–32. *Polycyclus major* Smith, n. sp. (p. 97). Type.

FIGURES 33–36. *Margarites senilis* Mojsisovics (p. 49).

33, 34. Mature specimen.

35, 36. Adolescent stage; diameter 6 millimeters.

All specimens figured on this plate came from the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone, Shasta County, Calif. Figures 1–5, 12–20, from the lower or *Trachyceras* subzone at the old quarry on Brock Mountain, 3 miles east of Madison's ranch; collection of J. P. Smith. Figures 6–11, 21–36, from the upper or *Juvavites* subzone, on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch; collection of U. S. Geological Survey.

PLATE LIX

FIGURES 1–3. *Choristoceras kellyi* Smith, n. sp. (p. 97). Type.

FIGURES 4–8. *Tirolites* (*Metatirolites*) *subpygmaeus* Mojsisovics (p. 95).

4–6. Adult shell; diameter 9 millimeters.

7, 8. Adolescent stage; diameter 4 millimeters.

FIGURES 9–11. *Tirolites* (*Metatirolites*) *quadrangulus* Mojsisovics (pp. 95–96). Shell and septa

FIGURES 12, 13. *Choristoceras klamathense* Smith, n. sp. (pp. 97–98). Type.

FIGURES 14–20. *Microtropites tubercularis* Mojsisovics (p. 48).

14, 15. Adult shell; diameter 16 millimeters.

16–18. Adult shell; diameter 12.5 millimeters.

19, 20. Adolescent stage; diameter 8.5 millimeters.

FIGURES 21–26. *Homerites semiglobosus* Hauer (p. 52).

21–23. Mature shell.

24–26. Adolescent stage.

FIGURES 27–33. *Margarites septentrionalis* Smith, n. sp. (p. 49).

27–29. Type.

30, 31. Adolescent stage; diameter 14.5 millimeters.

32, 33. Early adolescent stage; diameter 5 millimeters.

FIGURES 34–47. *Metasibirites pygmaeus* Smith, n. sp. (p. 65).

34–36. Type.

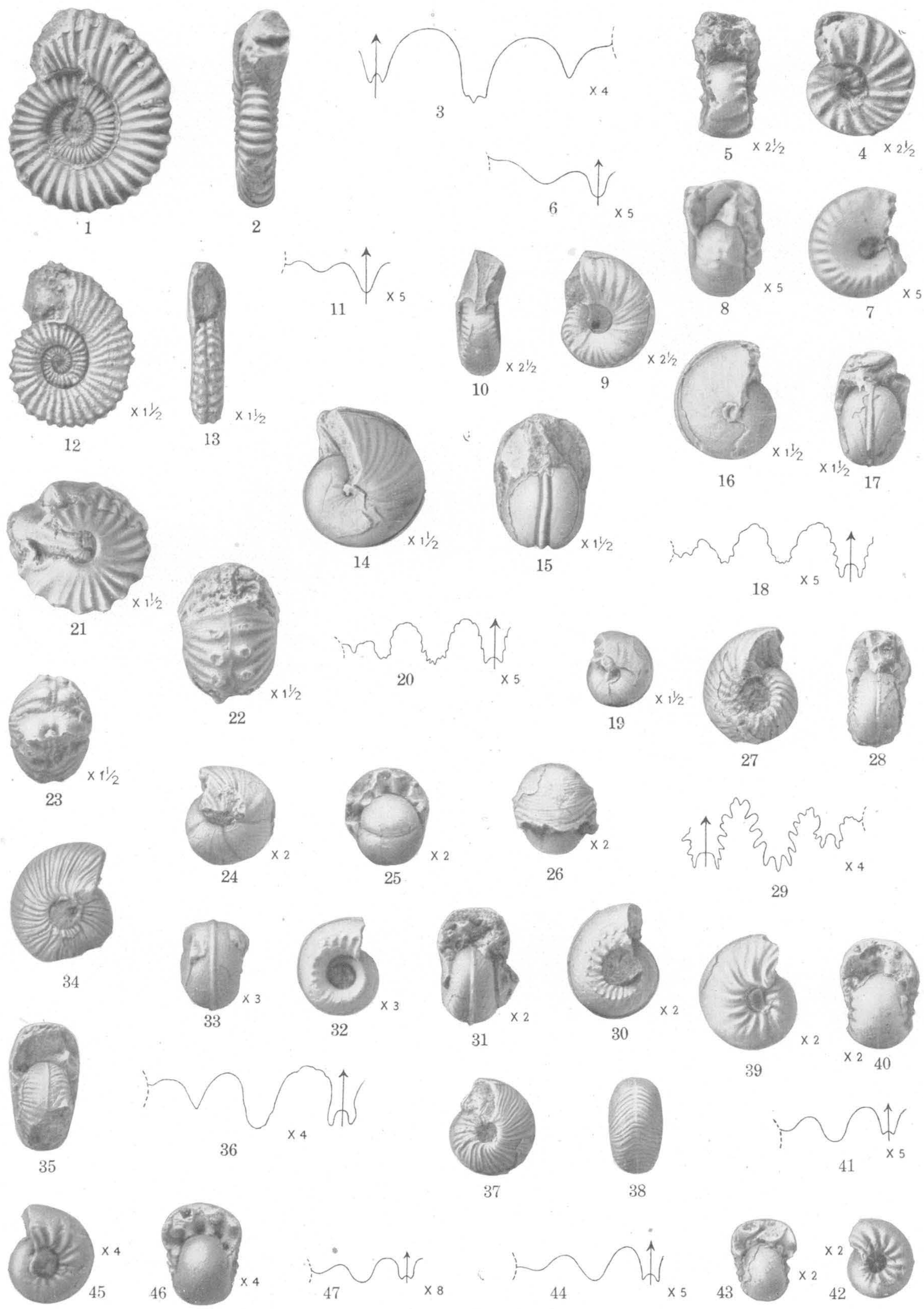
37, 38. Mature stage.

39–41. Diameter 9.5 millimeters.

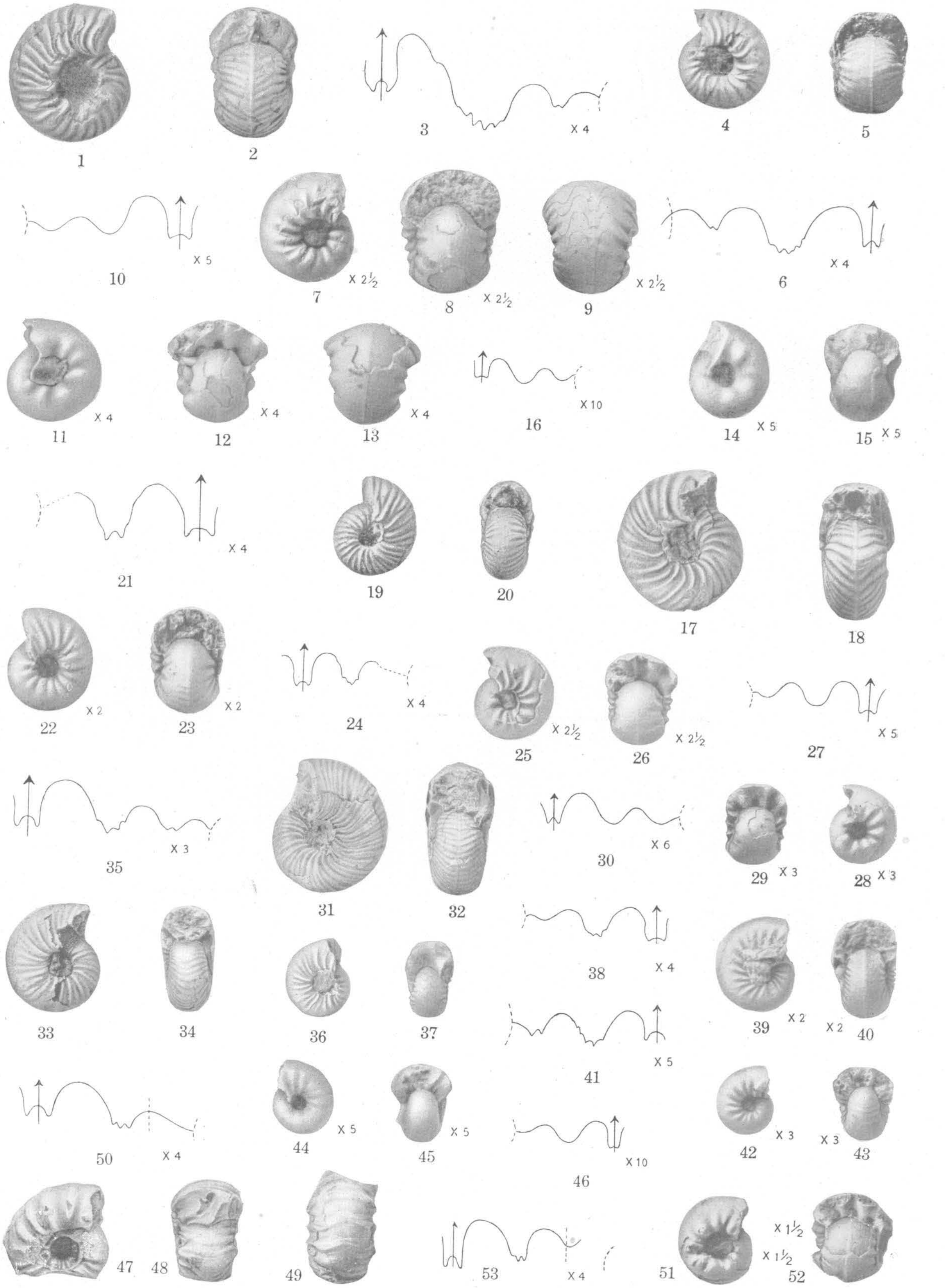
42–44. Early mature stage; diameter 7 millimeters.

45–47. Late larval stage; diameter 4.5 millimeters.

All specimens figured on this plate came from the upper or *Juvavites* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone, Shasta County, Calif. Figures 1–13, 21–23, from the North Fork of Squaw Creek, 3 miles north of Kelly's ranch; Figures 14–20, 34–47, from the north end and west side of Brock Mountain 5 miles north of Madison's ranch on Squaw Creek. All in collection of U. S. Geological Survey.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LX

FIGURES 1–16. *Metasibirites coei* Smith, n. sp. (p. 63).
1–3. Type.
4–6. Mature stage, showing septa.
7–10. Adolescent stage; diameter 8 millimeters.
11–13. Adolescent stage; diameter 4.5 millimeters.
14–16. Larval stage; diameter 3 millimeters.

FIGURES 17–30. *Metasibirites frechi* Hyatt and Smith (p. 63).
17, 18. Typical mature specimen.
19–21. Mature shell and septa.
22–24. Adolescent stage; diameter 9 millimeters.
25–27. Adolescent stage; diameter 6 millimeters.
28–30. Larval stage; diameter 4.5 millimeters.

FIGURES 31–46. *Metasibirites parvus* Hyatt and Smith (p. 64).
31, 32. Mature stage.
33–35. Shell and septa.
36–38. Shell and septa.
39–41. Adolescent stage; diameter 8 millimeters.
42, 43. Adolescent stage; diameter 4 millimeters.
44–46. Larval stage; diameter 2.5 millimeters.

FIGURES 47–53. *Metasibirites brockensis* Smith, n. sp. (p. 63).
47–50. Type.
51–53. Adolescent stage.

All specimens figured on this plate came from the upper or *Juvavites* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone at the north end and west side of Brock Mountain, 5 miles north of Madison's ranch on Squaw Creek, Shasta County, Calif. Collection of U. S. Geological Survey.

PLATE LXI

FIGURES 1–7. *Metasibirites pusillus* Smith, n. sp. (p. 65).
- 1–4. Type.
- 5–7. Early mature stage.

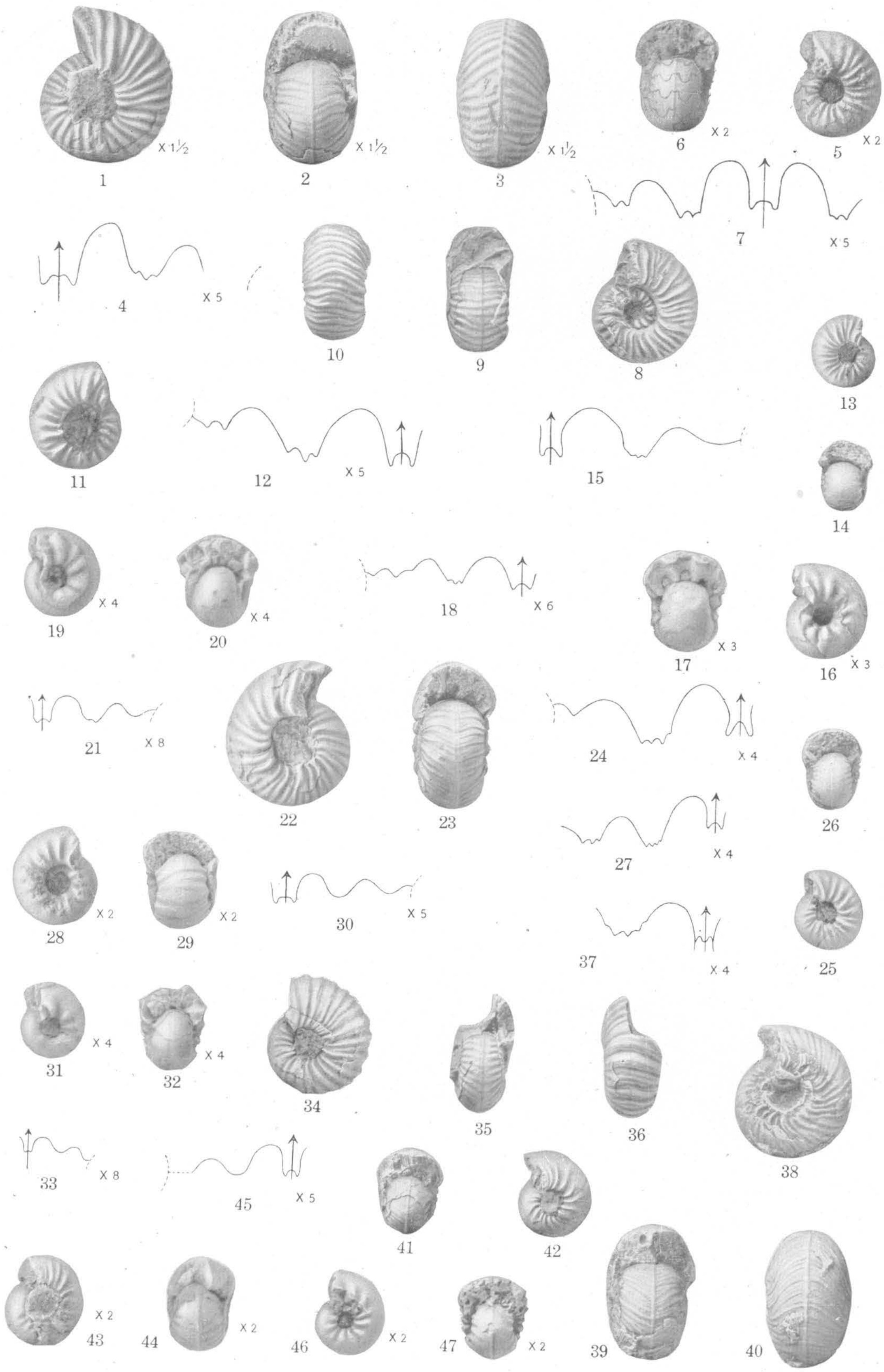
FIGURES 8–21. *Metasibirites mojsvarensis* Smith, n. sp. (p. 64).
- 8–10. Type.
- 11–12. Mature specimen.
- 13–15. Shell and septa.
- 16–18. Adolescent stage; diameter 5.5 millimeters.
- 19–21. Larval stage; diameter 4 millimeters.

FIGURES 22–33. *Metasibirites shastensis* Smith, n. sp. (p. 65).
- 22–24. Type.
- 25–27. Mature stage.
- 28–30. Adolescent stage; diameter 7.5 millimeters.
- 31–33. Larval stage; diameter 3 millimeters.

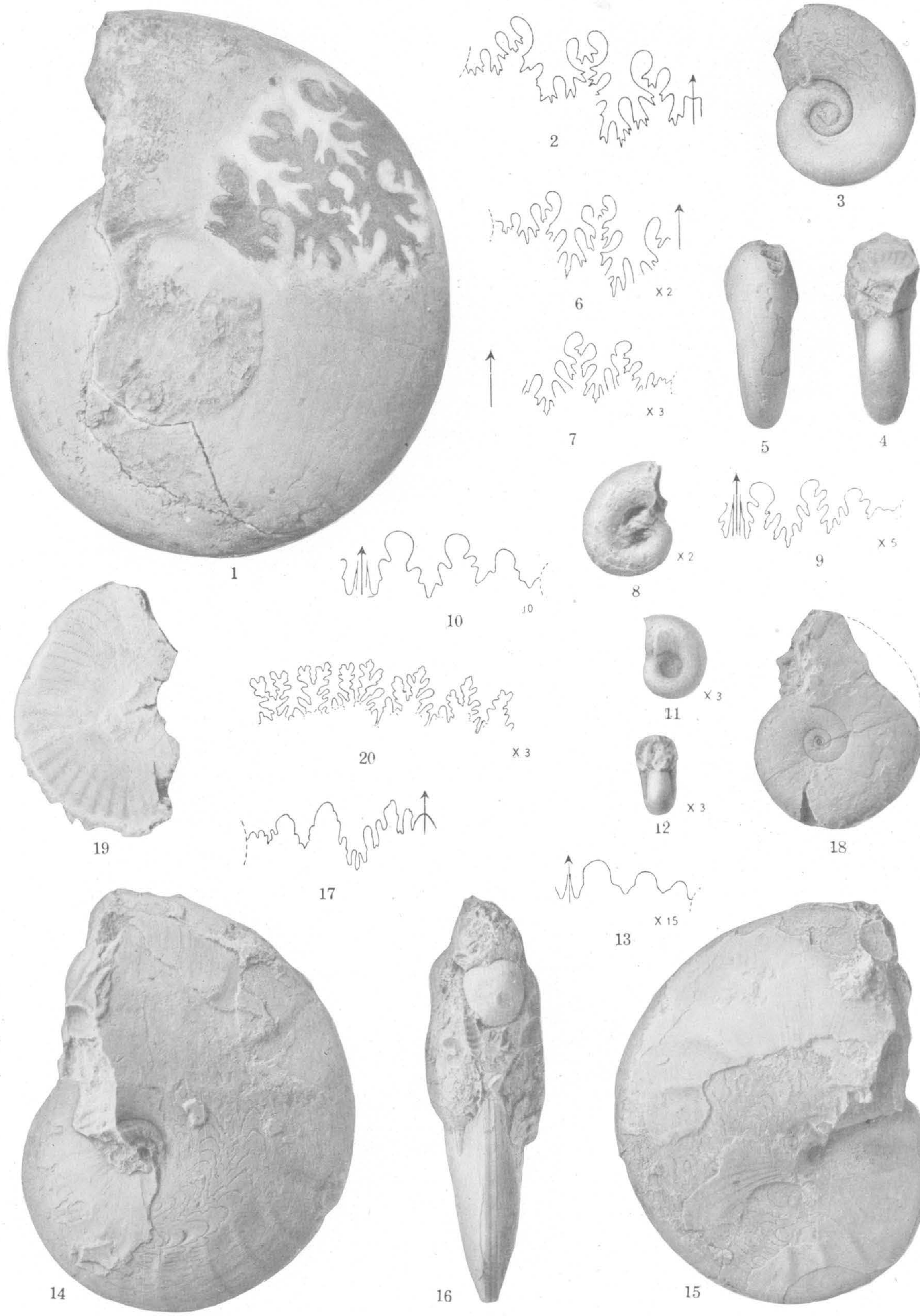
FIGURES 34–37. *Metasibirites gracilis* Smith, n. sp. (p. 64). Type.

FIGURES 38–47. *Metasibirites modestus* Smith, n. sp. (p. 64).
- 38–40. Type.
- 41–42. Shell.
- 43–45. Adolescent stage; diameter 7.5 millimeters.
- 46–47. Adolescent stage; diameter 4.5 millimeters.

All specimens figured on this plate came from the upper or *Juvavites* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone at the north end of Brock Mountain, about 5 miles north of Madison's ranch on Squaw Creek, Shasta County, Calif. Collection of the U. S. Geological Survey.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LXII

FIGURES 1–13. *Rhacophyllites* (*Discophyllites*) *patens* Mojsisovics (p. 100).

1, 2. Large adult specimen.

3–7. Adolescent stage; diameter 30 millimeters; Figure 6, septa at diameter 30 millimeters; Figure 7, septa at diameter 12 millimeters.

8–10. Adolescent stage; diameter 10 millimeters; Figure 9, septa at diameter 10 millimeters; Figure 10, septa at diameter 5 millimeters.

11–13. Late larval stage; diameter 5 millimeters; septa of same specimen at diameter about 2 millimeters.

FIGURES 14–17. *Klamathites schucherti* Smith, n. sp. (p. 74). Type.

FIGURES 18–20. *Pinacoceras rex* Mojsisovics (p. 75).

18. Typical specimen.

19, 20. Shell and septa.

All specimens figured on this plate came from the upper or *Juvavites* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone of Shasta County, Calif.; collection of the U. S. Geological Survey. Figures 1, 2 from the north end of Brock Mountain, 5 miles north of Madison's ranch on Squaw Creek; Figures 3–20 from the North Fork of Squaw Creek, 3 miles north of Kelly's ranch.

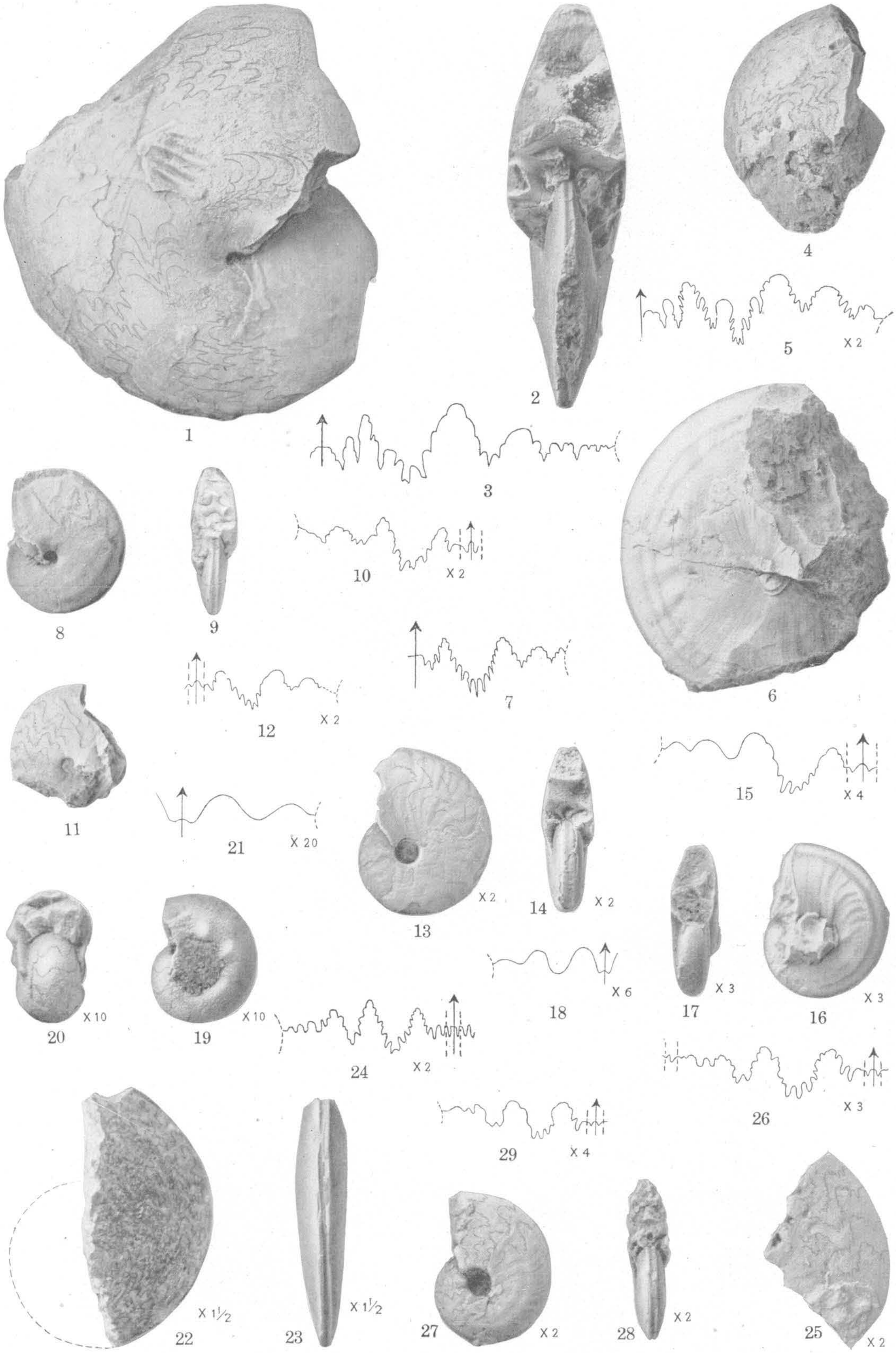
PLATE LXIII

FIGURES 1–5. *Klamathites kellyi* Smith, n. sp. (p. 74).
1–3. Type.
4, 5. Early mature stage.

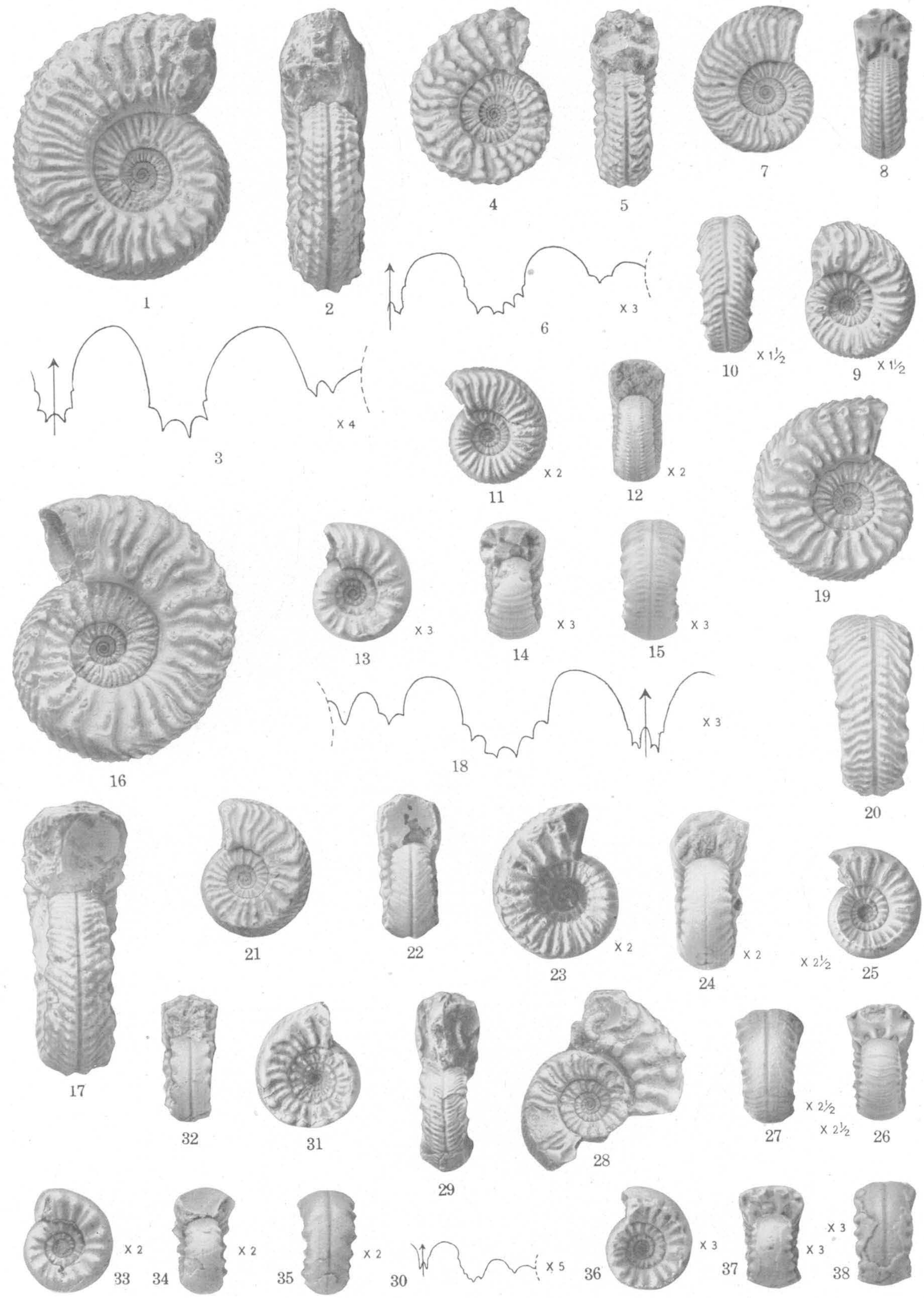
FIGURES 6–21. *Fremontites ashleyi* Hyatt and Smith (pp. 74–75).
6, 7. Typical mature specimen.
8–10. Adolescent stage; diameter 23 millimeters.
11, 12. Diameter 20 millimeters.
13–15. Adolescent stage; diameter 13.5 millimeters.
16–18. Adolescent stage; diameter 8 millimeters.
19–21. Larval stage corresponding to *Gephyroceras;* diameter 2 millimeters.

FIGURES 22–29. *Hauerites lawsoni* Smith, n. sp. (pp. 72–73).
22–24. Type.
25–26. Early mature stage; diameter 20 millimeters.
27–29. Adolescent stage; diameter 14 millimeters.

All specimens figured on this plate came from the lower or *Trachyceras* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone of Brock Mountain, east side of Squaw Creek, Shasta County, Calif. Figures 1–21 from point 1 mile north of the old stone quarry; collection of U. S. Geological Survey. Figures 22–29 from point near the old stone quarry 3 miles east of Madison's ranch; collection of J. P. Smith.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LXIV

FIGURES 1–15. *Clionites (Traskites) americanus* Smith, n. sp. (p. 85).
1–3. Type.
4–6. Early adult stage.
7, 8. Early adult stage.
9, 10. Adolescent stage; diameter 15 millimeters.
11, 12. Adolescent stage; diameter 10 millimeters.
13–15. Adolescent stage; diameter 7 millimeters.

FIGURES 16–27. *Clionites (Traskites) stantoni* Smith, n. sp. (pp. 87–88).
16–18. Type.
19–20. Early mature stage.
21, 22. Early mature stage.
23, 24. Adolescent stage; diameter 14 millimeters.
25–27. Adolescent stage; diameter 8 millimeters.

FIGURES 28–38. *Clionites (Neanites) minutus* Smith, n. sp. (p. 91).
28–30. Type.
31, 32. Early mature stage.
33–35. Adolescent stage; diameter 9 millimeters.
36–38. Early adolescent stage; diameter 6 millimeters.

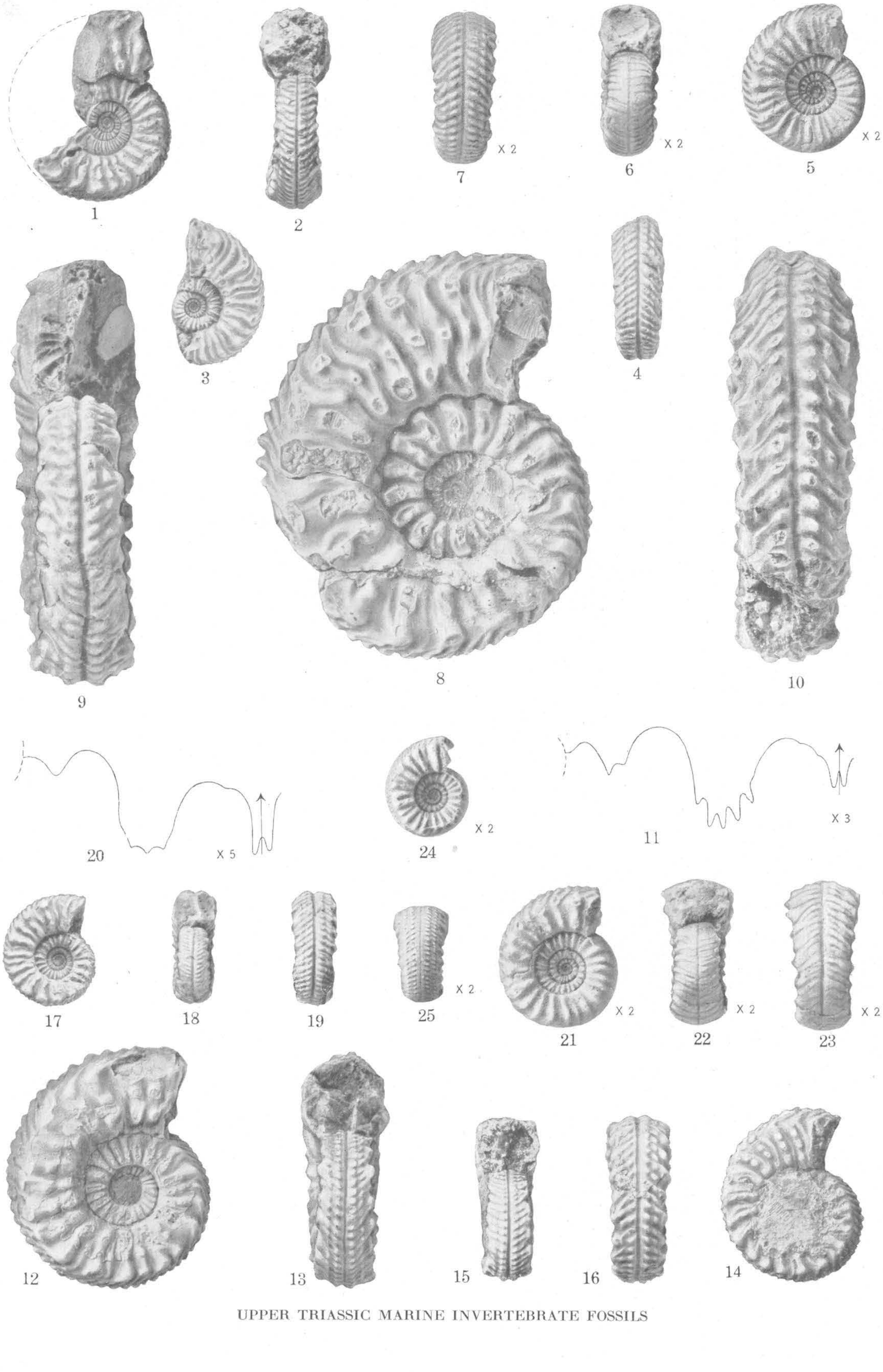
All specimens figured on this plate came from the lower or *Trachyceras* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone near the old stone quarry on Brock Mountain, on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch, Shasta County, Calif. Collection of J. P. Smith.

PLATE LXV

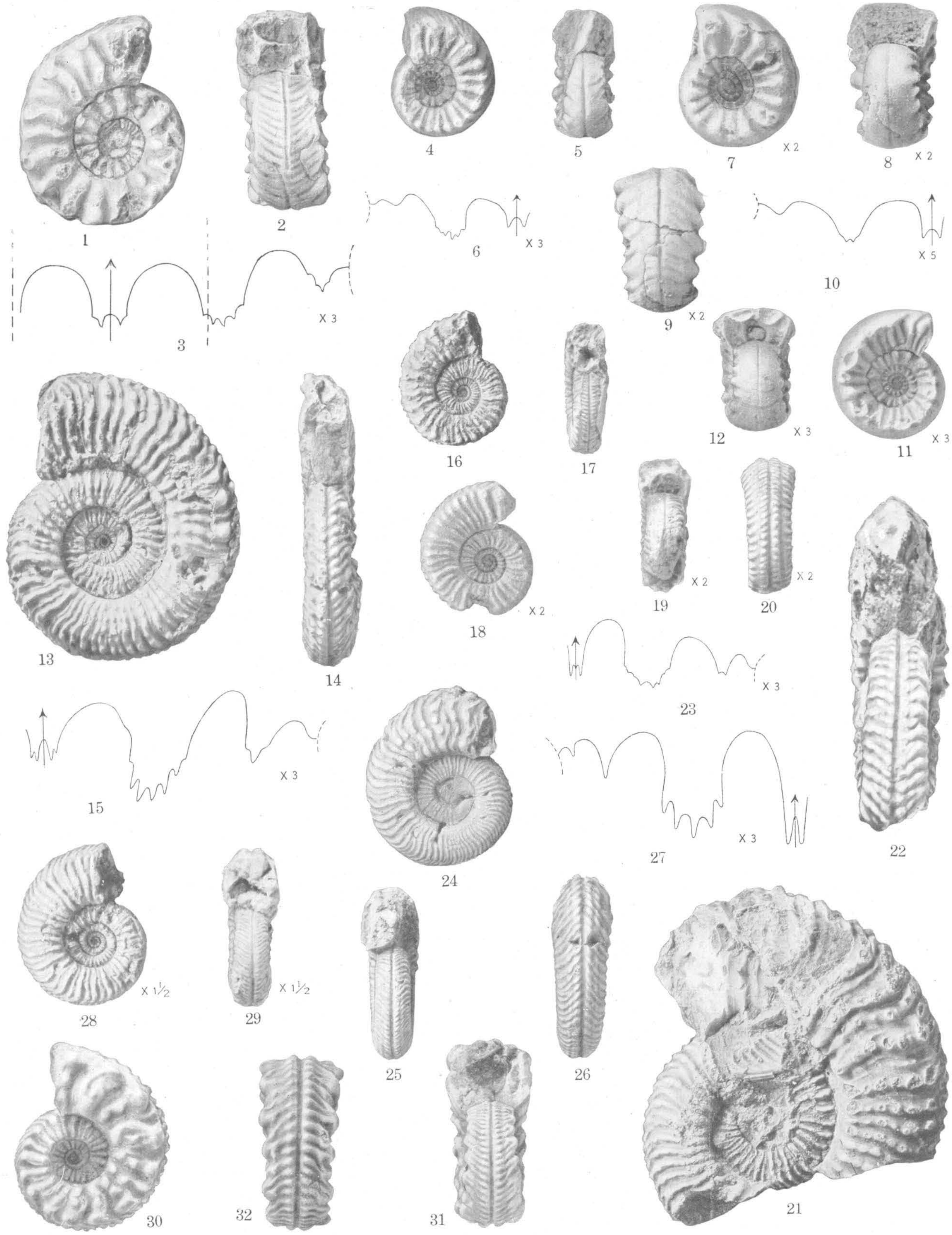
FIGURES 1–7. *Clionites* (*Traskites*) *nanus* Smith, n. sp. (p. 88).
1, 2. Type.
3, 4. Mature specimen, showing the young coil inside.
5–7. Adolescent stage; diameter 13 millimeters.

FIGURES 8–25. *Clionites* (*Traskites*) *tornquisti* Smith, n. sp. (p. 88).
8–11. Type.
12, 13. Early mature stage.
14–16. Early mature stage.
17–20. Adolescent stage.
21–23. Adolescent stage; diameter 12 millimeters.
24, 25. Adolescent stage; diameter 8 millimeters.

All specimens figured on this plate came from the lower or *Trachyceras* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone at the south end of Brock Mountain, on the divide between Squaw Creek and Pit River, Shasta County, Calif. Figures 1–11, 14–25, collection of J. P. Smith; Figures 12, 13, collection of U. S. Geological Survey.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LXVI

FIGURES 1–12. *Clionites* (*Californites*) *careyi* Smith, n. sp. (p. 92).
- 1–3. Type.
- 4–6. Early mature stage.
- 7–10. Adolescent stage; diameter 13 millimeters.
- 11, 12. Early larval stage; diameter 7.5 millimeters.

FIGURES 13–20. *Clionites* (*Stantonites*) *evolutus* Smith, n. sp. (p. 90).
- 13–15. Type.
- 16, 17. Early mature stage.
- 18–20. Adolescent stage; diameter 12 millimeters.

FIGURES 21–29. *Clionites* (*Shastites*) *whitneyi* Smith, n. sp. (p. 89).
- 21–23. Type.
- 24–27. Early mature stage.
- 28, 29. Adolescent stage; diameter 18 millimeters.

FIGURES 30–32. *Clionites* (*Traskites*) *robustus* Hyatt and Smith (p. 87). Adolescent stage.

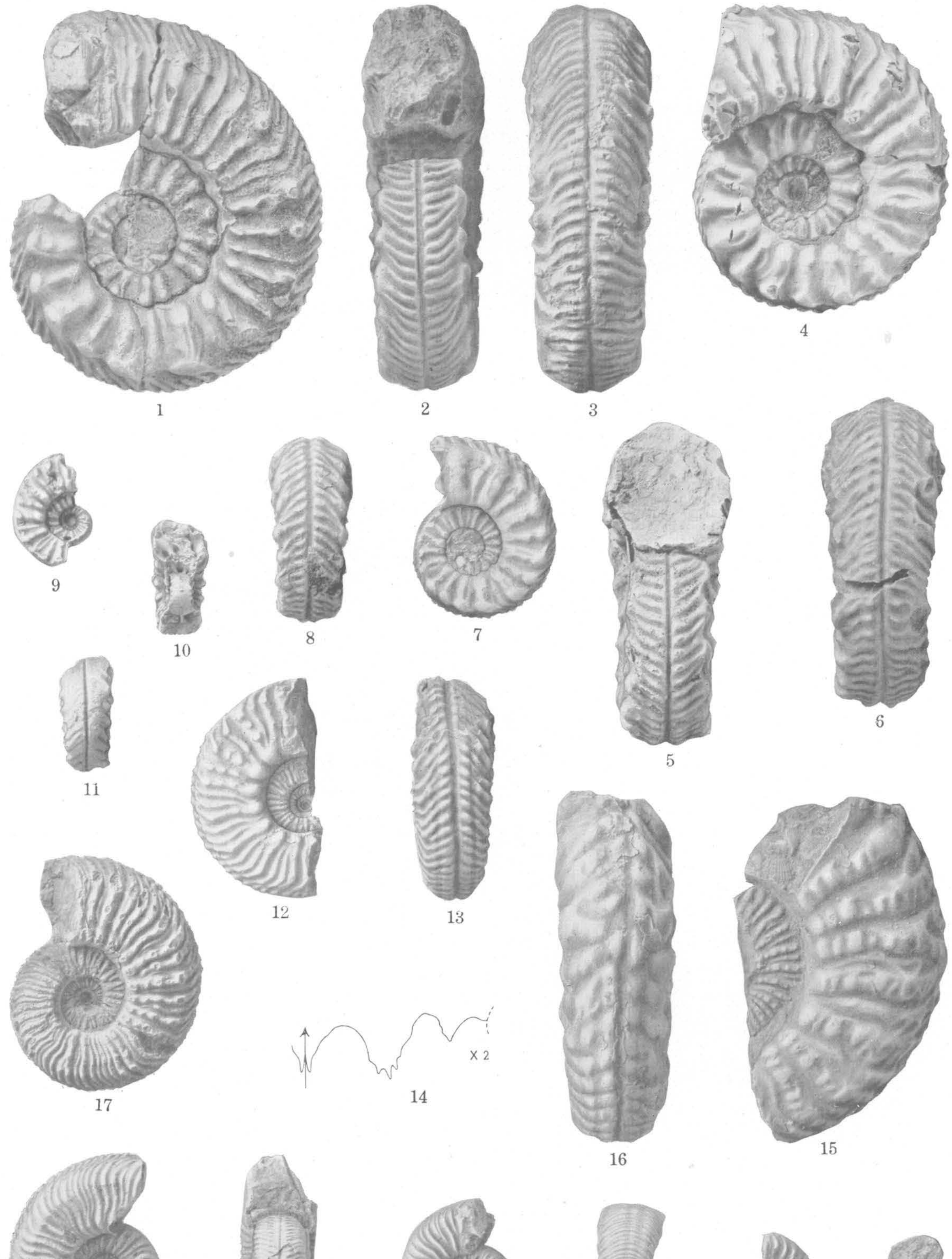
All specimens figured on this plate came from the lower or *Trachyceras* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone on Brock Mountain, on the divide between Squaw Creek and Pit River, 3 miles east of Madison's ranch, Shasta County, Calif. Collection of J. P. Smith.

PLATE LXVII

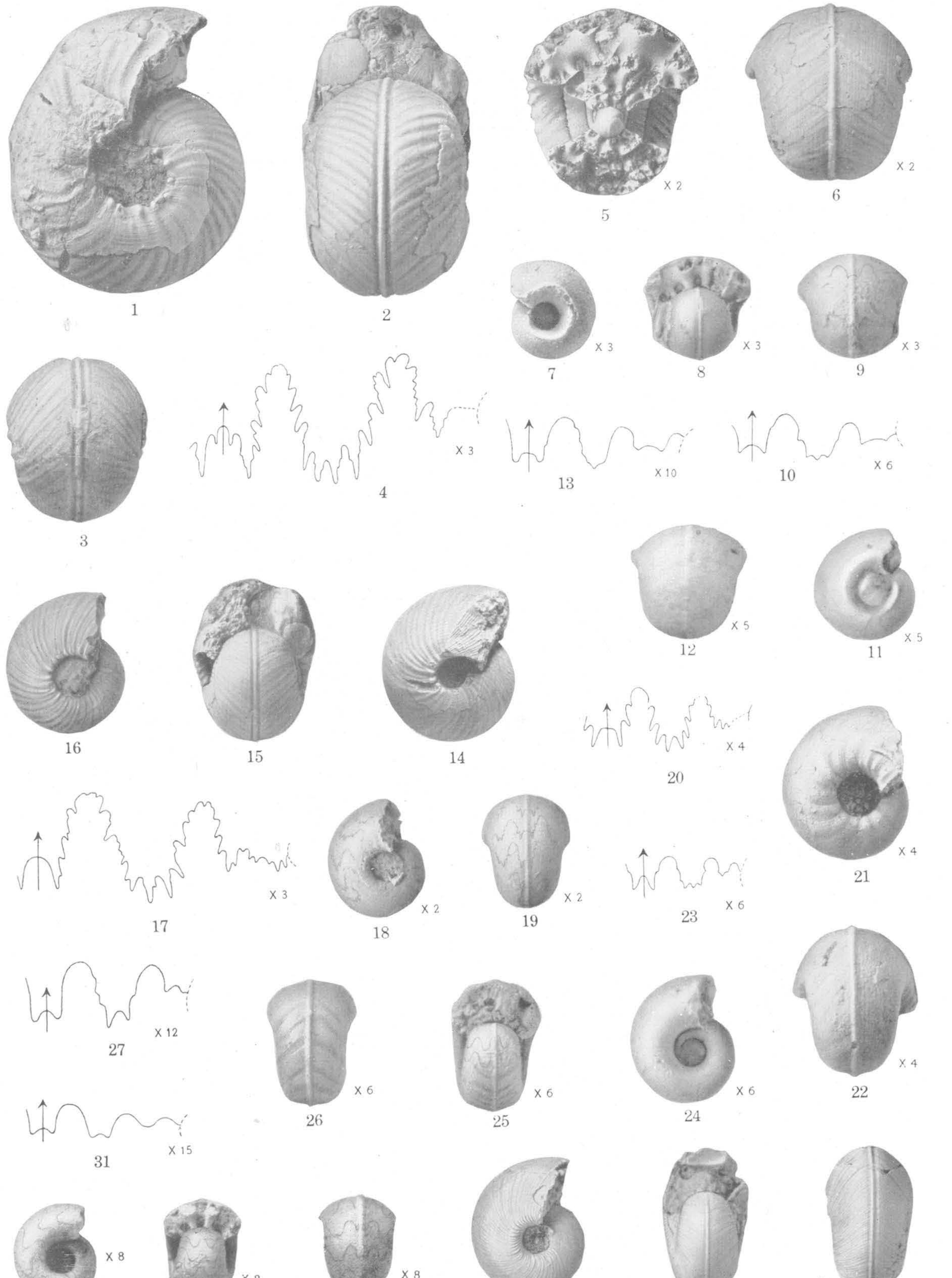
FIGURES 1–11. *Clionites* (*Neanites*) *osmonti* Smith, n. sp. (p. 91).
- 1–3. Type.
- 4–6. Adult stage.
- 7, 8. Adolescent stage.
- 9–11. Adolescent stage.

FIGURES 12–23. *Clionites* (*Shastites*) *compactus* Smith, n. sp. (p. 89).
- 12–14. Type.
- 15, 16. View showing fully mature or old-age characters.
- 17. Early mature stage.
- 18, 19. Adolescent stage; diameter 16 millimeters.
- 20–21. Adolescent stage; diameter 11 millimeters.
- 22, 23. Adolescent stage, showing larval stage inside; diameter 9 millimeters.

All specimens figured on this plate came from the lower or *Trachyceras* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone at the south end of Brock Mountain, on the divide between Squaw Creek and Pit River, Shasta County, Calif. Figures 1–3, 7–23, from Smith Cove, near the old quarry on the divide; collection of J. P. Smith. Figures 4–6 from point 1 mile north of the quarry; collection of U. S. Geological Survey.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LXVIII

FIGURES 1–13. *Tropites dilleri* Smith (p. 29).
- 1, 2. Type specimen, side and front, refigured.
- 3, 4. Cotype; rear and septa; refigured.
- 5, 6. Early mature stage; diameter 16 millimeters.
- 7–10. Late adolescent stage; diameter 5.5 millimeters; side, front, rear, and septa.
- 11–13. Early adolescent stage; diameter 3.5 millimeters; side, rear, and septa.

FIGURES 14–31. *Tropites torquillus* Mojsisovics (pp. 28–29).
- 14, 15. Adult shell.
- 16, 17. Shell and septa.
- 18–20. Adolescent stage; diameter 15 millimeters.
- 21–23. Adolescent stage; diameter 6.5 millimeters.
- 24–27. Late larval stage; diameter 3.5 millimeters.
- 28–31. Larval stage; diameter 2 millimeters.

FIGURES 32–34. *Tropites discobullatus* Mojsisovics (p. 28). Early mature stage, natural size.

All specimens figured on this plate came from the lower or *Trachyceras* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone of Brock Mountain, south end, on the divide between Squaw Creek and Pit River, Shasta County, Calif. They are in the collection of J. P. Smith, at Stanford University, with the exception of Figures 32–34, which are in the collection of the U. S. Geological Survey.

PLATE LXIX

Figures 1–12. *Tropites armatus* Smith, n. sp. (p. 31).

1, 2. Adult specimen.

3–5. Early adult stage.

6. Septa of a mature specimen.

7–9. Early adult stage.

10–12. Diameter 12 millimeters, showing development of septa.

Figures 13–24. *Tropites morloti* Mojsisovics (p. 31).

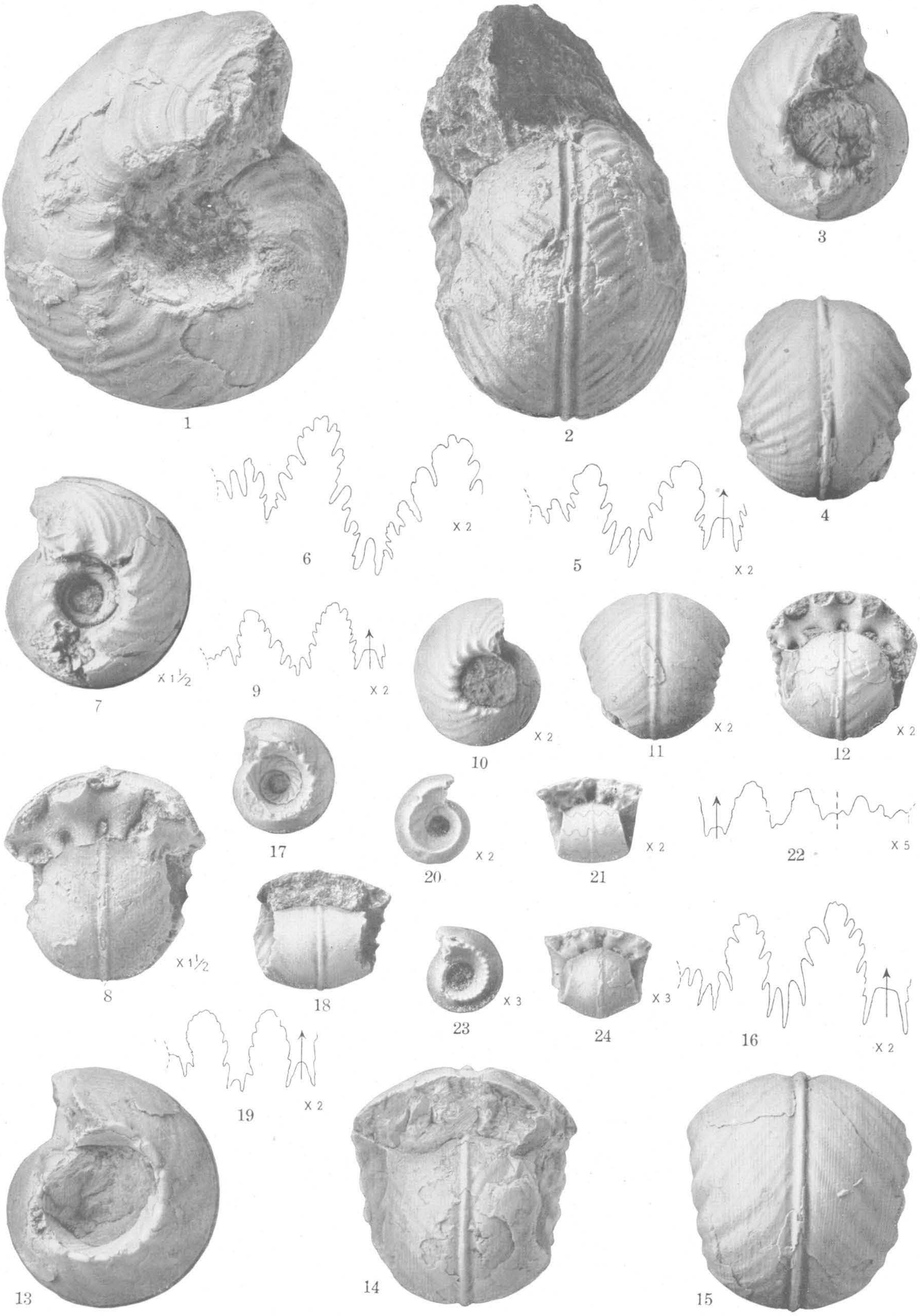
13–16. Adult stage.

17–19. Early adult stage.

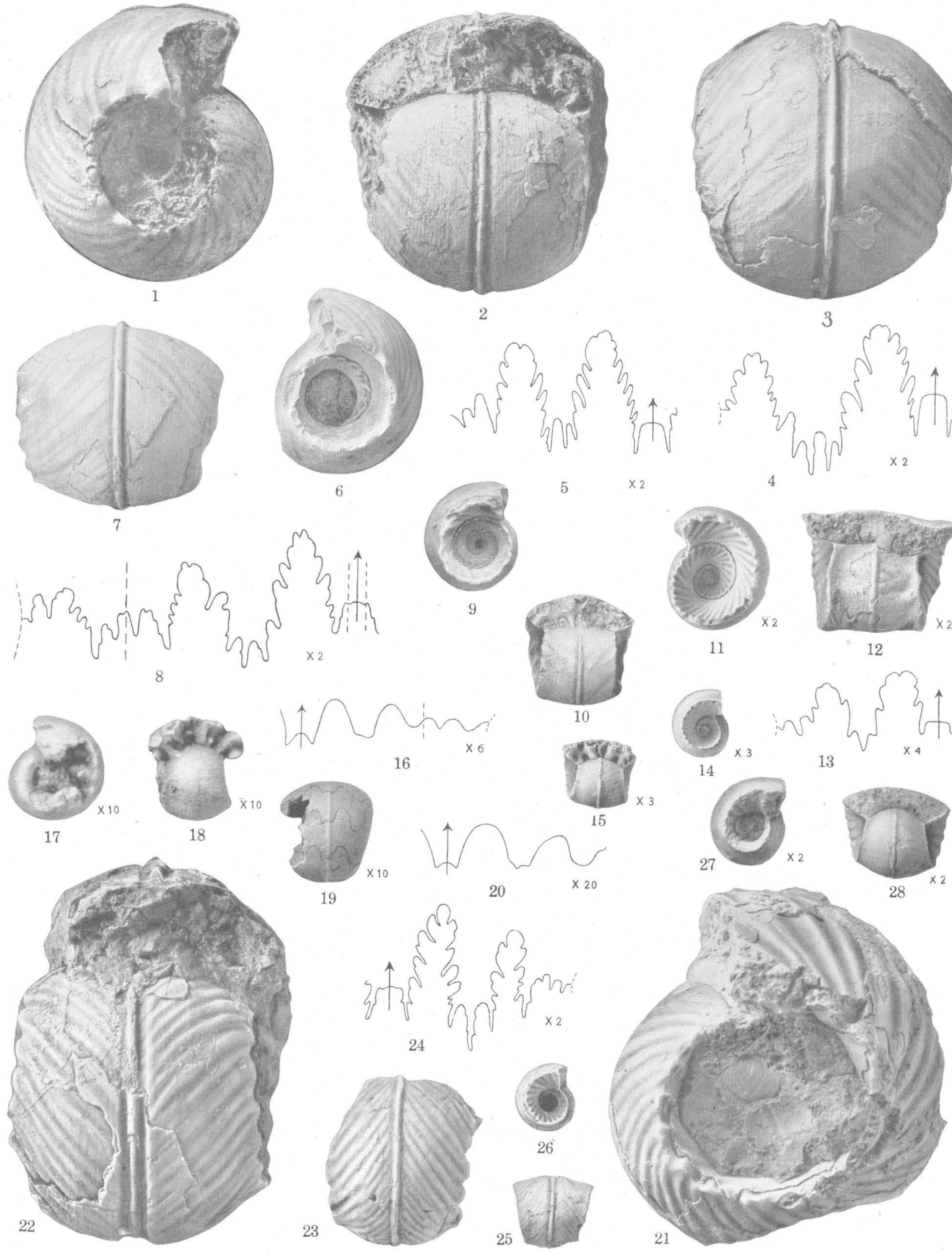
20–22. Adolescent stage.

23–24. Early adolescent stage; diameter 4.75 millimeter.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, in the lower or *Trachyceras* subzone of the zone of *Tropites subbullatus* on the south end of Brock Mountain, Shasta County, Calif. Collection of J. P. Smith.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LXX

FIGURES 1–20. *Tropites occidentalis* Smith, n. sp. (pp. 31–32).

1–4. Type.

5. Septa from another specimen.

6–8. Shell.

9, 10. Adolescent stage.

11–13. Adolescent stage; diameter 11 millimeters.

14–16. Adolescent stage; diameter 6 millimeters.

17–20. Larval stage; diameter 1.6 millimeters.

FIGURES 21–28. *Tropites fusobullatus* Mojsisovics (p. 32).

21, 22. Adult stage.

23, 24. Shell and septa.

25, 26. Adolescent stage.

27, 28. Early adolescent stage.

All specimens figured on this plate came from the lower or *Trachyceras* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone at the south end of Brock Mountain, Shasta County, Calif. Collection of J. P. Smith, except Figures 6–8, which are in the collection of the U. S. Geological Survey.

PLATE LXXI

FIGURES 1–3. *Tropites rotatorius* Smith, n. sp. (pp. 32–33). Type.

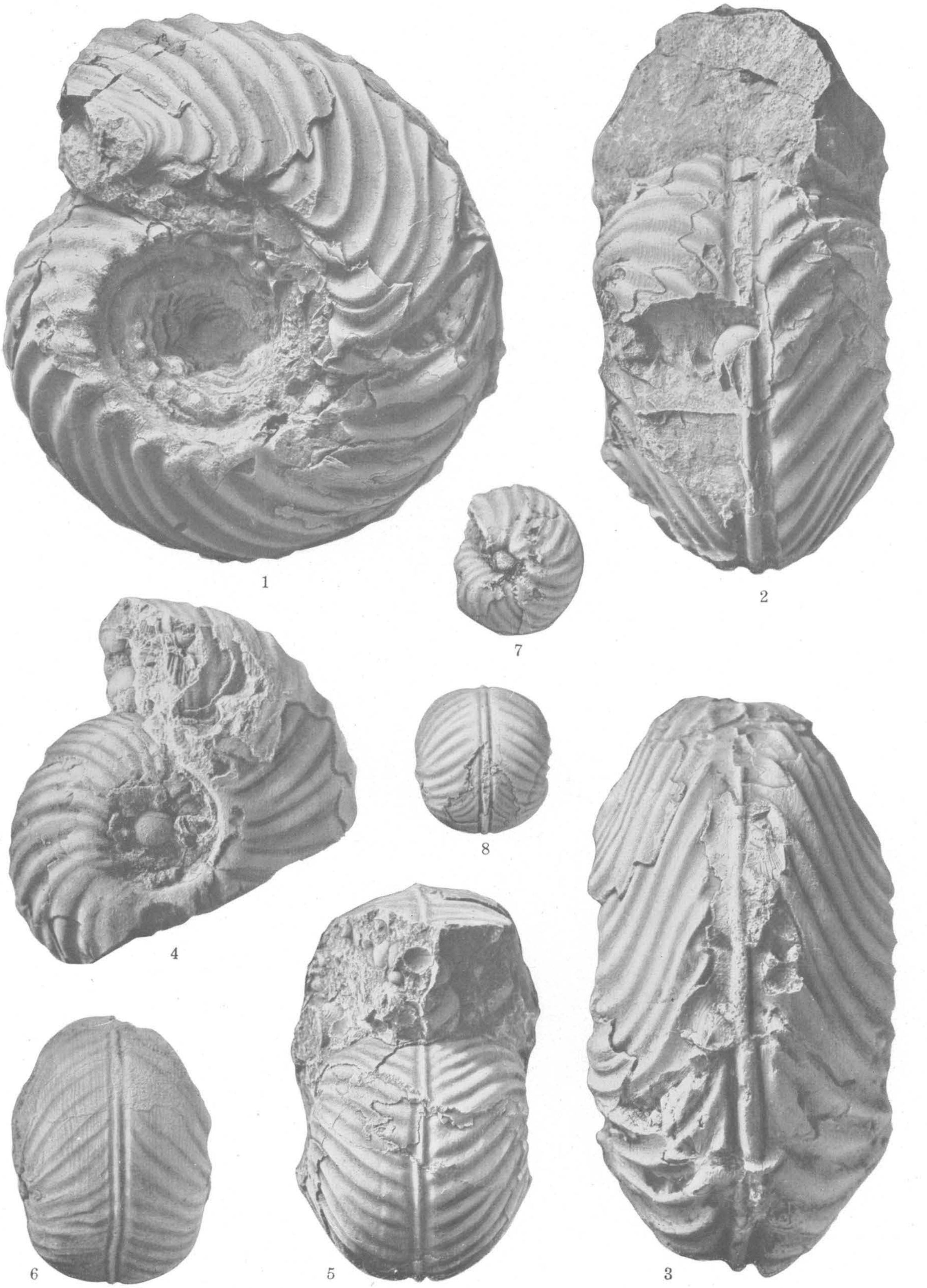
4–8. *Tropites rothpletzi* Smith, n. sp. (pp. 37–38).

4, 5. Type.

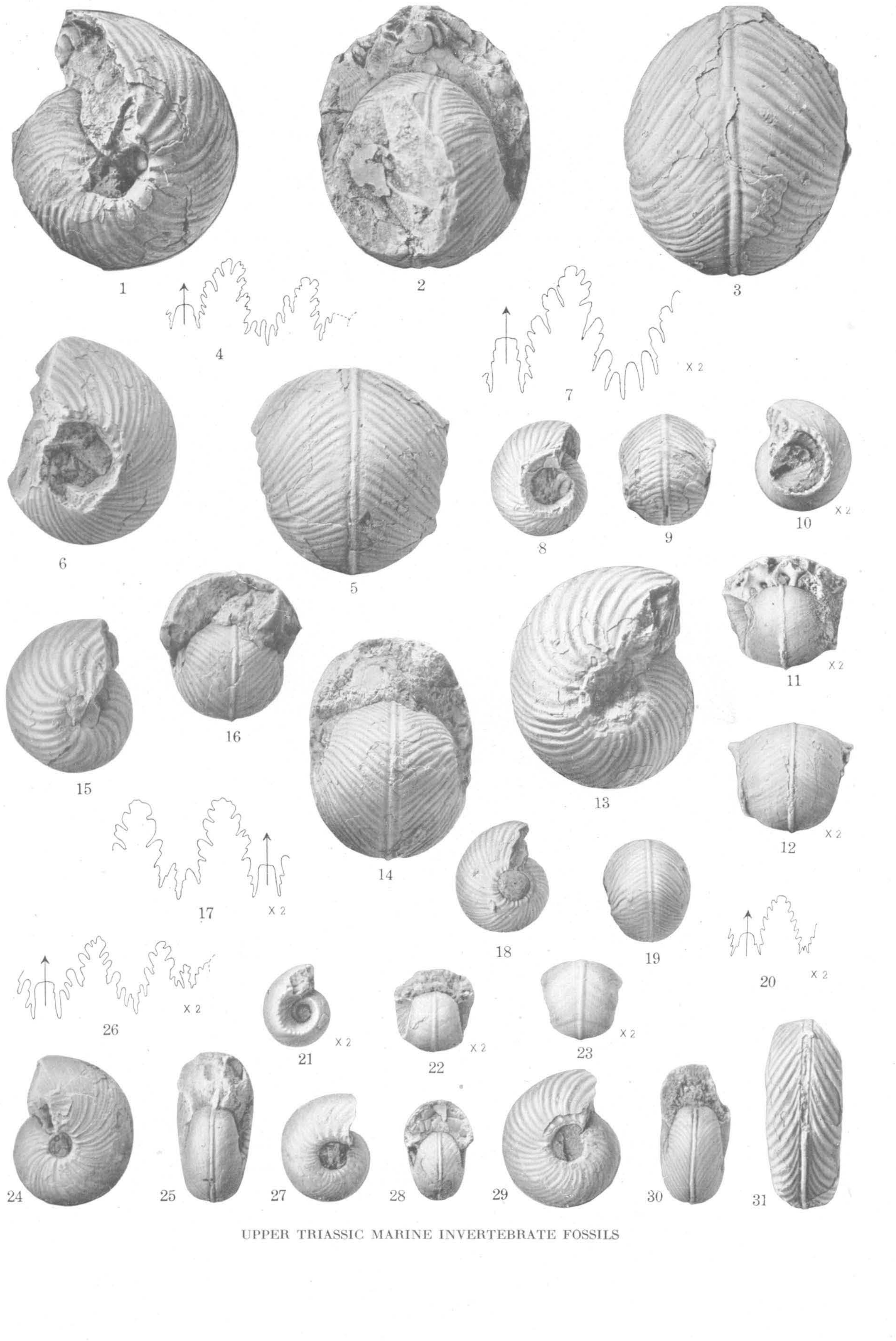
6. Early adult stage.

7, 8. Earlier adult stage.

All specimens figured on this plate came from the upper or *Juvavites* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone at the north end and west side of Brock Mountain, Shasta County, Calif., collection of U. S. Geological Survey, except Figures 7, 8, from the same horizon on Bear Mountain, south of Pit River, Shasta County, collection of J. P. Smith.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LXXII

FIGURES 1–12. *Tropites stearnsi* Smith, n. sp. (p. 37).
1–4. Type.
5–7. Early adult stage.
8, 9. Late adolescent stage.
10–12. Adolescent stage; diameter 10 millimeters.

FIGURES 13–23. *Tropites arthaberi* Smith, n. sp. (p. 37).
13, 14. Type.
15–17. Early mature stage; septa (fig. 17).
18–20. Late adolescent stage; septa (fig. 20).
21–23. Adolescent stage; diameter 7.5 millimeters.

FIGURES 24–28. *Tropites keili* Mojsisovics (p. 33).
24–26. Adult stage.
27, 28. Early adult stage.

FIGURES 29–31. *Tropites wodani* Mojsisovics (p. 33). Adult stage.

All specimens figured on this plate came from the upper or *Juvavites* subzone of the *Tropites subbullatus* zone in the Upper Triassic Hosselkus limestone at the north end and west side of Brock Mountain near Squaw Creek, Shasta County, Calif. Collection of U. S. Geological Survey.

PLATE LXXIII

FIGURES 1–6. *Tropites hessi* Smith, n. sp. (p. 37).

1–3. Type.

4–6. Early mature stage.

FIGURES 7–18. *Tropites morani* Smith, n. sp. (pp. 36–37).

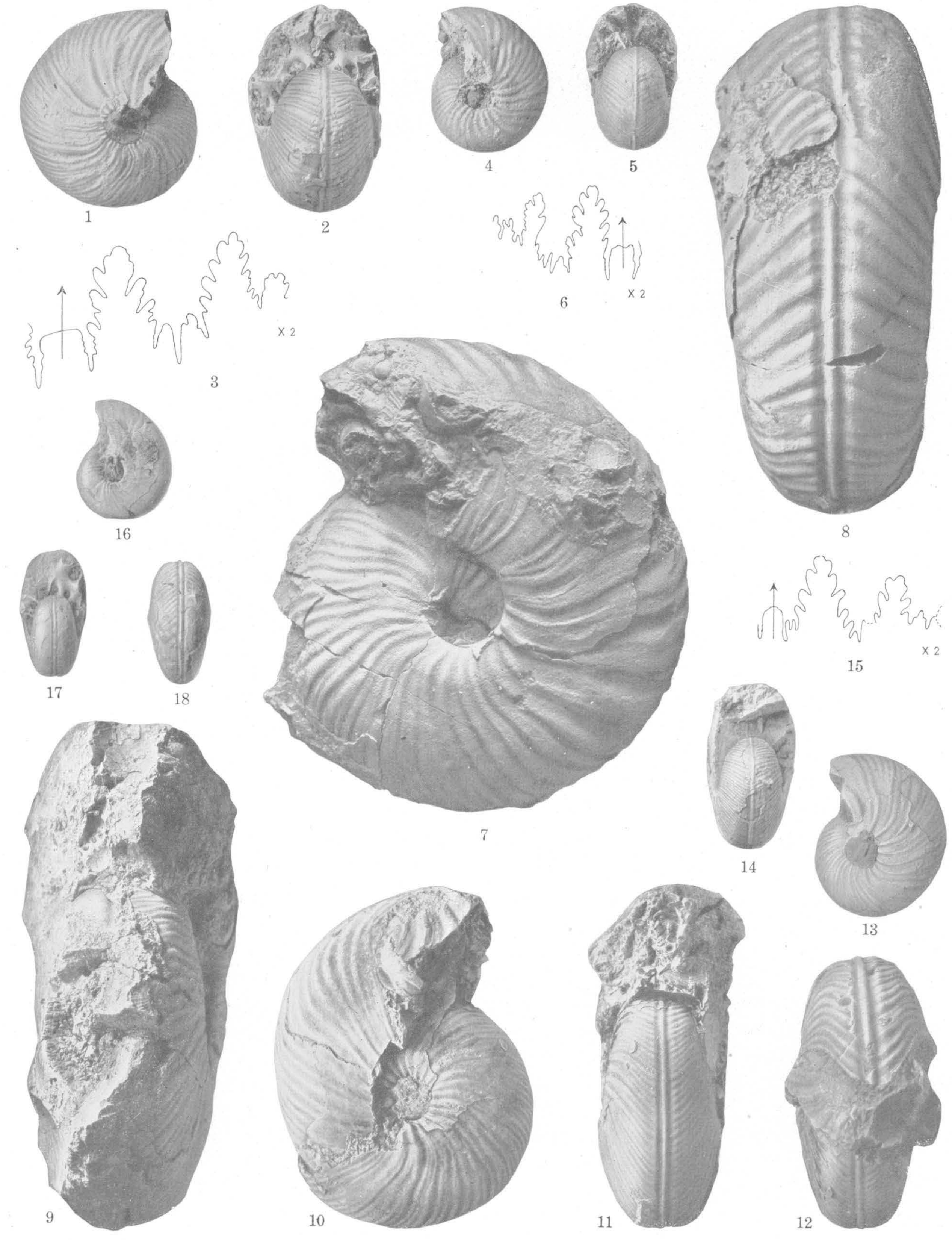
7–9. Type.

10–12. Mature specimen showing aperture.

13–15. Early mature stage.

16–18. Late adolescent stage.

All specimens figured on this plate came from the upper or *Juvavites* subzone of the zone of *Tropites subbullatus* in the Upper Triassic Hosselkus limestone at the north end and east side of Brock Mountain (Bear Cove), Shasta County, Calif., about 10 miles northeast of Winthrop (Bully Hill). Collection of U. S. Geological Survey.



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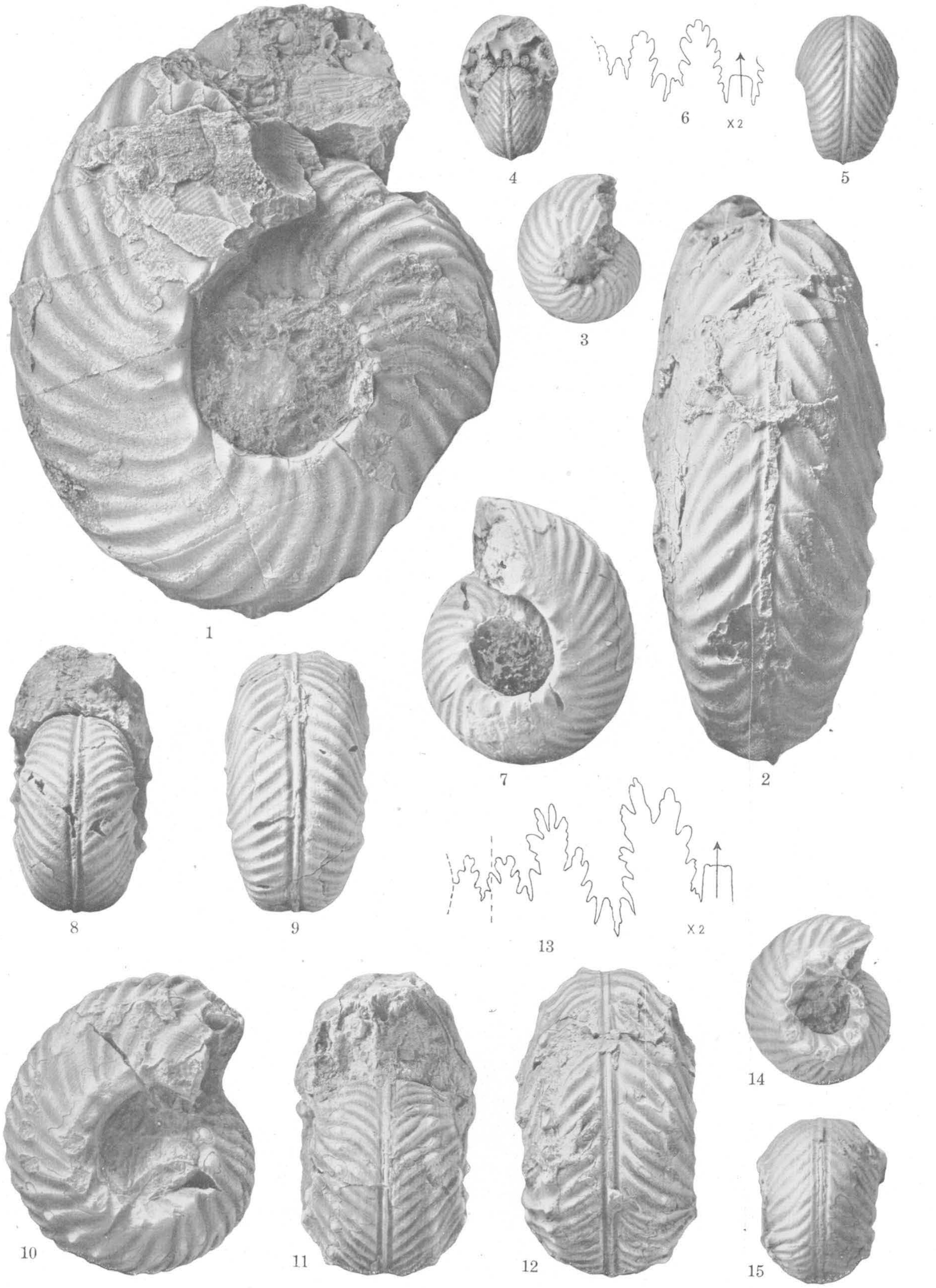


UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LXXIV

FIGURES 1–6. *Tropites brockensis* Smith, n. sp. (p. 32).

1, 2. Type.

3–6. Youthful specimen.

FIGURES 7–9. *Tropites mojsvarensis* Smith, n. sp. (p. 32). Type.

FIGURES 10–15. *Tropites johnsoni* Smith, n. sp. (p. 36).

10–13. Type.

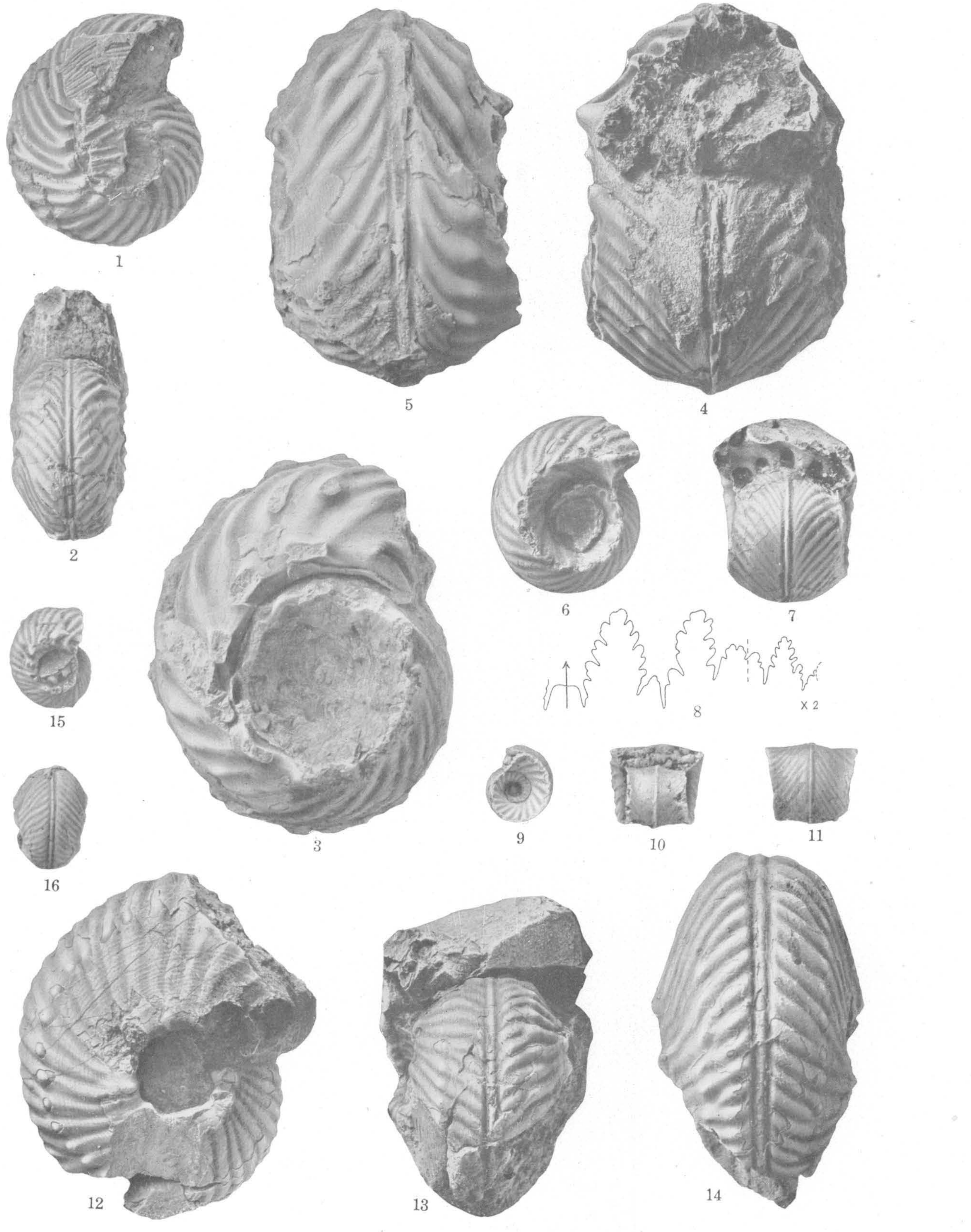
14, 15. Adolescent specimen.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, in the upper or *Juvavites* subzone of the zone of *Tropites subbullatus*, on Squaw Creek, Shasta County, Calif. Figures 1–7 from the North Fork, 3 miles north of Kelly's ranch; Figures 10–15 from the north end and east side of Brock Mountain (Bear Cove), between Squaw Creek and Pit River. Collection of U. S. Geological Survey.

PLATE LXXV

FIGURES 1, 2. *Tropites traski* Smith, n. sp. (p. 35). Type.
FIGURES 3–11. *Tropites boehmi* Smith, n. sp. (p. 36).
3–5. Type.
6–8. Early mature stage.
9–11. Adolescent stage.
FIGURES 12–16. *Tropites philippii* Smith, n. sp. (p. 36).
12–14. Type.
15, 16. Adolescent stage.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone in the upper or *Juvavites*, subzone of the zone of *Tropites subbullatus*, Squaw Creek, Shasta County, Calif. Figures 1–11 from the north end and west side of Brock Mountain; Figures 12–16 from the North Fork of Squaw Creek, 3 miles north of Kelly's ranch. Collection of U. S. Geological Survey.



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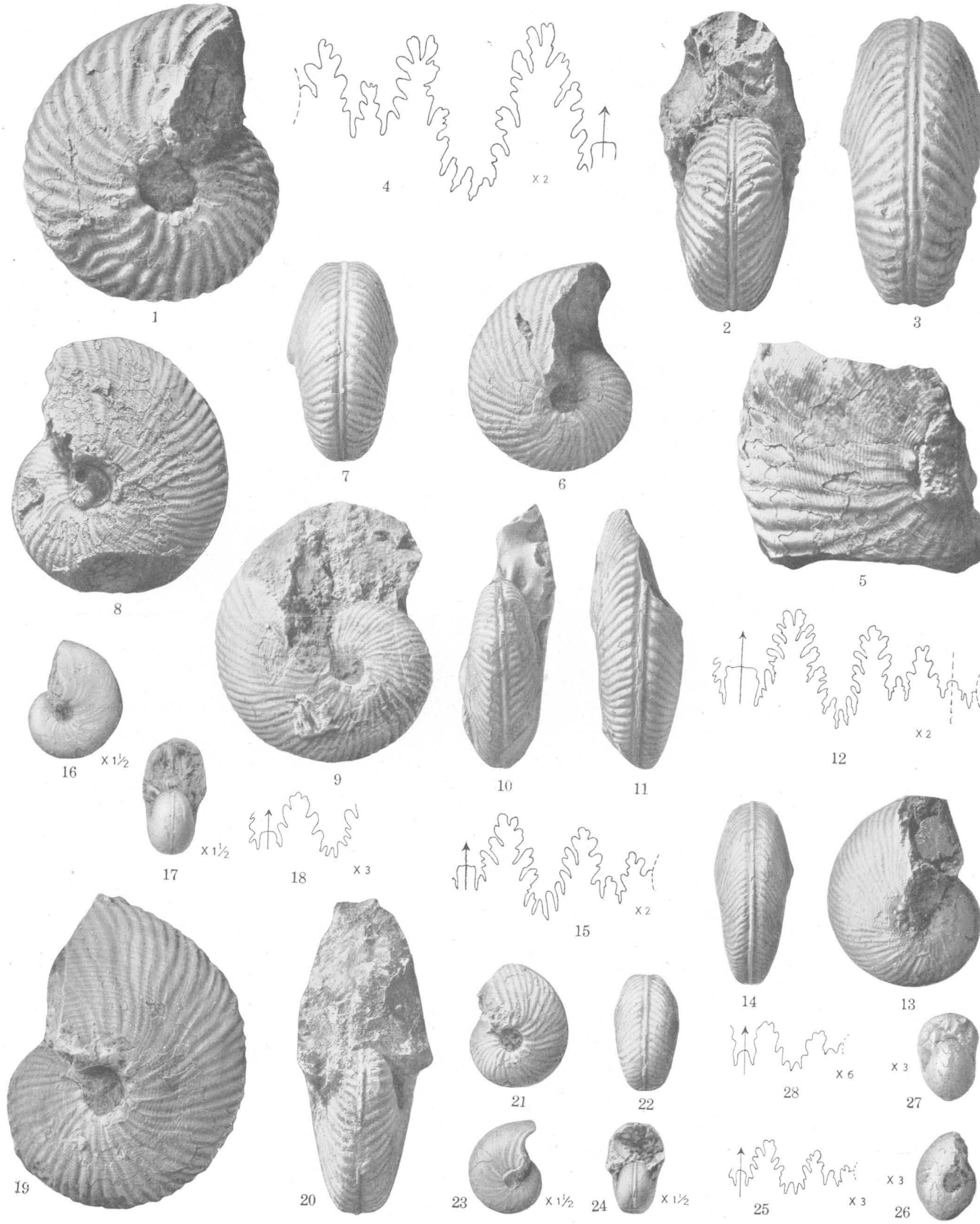


UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LXXVI

FIGURES 1–7. *Tropites kokeni* Smith, n. sp. (p. 35).

1–4. Type.

5. Fragment of a large specimen to show the sculpture.

6, 7. Early mature stage.

FIGURES 8–18. *Tropites reticulatus* Smith, n. sp. (pp. 34–35).

8–12. Type.

13, 14. Early mature stage.

15. Septa from another specimen.

16–18. Adolescent stage; diameter 14 millimeters.

FIGURES 19–28. *Tropites dieneri* Smith, n. sp. (p. 35).

19, 20. Type.

21, 22. Early mature stage.

23–25. Adolescent stage; diameter 11 millimeters.

26–28. Early adolescent stage; diameter 5 millimeters.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, in the upper or *Juvavites* subzone of the zone of *Tropites subbullatus* on the North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif. Collection of U. S. Geological Survey.

PLATE LXXVII

FIGURES 1–11. *Tropites schellwieni* Smith, n. sp. (p. 34).

1–4. Type.

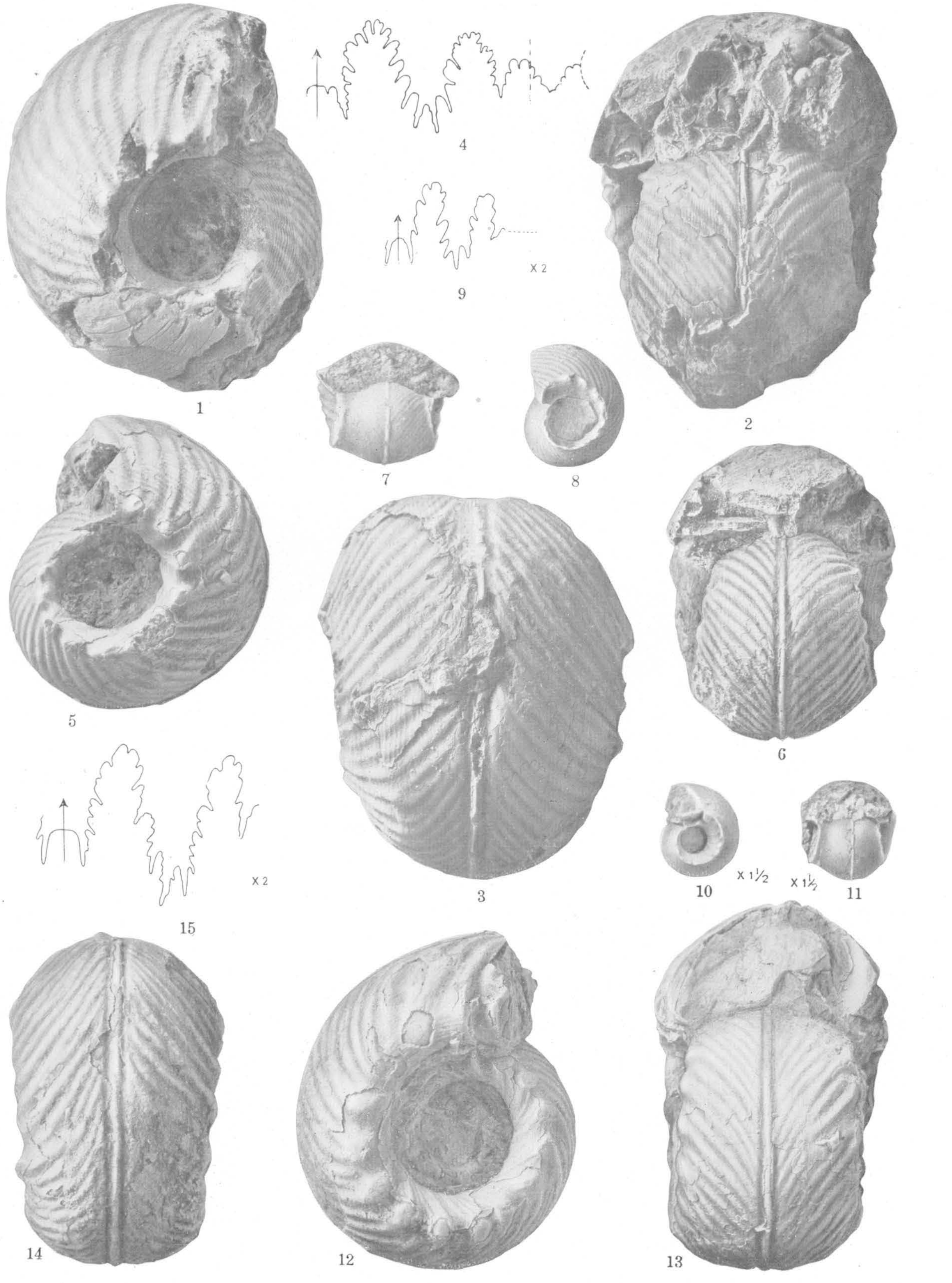
5, 6. Adult stage.

7–9. Adolescent stage.

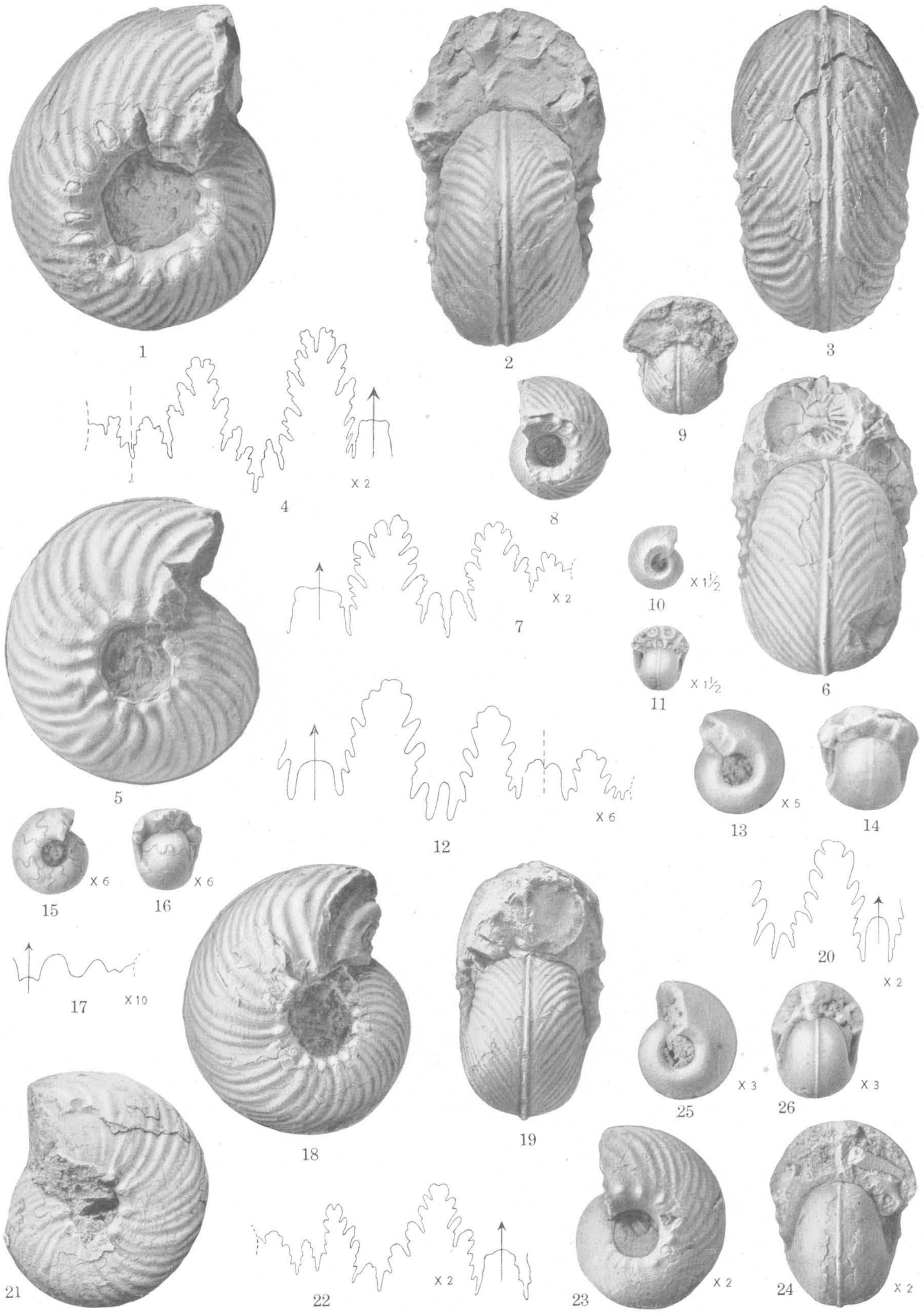
10, 11. Adolescent stage.

FIGURES 12–15. *Tropites kellyi* Smith, n. sp. (p. 34). Type.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, in the upper or *Juvavites* subzone of the zone of *Tropites subbullatus* on Squaw Creek, Shasta County, Calif. Figures 1–11 from the North Fork of Squaw Creek, 3 miles north of Kelly's ranch; Figures 12–15 from the north end and west side of Brock Mountain. Collection of U. S. Geological Survey.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LXXVIII

FIGURES 1–4. *Tropites shastensis* Smith, n. sp. (p. 34). Type.

FIGURES 5–17. *Tropites welleri* Smith (pp. 33–34).

5–7. Type.

8, 9. Adolescent stage.

10–12. Adolescent stage; diameter 11 millimeters.

13, 14. Larval stage; diameter 3.5 millimeters.

15–17. Larval stage; diameter 2.5 millimeters.

FIGURES 18–26. *Tropites ursensis* Smith, n. sp. (p. 33).

18–20. Type.

21, 22. Shell and septa.

23, 24. Adolescent stage; diameter 15 millimeters.

25, 26. Larval stage; diameter .7 millimeters.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, in the upper or *Juvavites* subzone of the zone of *Tropites subbullatus*, Squaw Creek, Shasta County, Calif. Figures 1–4 from the North Fork of Squaw Creek, 3 miles north of Kelly's ranch; Figures 5–17 from the north end and west side of Brock Mountain; Figures 18–26 from the north end and east side of Brock Mountain (Bear Cove). Collection of U. S. Geological Survey.

PLATE LXXIX

FIGURES 1–10. *Tropites subbullatus* Hauer (pp. 29–31).

1, 2. Adolescent stage; diameter 4.6 millimeters, showing the lobes becoming ammonitic at 4.5 millimeters.

3–6. Larval stage; diameter 2.04 millimeters, showing the goniatitic septa, and the beginning of the keel at diameter of 2 millimeters.

7–10. Larval stage; diameter 1.83 millimeters, showing *Gastrioceras* stage.

FIGURES 11–20. *Metasibirites parvus* Hyatt and Smith (p. 64).

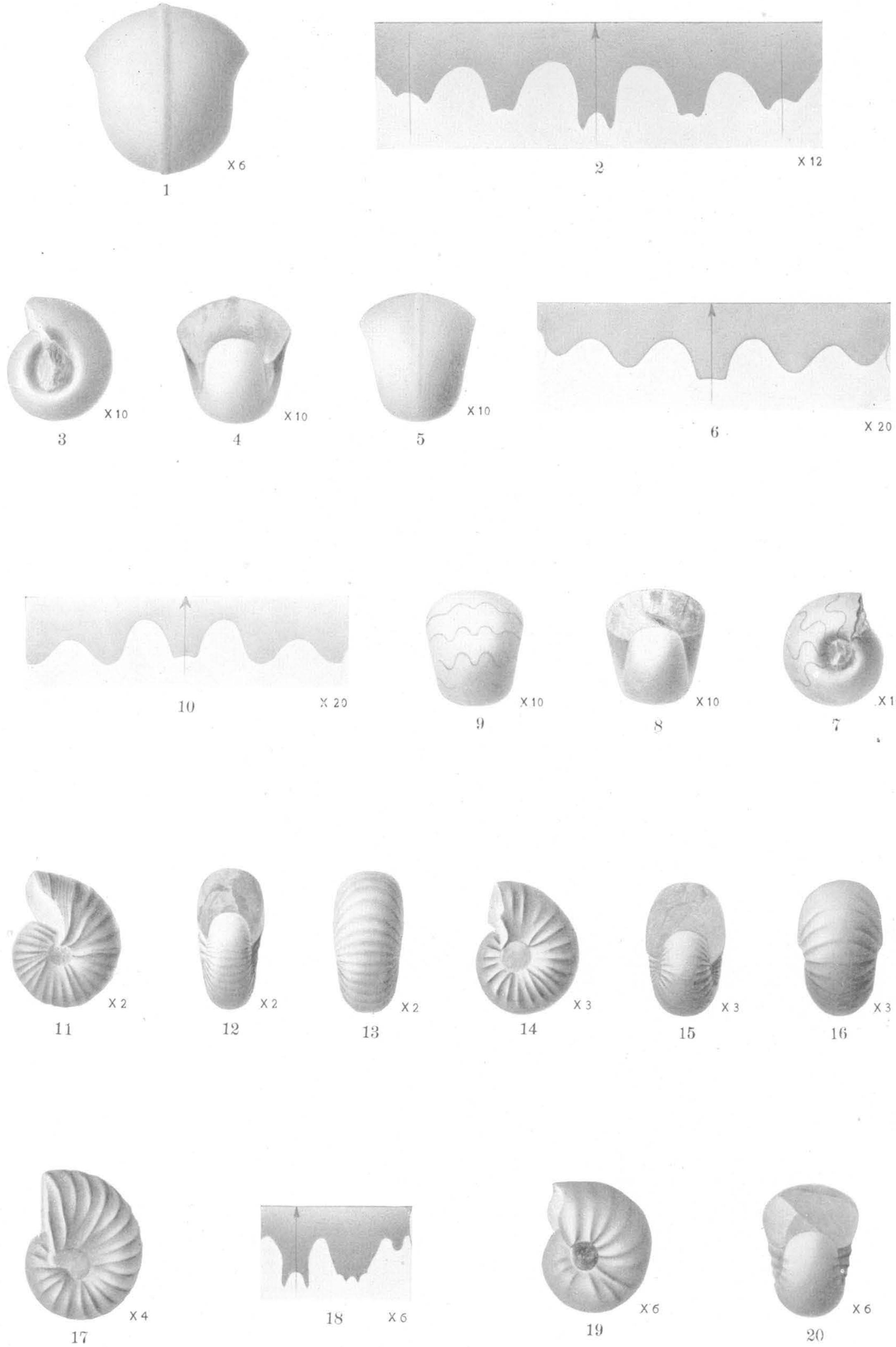
11–13. Type specimen; diameter 11 millimeters.

14–16. Smaller specimen; diameter 7 millimeters.

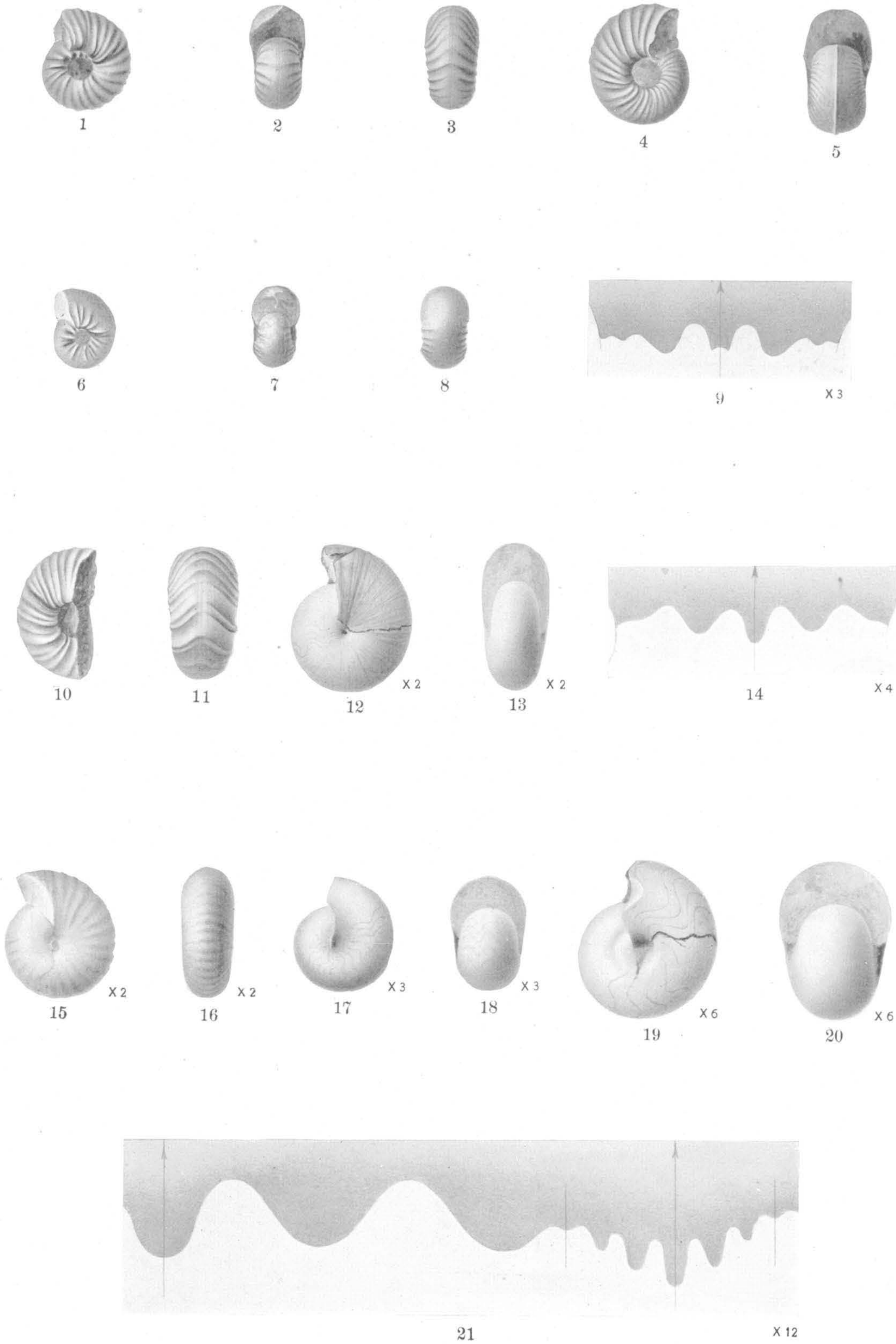
17, 18. Shell and septa; diameter 6 millimeters.

19, 20. Adolescent stage; diameter 3.44 millimeters.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, subzone of the zone of *Tropites subbullatus* 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LXXX

FIGURES 1–11. *Metasibirites frechi* Hyatt and Smith (p. 63).

1–8. Shell.

9. Septa of the same specimen.

10, 11. An old specimen showing change of sculpture.

FIGURES 12–21. *Paraganides californicus* Hyatt and Smith (p. 71).

12–18. Type specimen.

19–21. Adolescent stage; diameter 3.5 millimeters.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the zone of *Tropites subbullatus*, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

PLATE LXXXI

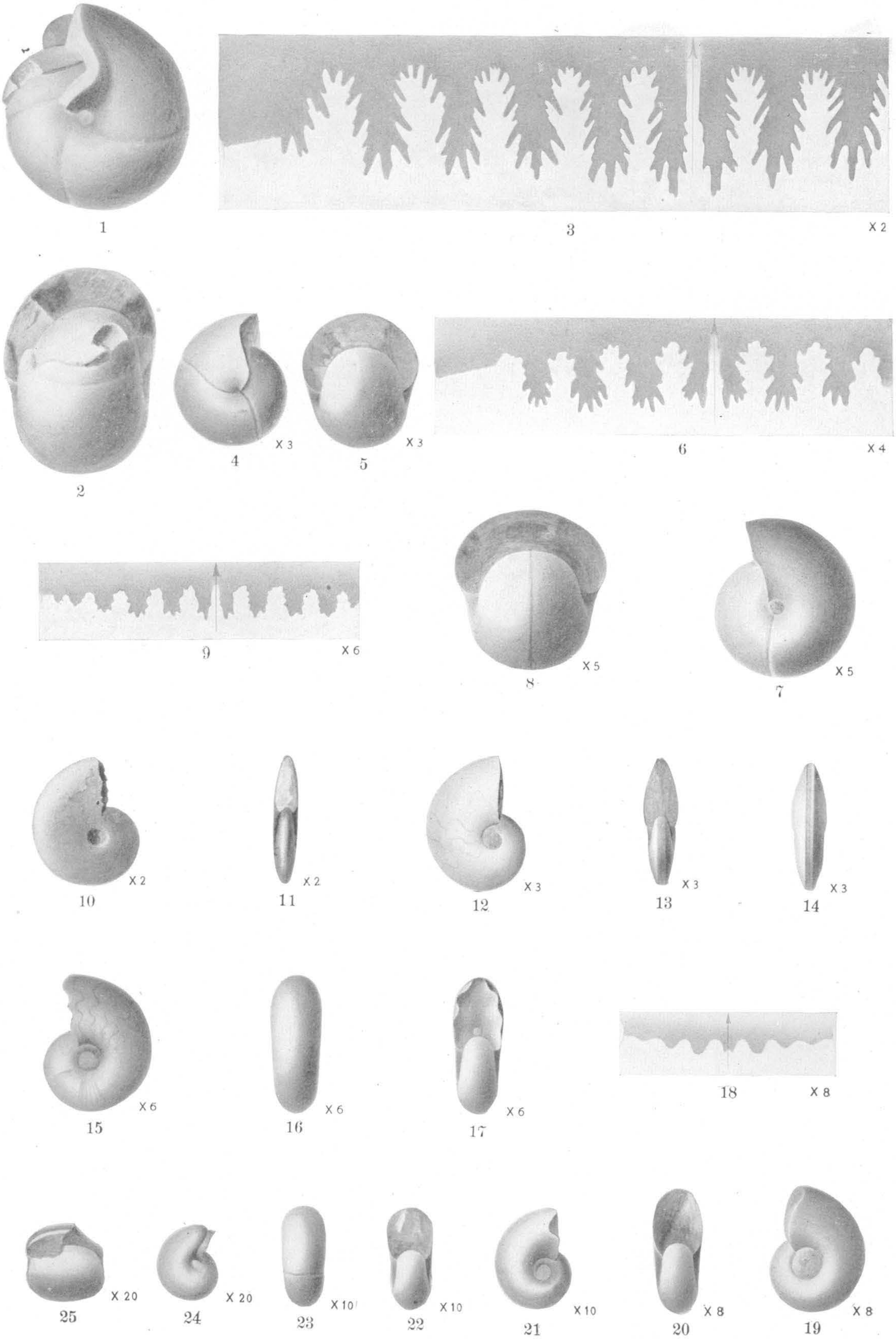
FIGURES 1–9. *Arcestes pacificus* Hyatt and Smith (pp. 68–69).

1–3. Type specimen.
4–6. Diameter 11 millimeters.
7–9. Diameter 5.34 millimeters.

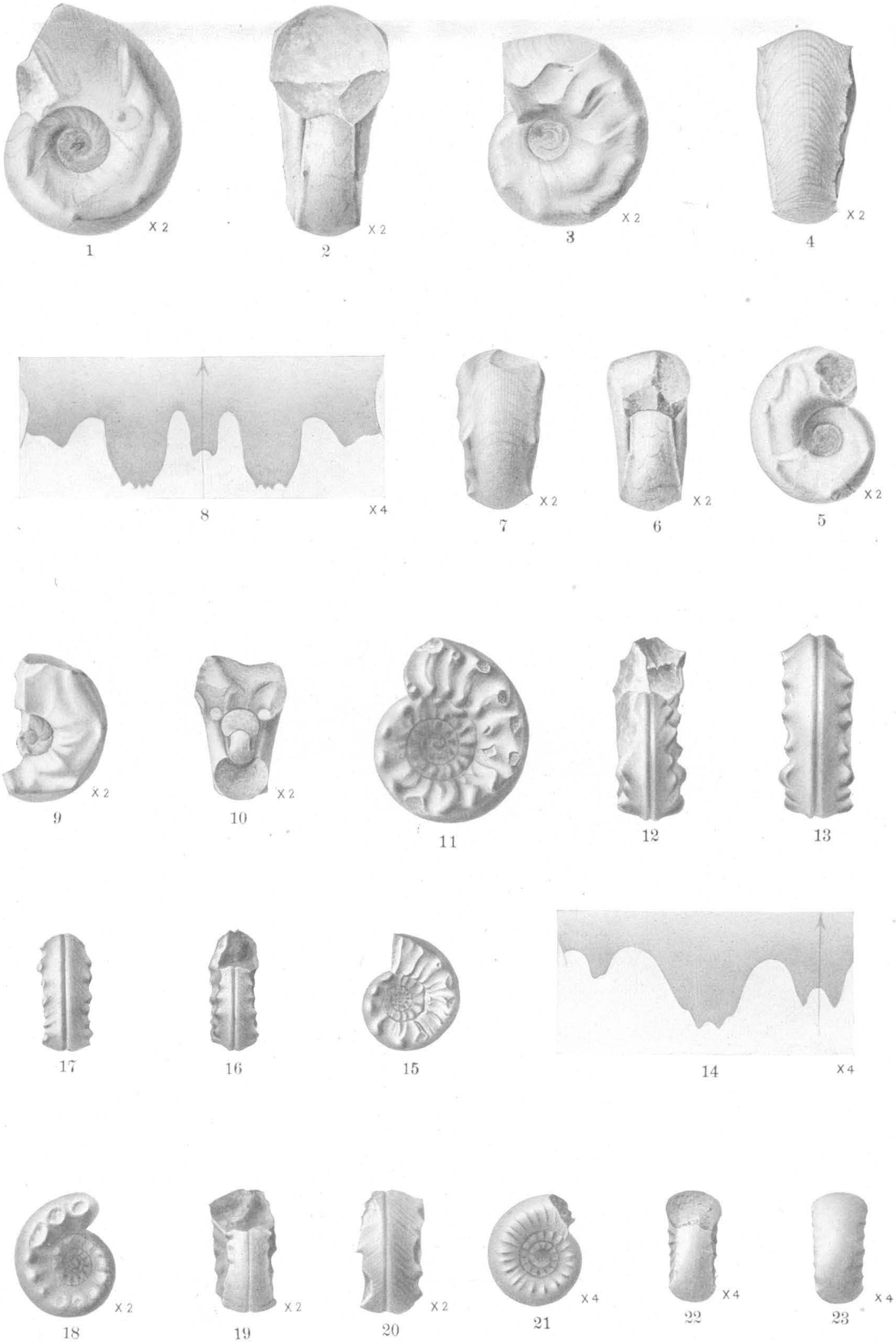
FIGURES 10–25. *Dieneria arthaberi* Hyatt and Smith (p. 76).

10, 11. Diameter 10 millimeters.
12–14. Adolescent stage; diameter 7 millimeters.
15–18. *Ambites* stage; diameter 3.6 millimeters.
19, 20. Larval stage; diameter 2.52 millimeters.
21–23. Larval stage; diameter 1.64 millimeters.
24, 25. Larval stage; diameter 0.66 millimeter.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, in the *Juvavites* subzone of the zone of *Tropites subbullatus* 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LXXXII

FIGURES 1–10. *Tirolites (Metatirolites) foliaceus* Dittmar (p. 95).

1, 2. Diameter 19.5 millimeters.
3, 4. Diameter 17 millimeters.
5–8. Diameter 13 millimeters.
9, 10. Diameter 12 millimeters.

FIGURES 11–23. *Clionites merriami* Hyatt and Smith (p. 92).

11–14. Shell and septa.
15–17. Natural size.
18–20. Adolescent stage; diameter 10 millimeters.
21–23. Larval stage; diameter 4.5 millimeters.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the zone of *Tropites subbullatus*, 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.

PLATE LXXXIII

FIGURES 1–13. *Arpadites gabbi* Hyatt and Smith (pp. 93–94).

1–3. End of adolescent stage; diameter 9.5 millimeters.

4–6. *Dinarites* stage; diameter 4.6 millimeters.

7–10. *Dinarites* stage; diameter 3.46 millimeters.

11–13. *Tirolites* stage; diameter 2.19 millimeters.

FIGURES 14–27. *Clionites* (*Neanites*) *californicus* Hyatt and Smith (p. 90).

14–16. Type, natural size.

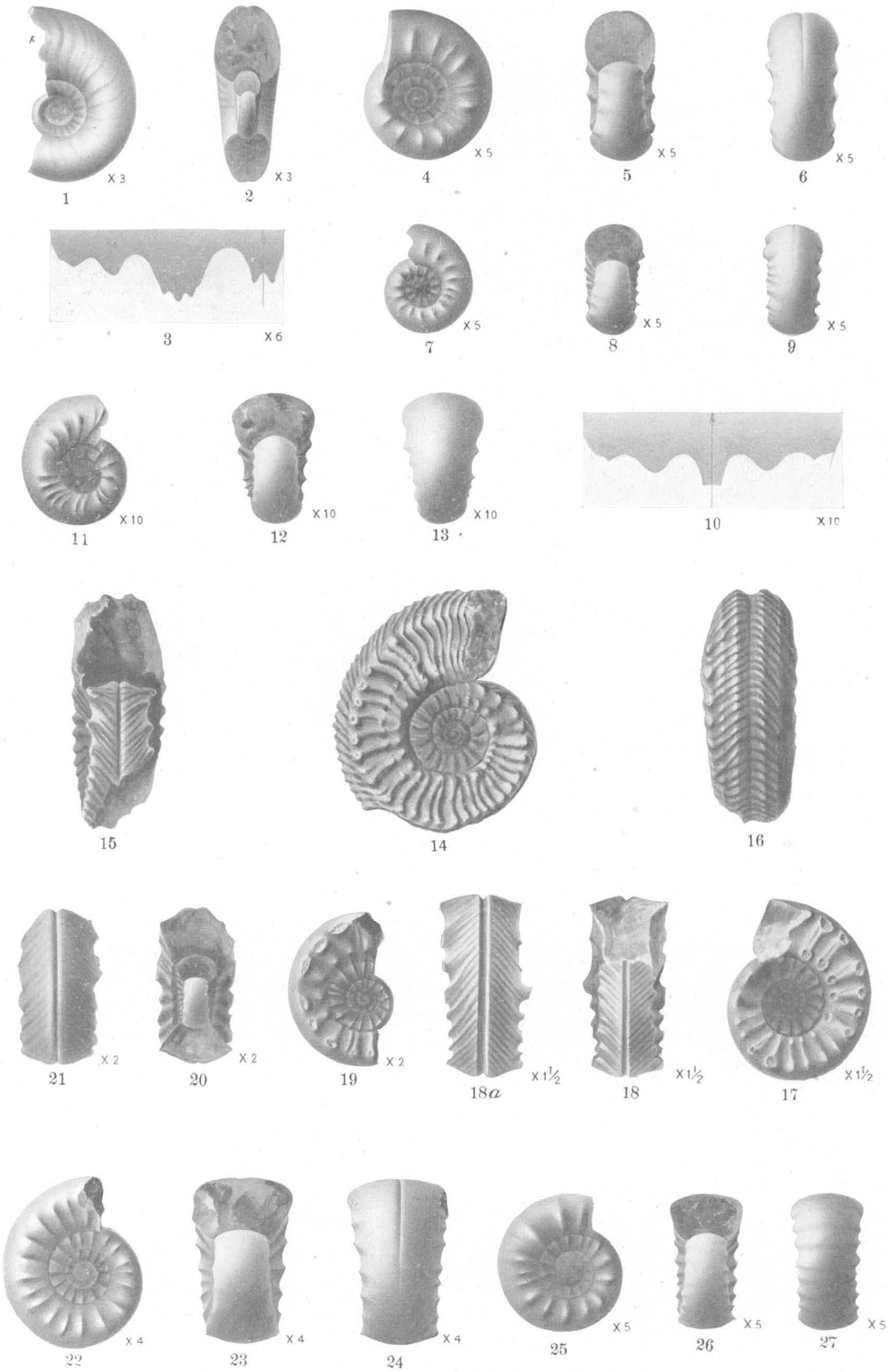
17–18a. *Californites* stage.

19–21. *Californites* stage; adolescent; diameter 13 millimeters.

22–24. *Tirolites* stage; adolescent; diameter 6 millimeters.

25–27. *Tirolites* stage; diameter 4.5 millimeters.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, in the *Trachyceras* subzone of the zone of *Tropites subbullatus* 3 miles east of Madison's ranch, between Squaw Creek and Pit River, Shasta County, Calif. Collection of J. P. Smith.



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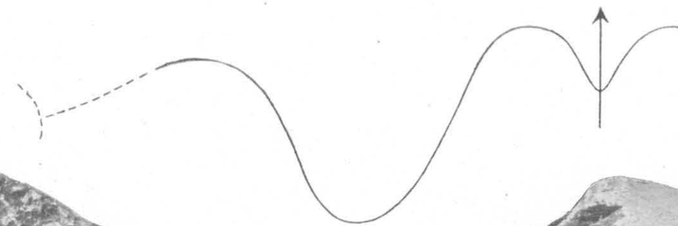

3

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UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LXXXIV

FIGURES 1-3. *Proclydonautilus ursensis* Smith, n. sp. (p. 103). Type: Upper Triassic Hosselkus limestone, upper or *Juvavites* subzone of the zone of *Tropites subbullatus*, north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. Collection of the U. S. Geological Survey.

PLATE LXXXV

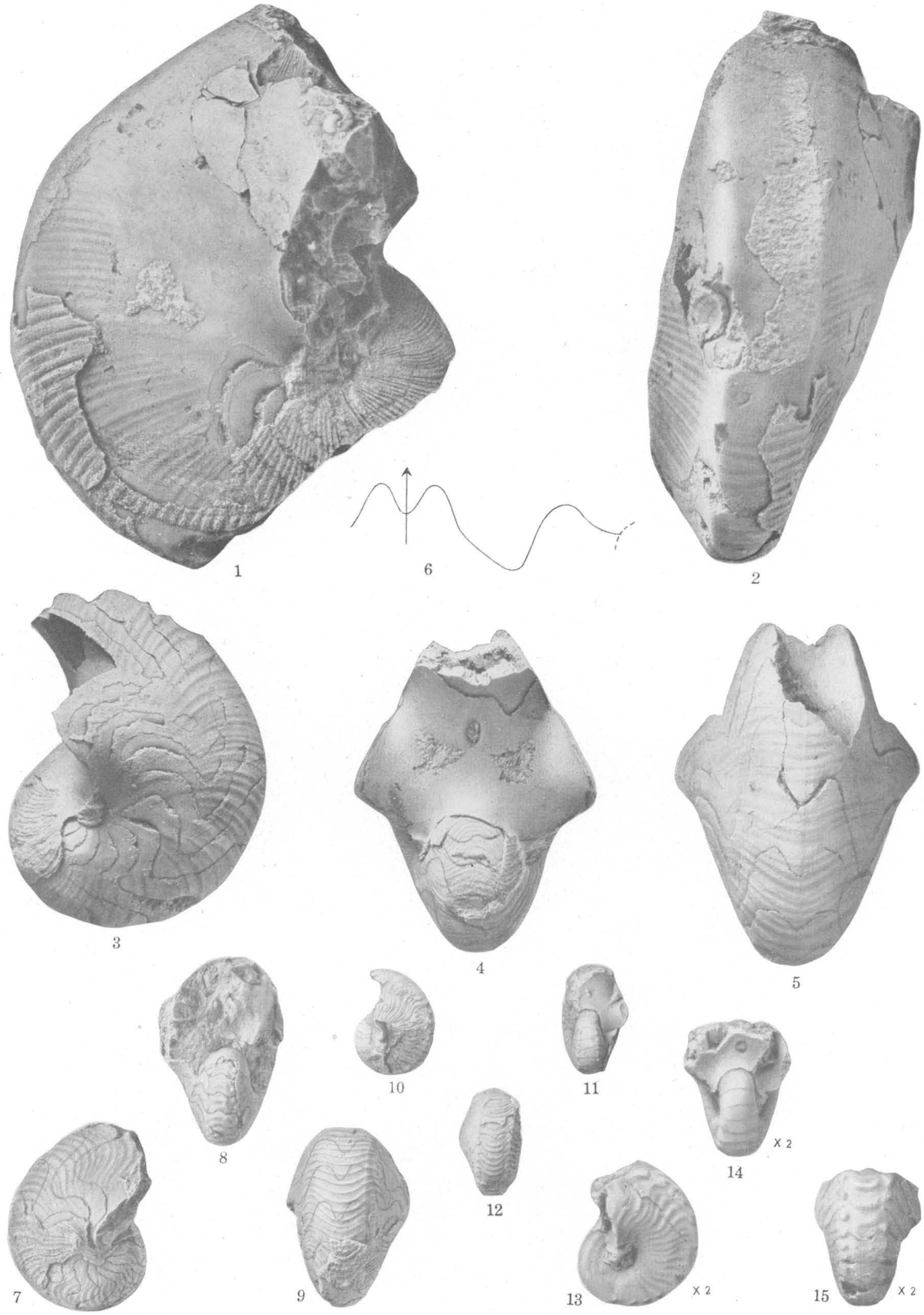
FIGURES 1–5. *Proclydonautilus ursensis* Smith, n. sp. (p. 103).
1, 2. Adolescent stage.
3–5. Late larval stage; diameter 8 millimeters.

FIGURES 6–11. *Proclydonautilus stantoni* Smith (p. 103).
6–8. Type.
9–11. Youthful stage.

FIGURES 12–18. *Styrionautilus sauperi* Hauer (p. 107).
12–14. Adult stage.
15, 16. Adolescent stage.
17, 18. Late larval stage; diameter 7 millimeters.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, in the upper or *Juvavites* subzone of the zone of *Tropites subbullatus,* at the north end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. Figures 1–5 from Bear Cove, east side of Brock Mountain; Figures 6–18 from the west side of Brock Mountain. Figures 1–11 collection of U. S. Geological Survey; Figures 12–18 collection of J. P. Smith.

UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LXXXVI

FIGURES 1–15. *Cosmonautilus pacificus* Smith, n. sp. (p. 105).

1, 2. Type.

3–6. Early mature stage.

7–9. Adolescent stage.

10–12. Early adolescent stage.

13–15. Transition from larval to adolescent stage; diameter 12 millimeters.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, *Juvavites* subzone of the zone of *Tropites subbullatus*, at the north end of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. Collection of U. S. Geological Survey.

PLATE LXXXVII

FIGURES 1–11. *Cosmonautilus shastensis* Smith, n. sp. (p. 105).

1, 2. Type.

3–6. Adolescent stage.

7–9. Adolescent stage; diameter 12 millimeters.

10, 11. Larval stage; diameter 7 millimeters.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, upper or *Juvavites* subzone of the zone of *Tropites subbullatus*, Bear Cove, north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. Collection of U. S. Geological Survey.


3


4


5


X 1½

7


X 1½

8


X 1½

9


6


X 3

10

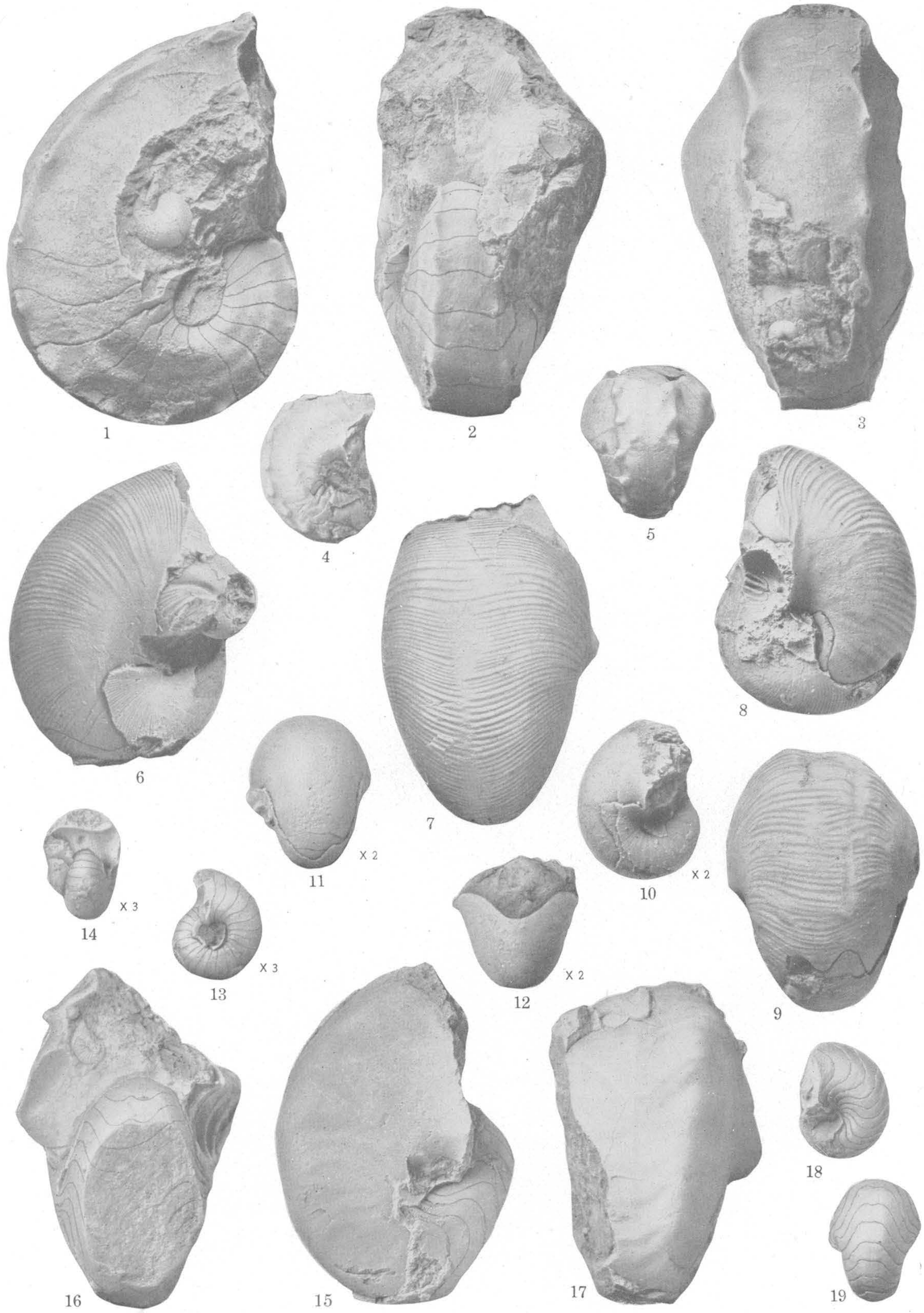

X 3

11


1


2

UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE LXXXVIII

FIGURES 1–5. *Grypoceras (Gryponautilus) cooperi* Smith, n. sp. (p. 107).
1–3. Type.
4, 5. Adolescent stage.
FIGURES 6–14. *Proclydonautilus spirolobus* Dittmar (p. 103).
6, 7. Adult stage.
8, 9. Early adult stage.
10–12. Adolescent stage; diameter 13 millimeters.
13, 14. Larval stage; diameter 6.5 millimeters.
FIGURES 15–19. *Clydonautilus hessi* Smith, n. sp. (pp. 107–108).
15–17. Type.
18, 19. Adolescent stage.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, upper or *Juvavites* subzone of the zone of *Tropites subbullatus,* Bear Cove, north end and east side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. Collection of U. S. Geological Survey.

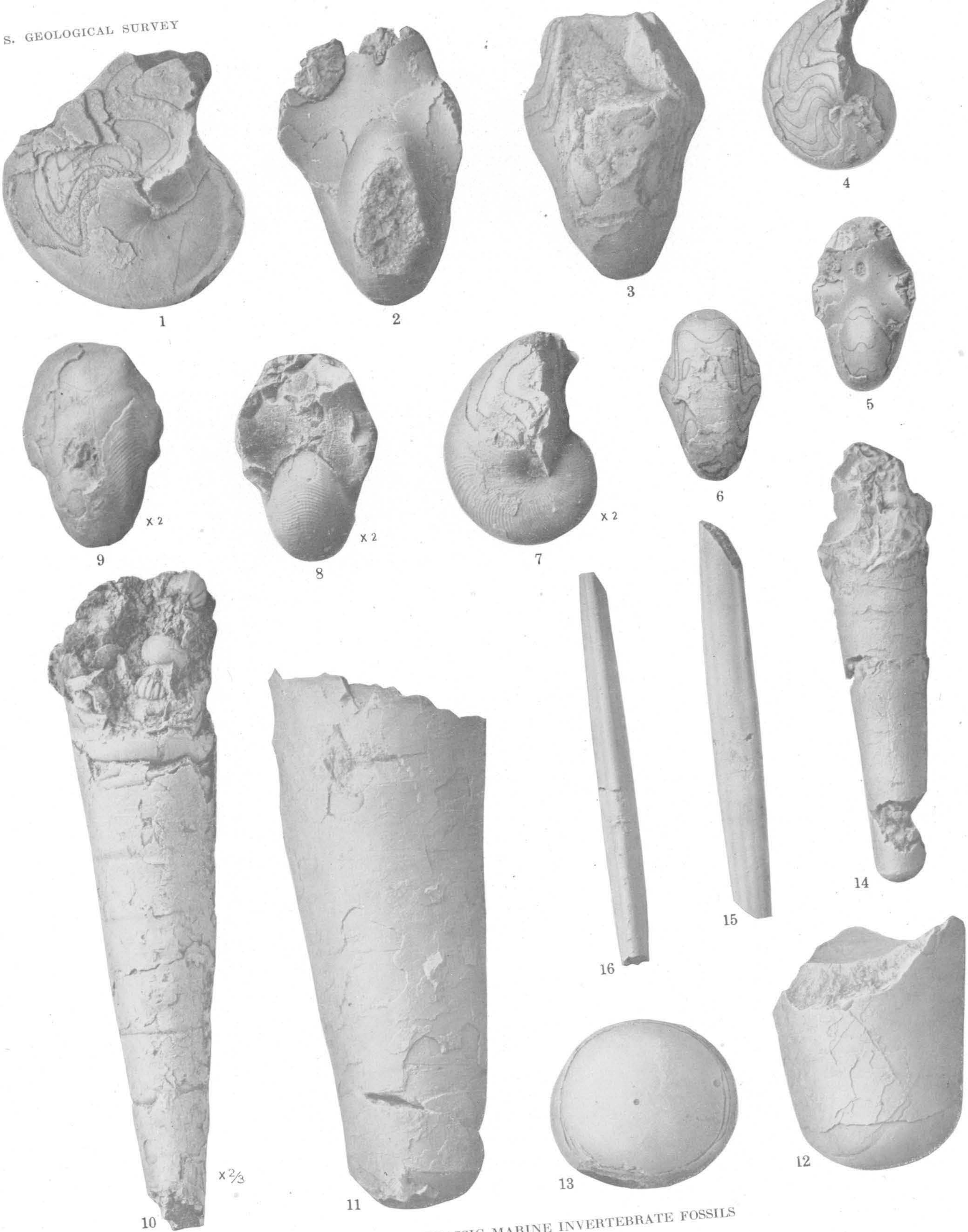
PLATE LXXXIX

FIGURES 1–9. *Cosmonautilus hersheyi* Smith, n. sp. (pp. 104–105).
- 1–3. Type.
- 4–6. Early mature stage.
- 7–9. Adolescent stage.

FIGURES 10–14. *Dictyoconites americanus* Smith, n. sp. (p. 101).
- 10. Type.
- 11. Adult specimen.
- 12, 13. Large specimen showing siphuncle.
- 14. Adolescent stage.

FIGURES 15, 16. *Atractites drakei* Smith, n. sp. (pp. 100–101). Type.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, *Juvavites* subzone of the zone of *Tropites subbullatus*, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. Figures 1–9, 11–16, from Bear Cove, north end and east side of Brock Mountain; Figure 10 from the old quarry at the southeast end of Brock Mountain. Collection of U. S. Geological Survey.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XC

Cosmonautilus dilleri Hyatt and Smith (p. 104). Adult specimen; diameter 37 centimeters. From the Upper Triassic Hosselkus limestone, upper or *Juvavites* subzone of the zone of *Tropites subbullatus*, at the north end and west side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. Collection of U. S. Geological Survey.

PLATE XCI

FIGURES 1, 2. *Cosmonautilus dilleri* Hyatt and Smith (p. 104).

1. Early mature stage; diameter 16 centimeters.
2. Rear view of specimen shown on Plate XC, Figure 1; diameter 37 centimeters.

From the Upper Triassic Hosselkus limestone, upper or *Juvavites* subzone of the zone of *Tropites subbullatus*, north end and west side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. Collection of U. S. Geological Survey.

1

x$\frac{1}{3}$

2

UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

1

2

UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XCII

FIGURES 1, 2. *Cosmonautilus dilleri* Hyatt and Smith (p. 104). Front and rear views of specimen shown on Plate XC, Figure 1; diameter 16 centimeters, slightly reduced. From the Upper Triassic Hosselkus limestone, upper or *Juvavites* subzone of the zone of *Tropites subbullatus*, north end and west side of Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. Collection of U. S. Geological Survey.

PLATE XCIII

FIGURES 1–5. *Halobia superba* Mojsisovics (p. 118).

1. Left valve of a plaster cast. *Trachyceras* subzone, old quarry, Brock Mountain.
2. Right valve (original of California Acad. Sci. Proc., 3d ser., Geology, vol. 1, pl. 48, fig. 1, 1904). *Trachyceras* subzone, old quarry, Brock Mountain.
3. Left valve, adolescent stage. *Juvavites* subzone, north end and west side, Brock Mountain.

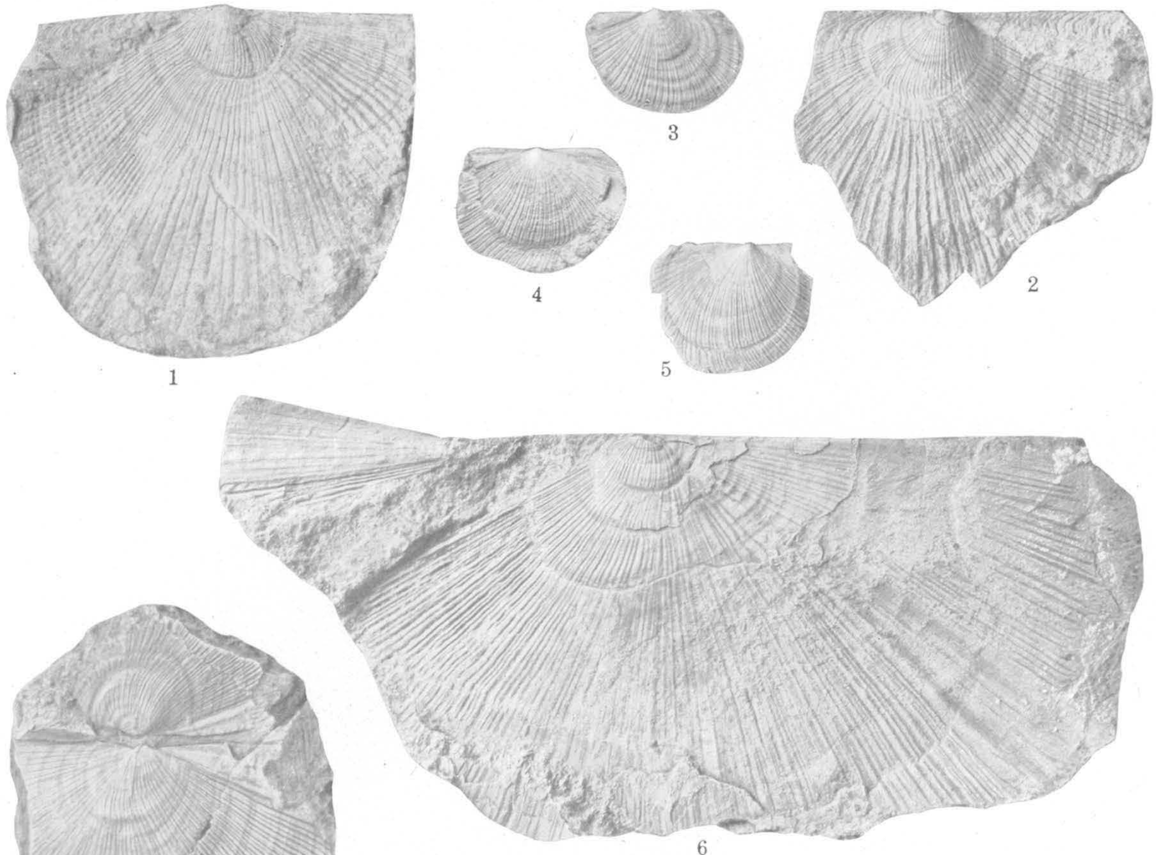
4, 5. Right and left valves at end of adolescent stage. *Juvavites* subzone, north end and west side, Brock Mountain.

FIGURES 6–7. *Halobia gigantea* Smith, n. sp. (p. 116).

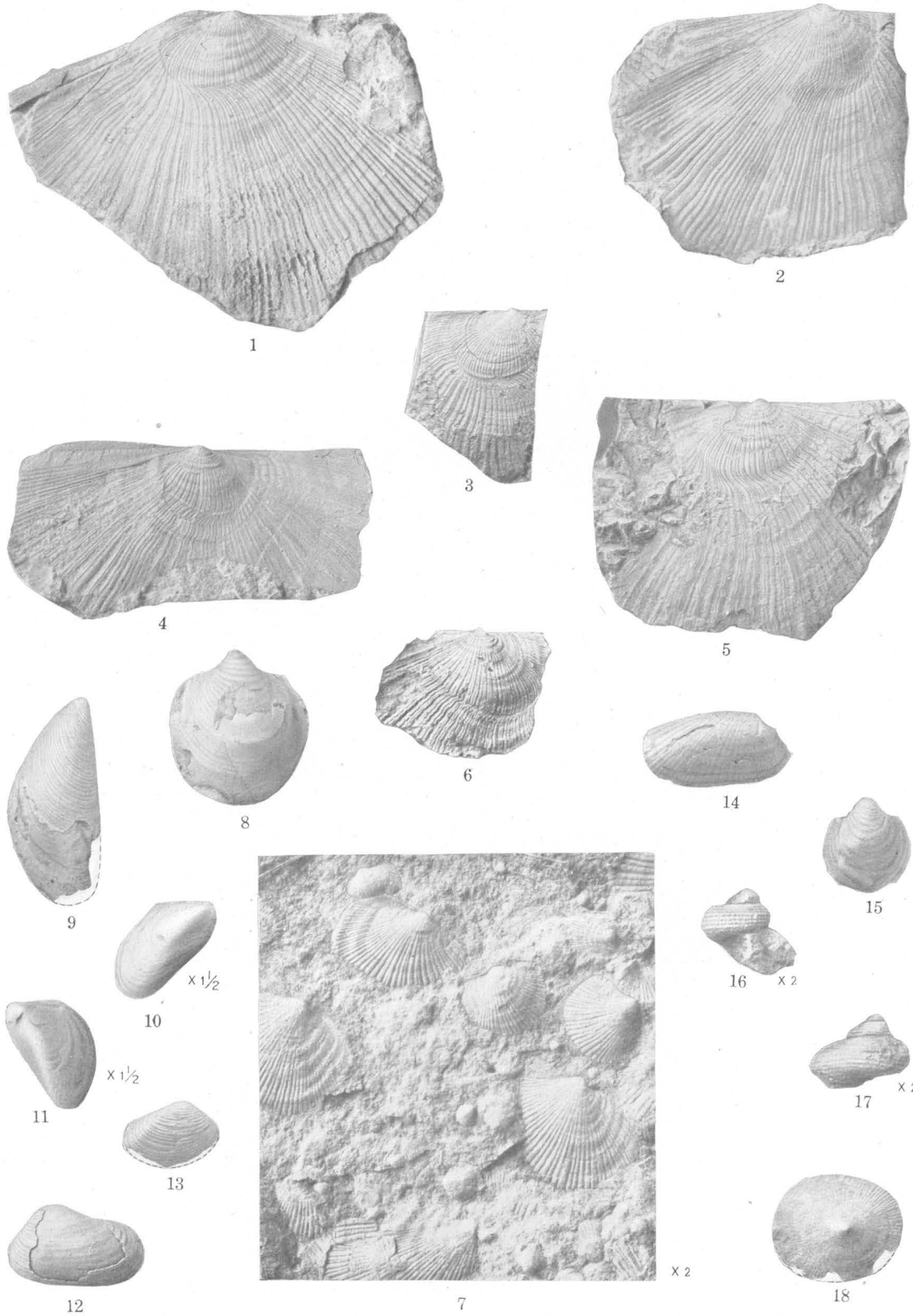
6. Type. *Juvavites* beds of Bear Cove, north end and east side.
7. Right valve, *Trachyceras* subzone, west side of Brock Mountain, 1½ miles north of the old stone quarry.

FIGURE 8. *Halobia cordillerana* Smith, n. sp. (p. 114). Adult stage, showing both valves. *Juvavites* subzone, north end and west side, Brock Mountain.

All specimens figured on this plate came from zone of *Tropites subbullatus*, of the Upper Triassic Hosselkus limestone on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. Figures 1, 2, collection of J. P. Smith; Figures 3–8, collection of U. S. Geological Survey.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XCIV

FIGURES 1–3. *Halobia gigantea* Smith, n. sp. (p. 116).

1. Right valve, north end and west side of Brock Mountain, *Juvavites* subzone.
2. Left valve, plaster cast.
3. Adolescent stage, right valve; north end and west side of Brock Mountain, *Juvavites* subzone.

FIGURES 4–6. *Halobia ornatissima* Smith, n. sp. (p. 117).

4. Type; north end and west side of Brock Mountain, *Juvavites* subzone.
5. Right valve.
6. Left valve.

FIGURE 7. *Halobia superba* Mojsisovics (p. 118). Slab showing young specimens; *Trachyceras* subzone, old quarry.

FIGURE 8. *Cardiomorpha? digglesi* Smith, n. sp. (p. 111). Type; *Trachyceras* subzone, old quarry, southwest end Brock Mountain.

FIGURE 9. *Mytilus ursensis* Smith, n. sp. (p. 111). Type; Bear Cove, northeast end of Brock Mountain, *Juvavites* subzone.

FIGURES 10–11. *Myoconcha nana* Smith, n. sp. (p. 111). Right and left valves of the type; *Juvavites* subzone, northwest end of Brock Mountain.

FIGURE 12. *Posidonia madisonensis* Smith, n. sp. (pp. 112–113). Type, left valve; *Juvavites* subzone, northwest end of Brock Mountain.

FIGURE 13. *Posidonia jacksoni* Smith, n. sp. (p. 112). Type; *Trachyceras* subzone, old quarry, southwest end of Brock Mountain.

FIGURE 14. *Anoplophora? shastensis* Smith, n. sp. (p. 110). Type; northwest side of Brock Mountain, *Juvavites* subzone.

FIGURE 15. *Capulus silverthorni* Smith, n. sp. (p. 108). Type; old quarry, southwest side of Brock Mountain, *Trachyceras* subzone.

FIGURES 16–17. *Collonia occidentalis* Smith, n. sp. (p. 108). Front and rear views; type; *Trachyceras* subzone, old quarry, Brock Mountain.

FIGURE 18. *Patella stuarti* Smith, n. sp. (p. 108). Type; Bear Cove, northeast end of Brock Mountain, *Juvavites* subzone.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, zone of *Tropites subbullatus*, on Brock Mountain, between Squaw Creek and Pit River, Shasta County, Calif. Collection of U. S. Geological Survey.

PLATE XCV

FIGURES 1–2. *Halobia oregonensis* Smith, n. sp. (p. 117).

1. Type, right valve; Martin Bridge, Eagle River, Baker County, Oreg., in beds of upper Karnic age.
2. Cotype, left valve.

FIGURES 3–4. *Halobia halorica* Mojsisovics (p. 116). From *Halobia*-bearing shales of lower Noric age, Martin Bridge, Baker County, Oreg.

FIGURE 5. *Halobia dilatata* Kittl (p. 115). From *Halobia*-bearing shales of lower Noric age, Martin Bridge, Eagle River, Baker County, Oreg.

FIGURE 6. *Isocrinus californicus* Clark (p. 125). Slab from the *Juvavites* subzone of the *Tropites subbullatus* zone, in the Hosselkus limestone, northwest side of Brock Mountain, Shasta County, Calif.

FIGURE 7. *Halobia salinarum* Bronn (p. 118). Slab from *Halobia*-bearing shales of upper Karnic age, Martin Bridge, Eagle River, Baker County, Oreg.

FIGURES 8–9. *Pseudomonotis subcircularis* Gabb (pp. 120–121).

8. From *Pseudomonotis* zone of lower Noric age, in the Swearinger slate of Genesee Valley, Plumas County, Calif.
9. Young specimen from same locality.

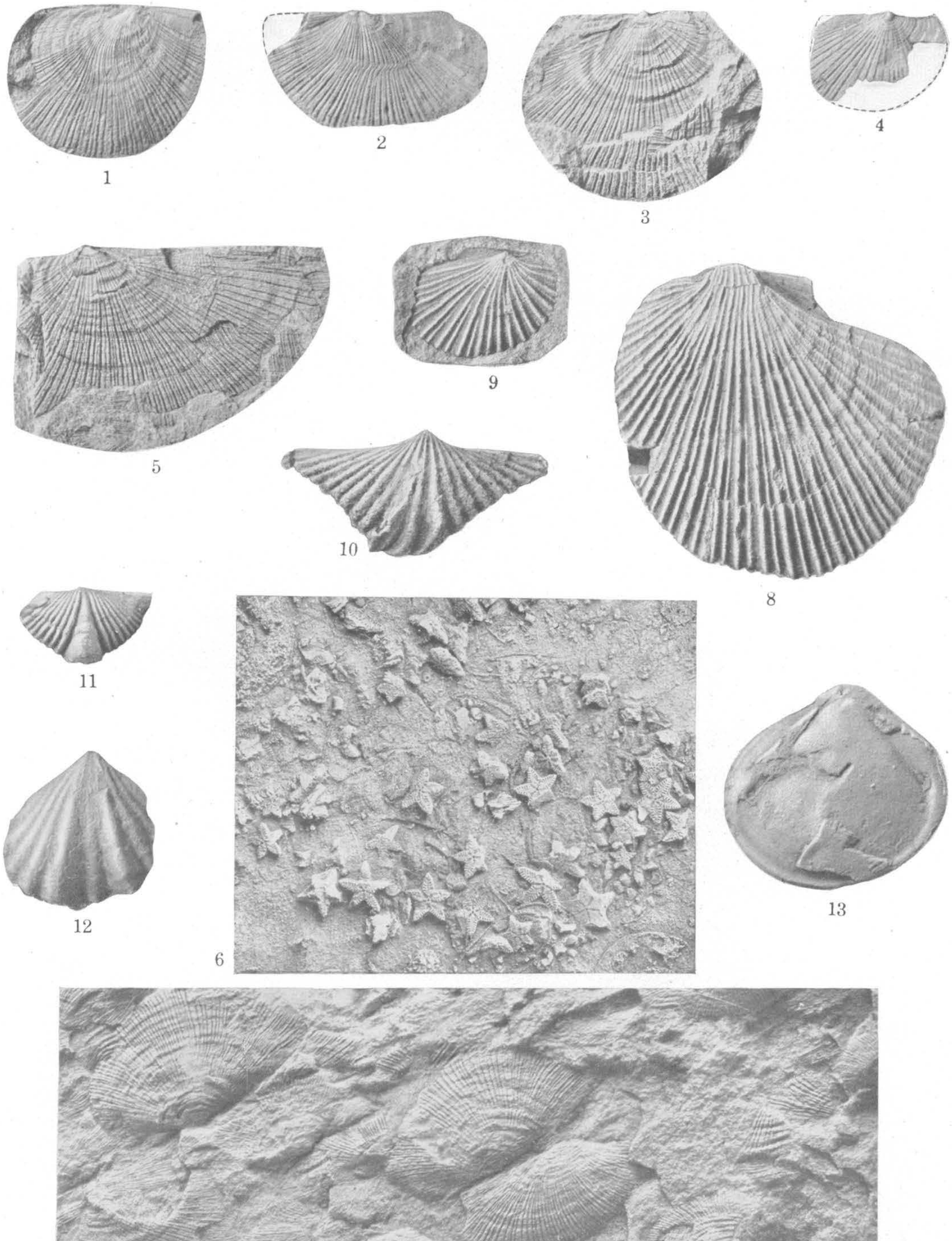
FIGURES 10–11. *Spiriferina pittensis* Smith, n. sp. (p. 124).

10. Lower valve; *Spiriferina* zone, Brock Mountain, Shasta County, Calif.
11. Upper valve, same locality as Figure 10.

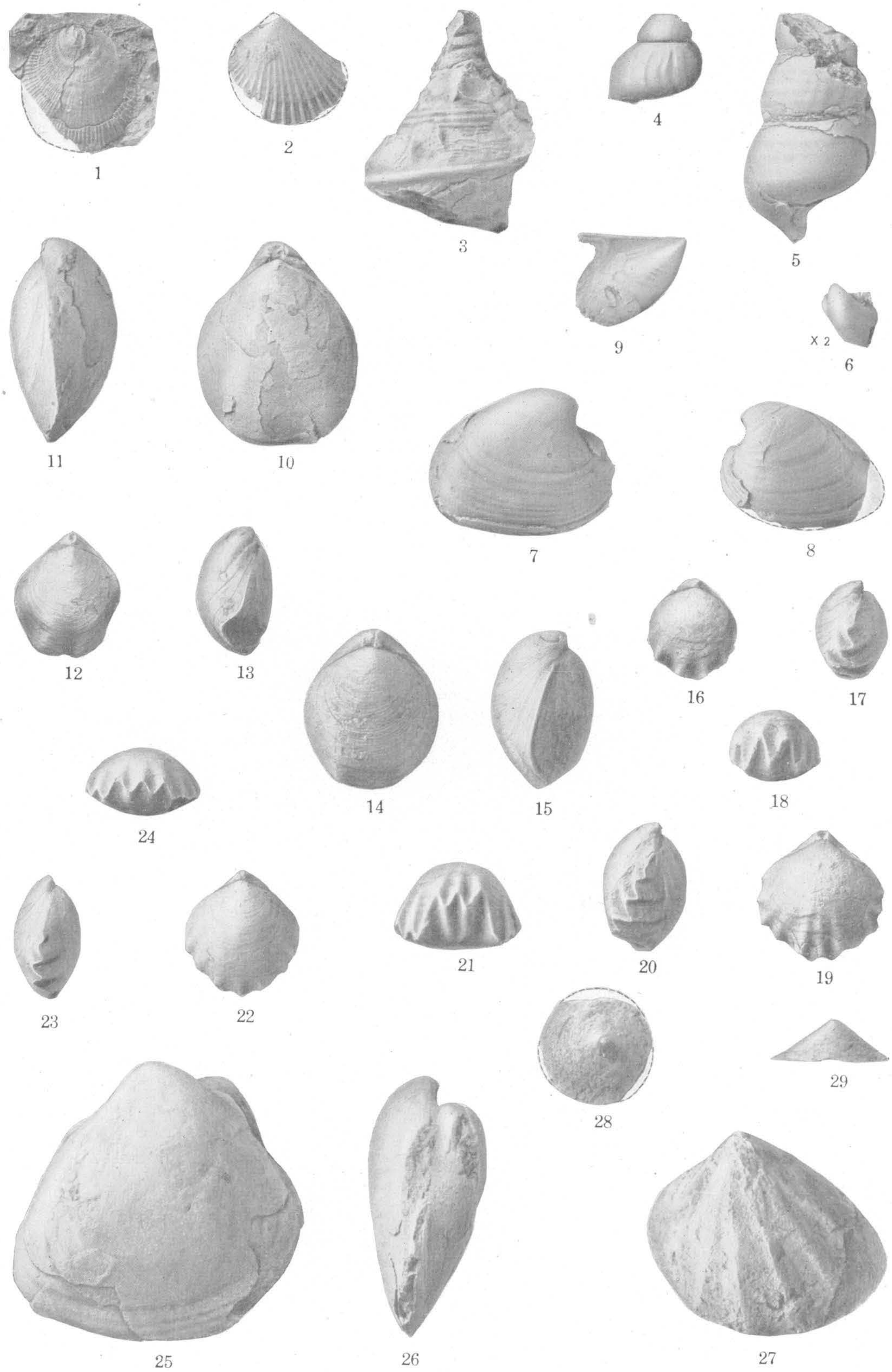
FIGURE 12. *Spiriferina coreyi* Smith, n. sp. (p. 124). Type; *Juvavites* subzone of *Tropites subbullatus* zone of Hosselkus limestone, old quarry on southwest end of Brock Mountain, Shasta County, Calif.

FIGURE 13. *Pecten (Entolium) ceruleus* Smith, n. sp. (p. 121). Type; from the *Halobia oregonensis* zone, of upper Karnic age, at Martin Bridge on Eagle River, Baker County, Oreg.

All specimens figured on this plate came from the Upper Triassic. Collection of U. S. Geological Survey, except Figures 8 and 9, which are in the collection of the University of California.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XCVI

FIGURE 1. *Dimyodon storrsi* Smith, n. sp. (p. 122). Type; *Juvavites* subzone, North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

FIGURE 2. *Cardita jenkinsi* Smith, n. sp. (p. 111). Type; same locality and subzone as Figure 1.

FIGURE 3. *Worthenia klamathensis* Smith, n. sp. (p. 108). Type; same locality and subzone as Figure 1.

FIGURE 4. *Omphaloptycha obesa* Smith, n. sp. (p. 108). Type; same locality and subzone as Figure 1.

FIGURE 5. *Omphaloptycha shastensis* Smith, n. sp. (p. 108). Type; same locality and subzone as Figure 1.

FIGURE 6. *Cassianella shastensis* Smith, n. sp. (p. 112). Type; same locality and subzone as Figure 1.

FIGURES 7, 8. *Cardinia gleimi* Smith, n. sp. (pp. 110–111).

7. Type, right valve; same locality and subzone as Figure 1.
8. Cotype, left valve; same locality and subzone as Figure 1.

FIGURE 9. *Avicula soperi* Smith, n. sp. (p. 112). Type; same locality and subzone as Figure 1.

FIGURES 10, 11. *Spirigera milesi* Smith, n. sp. (p. 125). Front and side views of the type; old stone quarry at the southwest end of Brock Mountain, Shasta County, Calif., *Trachyceras* subzone.

FIGURES 12, 13. *Dielasma julicum* Bittner (pp. 123–124). Same locality and subzone as Figure 10.

FIGURES 14, 15. *Terebratula? piriformis* Suess (p. 124). Same locality and subzone as Figure 10.

FIGURES 16–18. *Rhynchonella howardi* Smith, n. sp. (p. 122). Type; same locality and subzone as Figure 10.

FIGURES 19–21. *Rhynchonella richardsoni* Smith, n. sp. (p. 123). Type; same locality and subzone as Figure 10.

FIGURES 22–24. *Rhynchonella winnemae* Smith, n. sp. (p. 123). Type; same locality and subzone as Figure 10.

FIGURES 25, 26. *Myophoria brockensis* Smith, n. sp. (p. 110). Type, side and rear views; same locality as Figure 10; *Juvavites* subzone.

FIGURE 27. *Myophoria humboldtensis* Smith, n. sp. (p. 110). Type; *Pseudomonotis* zone, Muttleberry Canyon, West Humboldt Range, Nev.

FIGURES 28, 29. *Patella sheehani* Smith, n. sp. (p. 108). Type; same locality and subzone as Figure 1.

All specimens figured on this plate came from the Upper Triassic Hosselkus limestone, zone of *Tropites subbullatus*, Shasta County, Calif., except Figure 27, which is from the *Pseudomonotis* zone of the Star Peak formation, West Humboldt Range, Nev. Collection of U. S. Geological Survey.

PLATE XCVII

FIGURES 1–3. *Halobia superba* Mojsisovics (p. 118).

1. *Halobia*-bearing beds of Karnic age, north bank of Yukon River, one-fourth mile above mouth of Nation River, Alaska (U. S. Geological Survey No. 4054, 1906).
2. Portion of slab of limestone with adolescent stages, ×2; same locality as Figure 1.
3. The same slab as Figure 2, entire.

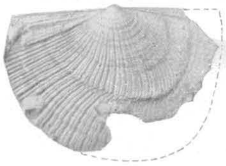
FIGURES 4–8. *Halobia ornatissima* Smith (p. 117).

4. Plaster cast, from mold, left valve, locality No. 4823, north side of Hamilton Bay, Kupreanof Island, Alaska.
5. Smaller specimen, left valve; same locality as Figure 4.
6. Early mature stage, left valve; same locality as Figure 4.
7. Early mature stage, right valve; same locality as Figure 4.
8. Left valve; point between Herring and Chapin bays, Admiralty Island, Alaska (locality No. 10180, U. S. Geological Survey).

FIGURES 9, 10. *Halobia distincta* Mojsisovics (p. 115).

9. Left valve, locality 8849, bed 4, on point at north entrance of Herring Bay, Admiralty Island, Alaska.
10. Right valve, same locality as Figure 9.

All specimens figured on this plate came from the Upper Triassic *Juvavites* subzone of the zone of *Tropites subbullatus* of Alaska. Collection of U. S. Geological Survey.



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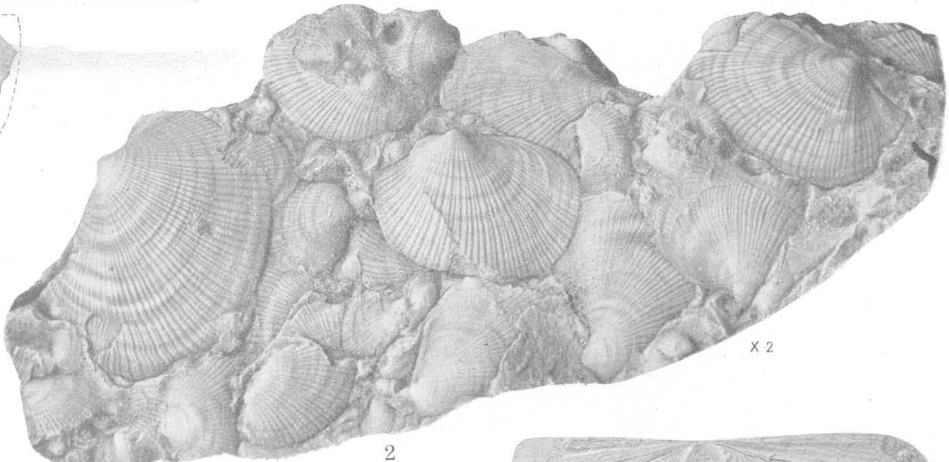

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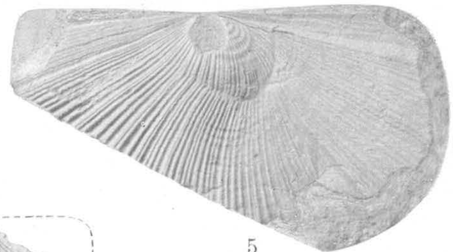

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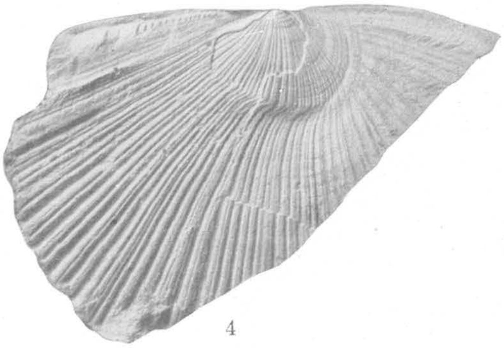

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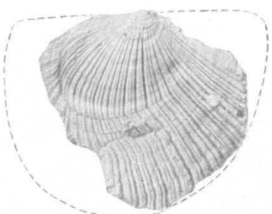

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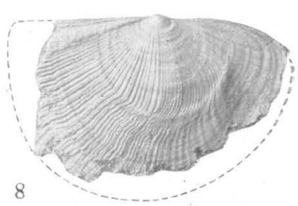

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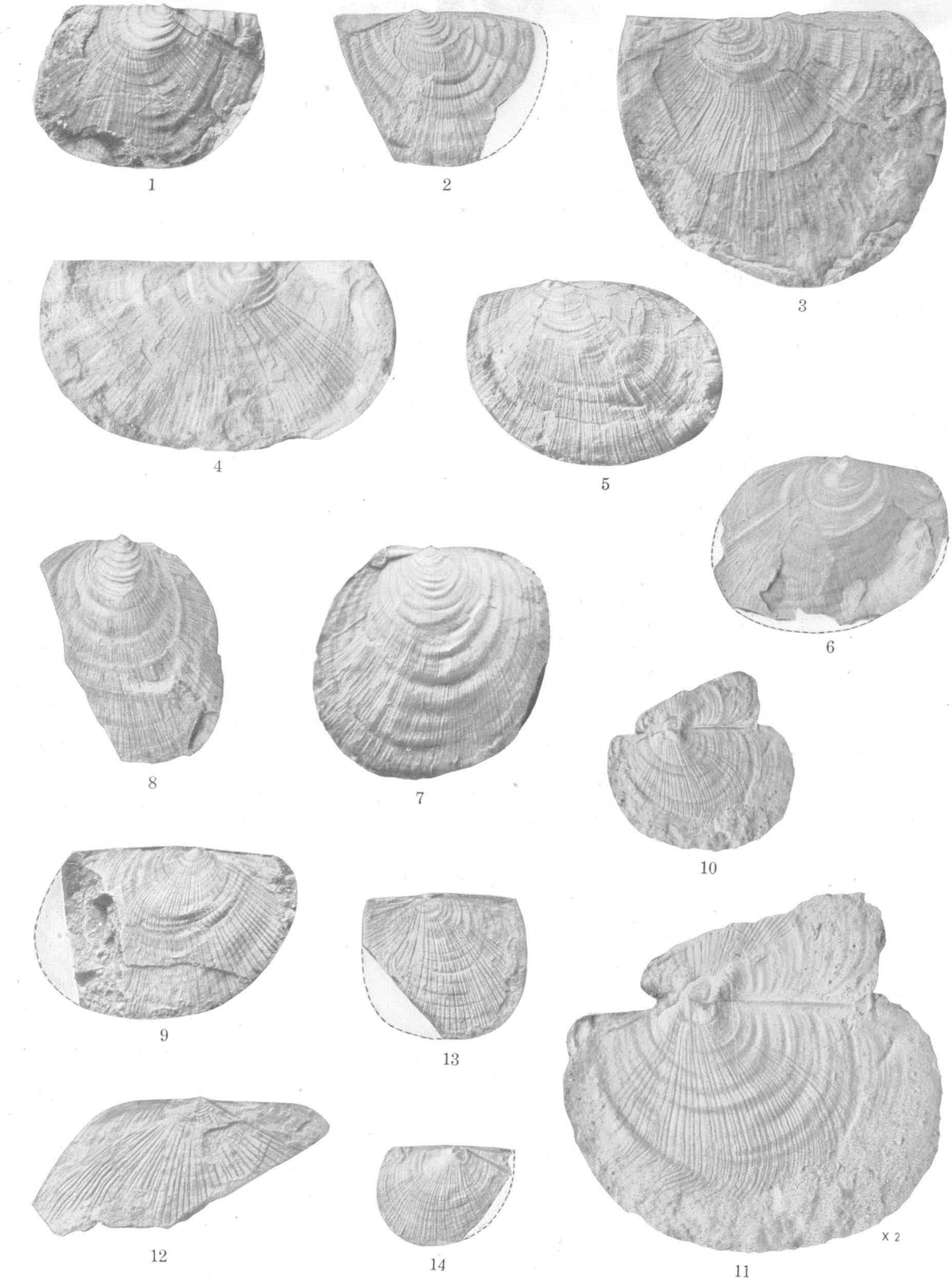
UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE XCVIII

FIGURES 1–4. *Halobia septentrionalis* Smith, n. sp. (p. 118).

1. Type, right valve; Keku Islet No. 1, Herring Bay, Admiralty Island, Alaska (locality 10196 U. S. Geological Survey).
2. Left valve; same locality as Figure 1.
3. Left valve; same locality as Figure 1.
4. Right valve, plaster cast; same locality as Figure 1.

FIGURES 5, 6. *Halobia dalliana* Smith, n. sp. (p. 115).

5. Type, left valve; same locality as Figure 1.
6. Right valve; same locality as Figure 1.

FIGURES 7, 8. *Halobia symmetrica* Smith, n. sp. (p. 119).

7. Type, left valve; same locality as Figure 1.
8. Right valve; same locality as Figure 1.

FIGURE 9. *Halobia cordillerana* Smith, n. sp. (p. 114). Right valve; locality 10197, Keku Islet No. 3, Herring Bay, Admiralty Island, Alaska.

FIGURES 10, 11. *Halobia fallax* Mojsisovics (pp. 115–116).

10. Yukon Valley, left bank of Nation River, 2 miles above mouth (plaster cast).
11. Same specimen.

FIGURE 12. *Halobia halorica* Mojsisovics (p. 116). Same locality as Figure 10.

FIGURES 13, 14. *Halobia lineata* Muenster (p. 116).

13. Left valve; same locality as Figure 10.
14. Right valve; same locality as Figure 10.

All specimens figured on this plate came from the Upper Triassic *Halobia*-bearing shales of Alaska. Collection of U. S. Geological Survey.

PLATE XCIX

FIGURES 1–6. *Halobia cordillerana* Smith, n. sp. (p. 114).

1. Adult stage; locality 8897 (bed 86), south bank of Yukon River about 1 mile above Nation River, Alaska.
2. Type, right valve; same locality as Figure 1.
3. Slab showing two right valves; same locality as Figure 1.
4. Left valve; same locality as Figure 1.
5. Left valve, plaster cast; same locality as Figure 1.
6. Right valve, adolescent stage; same locality as Figure 1.

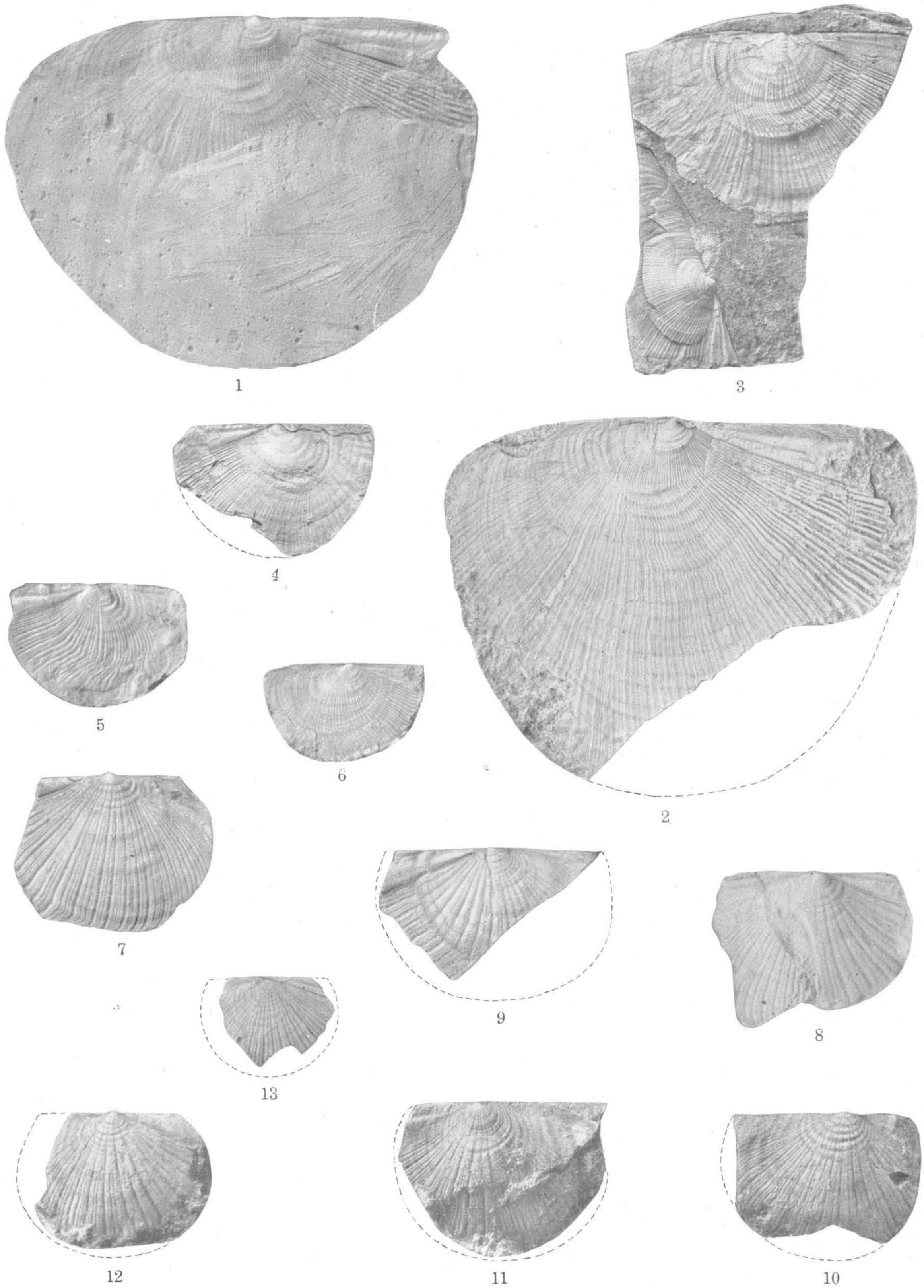
FIGURES 7–9. *Halobia brooksi* Smith, n. sp. (p. 114).

7. Type, left valve; ridge on west bank of Roadhouse Creek, 2 miles from Kuskulana River, Alaska (locality 8153 ($12AC_4$), U. S. Geological Survey).
8. Right valve, from plaster cast; same locality as Figure 7.
9. Left valve, showing zigzag of ribs; same locality as Figure 7.

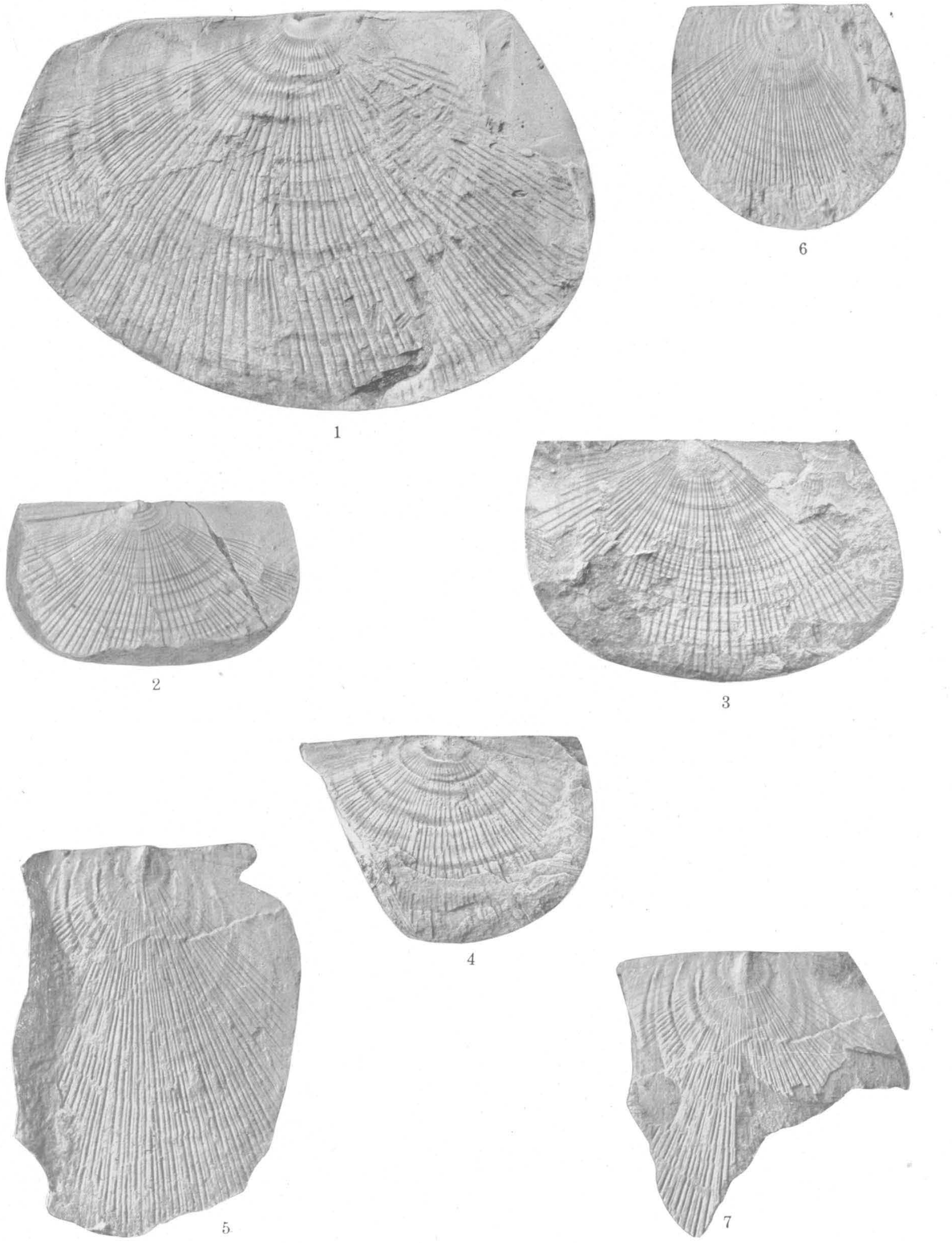
FIGURES 10–13. *Halobia austriaca* Mojsisovics (pp. 113–114).

10. Right valve; ridge between forks of Rock Creek, Copper River region, Alaska (locality 9935, U. S. Geological Survey).
11. Left valve; same locality as Figure 10.
12. Right valve; same locality as Figure 10.
13. Right valve; point at north entrance of Herring Bay, Admiralty Island, Alaska (locality 8847, U. S. Geological Survey).

All specimens figured on this plate came from the zone of *Tropites subbullatus*, of Alaska. Collection of U. S. Geological Survey.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE C

FIGURES 1–4. *Halobia dilatata* Kittl (p. 115).

1. Right valve.
2. Left valve; locality 9533 (15 ACh, 115), U. S. Geological Survey.
3. Same locality as Figure 2.
4. Right valve.

FIGURES 5–7. *Halobia alaskana* Smith, n. sp. (p. 113).

5. Type, right valve, plaster cast.
6. Smaller specimen, right valve.
7. Right valve.

All specimens figured on this plate came from the Upper Triassic coral zone, of lower Noric age, at Thompson Cove, Gravina Island, Alaska. Figures 1, 4–7, collection of Stanford University; Figures 2, 3, collection of U. S. Geological Survey.

PLATE CI

FIGURES 1, 2. *Monotis alaskana* Smith, n. sp. (pp. 119–120).

1. Type, left valve; locality 9961, F. 43, Mill Creek near the forks, Copper River region, Alaska; *Pseudomonotis* zone.
2. Cotype, right valve; same locality as Figure 1.

FIGURE 3. *Myophoria beringiana* Smith, n. sp. (pp. 109–110). Type; locality 8836 (No. 8), Gravina Island, Alaska; coral zone of Noric age.

FIGURES 4, 5. *Cassianella gravinaensis* Smith, n. sp. (p. 112).

4. Type, side view; same locality as Figure 3.
5. View from above, same specimen as Figure 4.

FIGURE 6. *Purpurina gravinaensis* Smith (p. 109). Type; locality 9535, Gravina Island, Alaska; coral zone of Noric age.

FIGURE 7. *Protorcula bassetti* Smith, n. sp. (p. 109). Type; locality 8834, north arm of Threemile Cove, Gravina Island, Alaska; coral zone of Noric age.

FIGURE 8. *Pseudomonotis subcircularis* Gabb (pp. 120–121). Locality 3107, Cold Bay, Alaska; *Pseudomonotis* zone. (Martin, G. C., Geol. Soc. America Bull., vol. 27, pl. 29, fig. 1, 1916.)

FIGURES 9, 10. *Pecten (Entolium) yukonensis* Smith, n. sp. (p. 122).

9. Type; locality 9384, south bank of Yukon River, opposite Nation River, Alaska; beds of upper Karnic age.
10. Same locality as Figure 9.

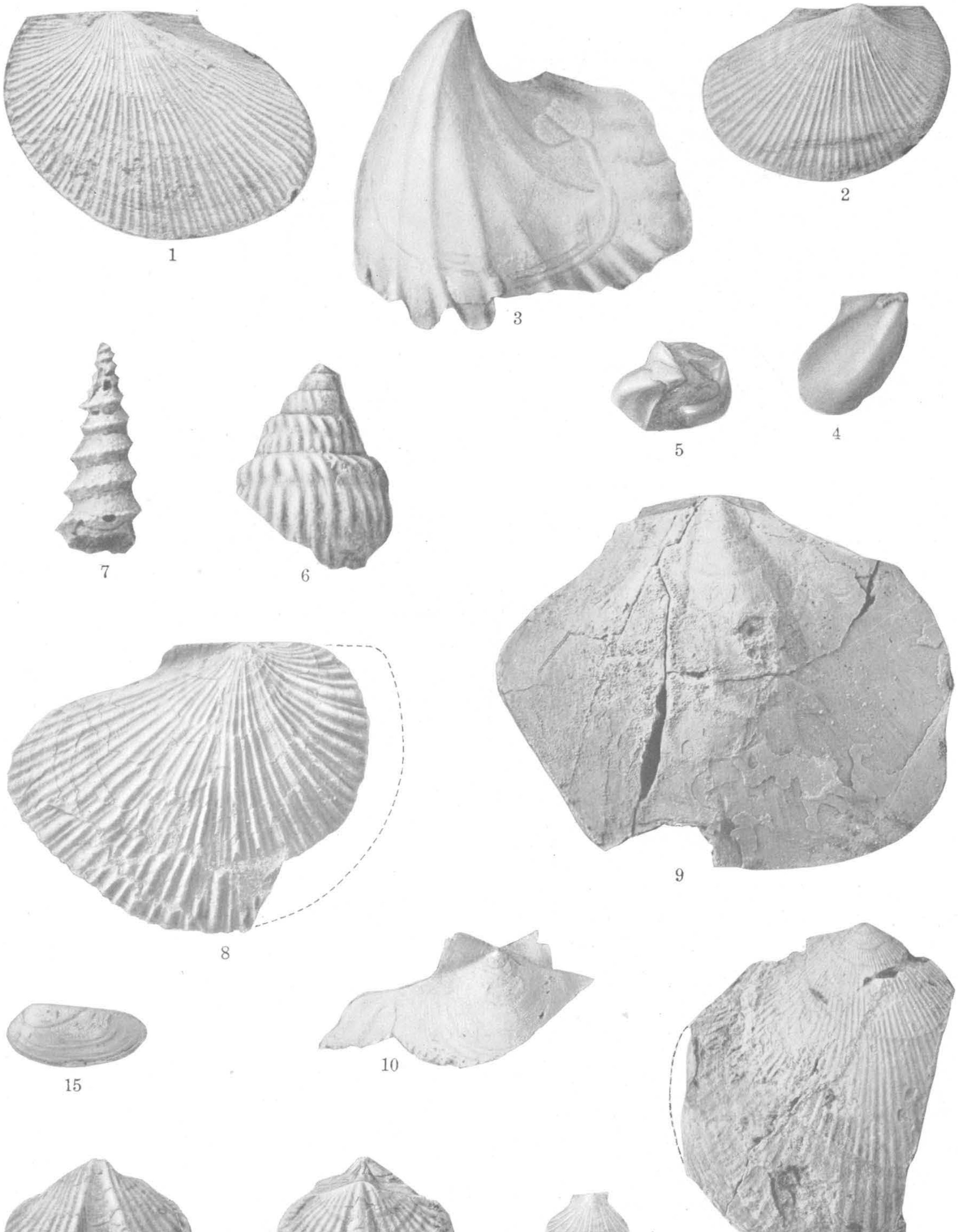
FIGURE 11. *Lima martini* Smith, n. sp. (p. 122). Type; same locality as Figure 9.

FIGURE 12. *Eumorphotis nationalis* Smith, n. sp. (p. 121). Type; locality 9385, same as Figure 9.

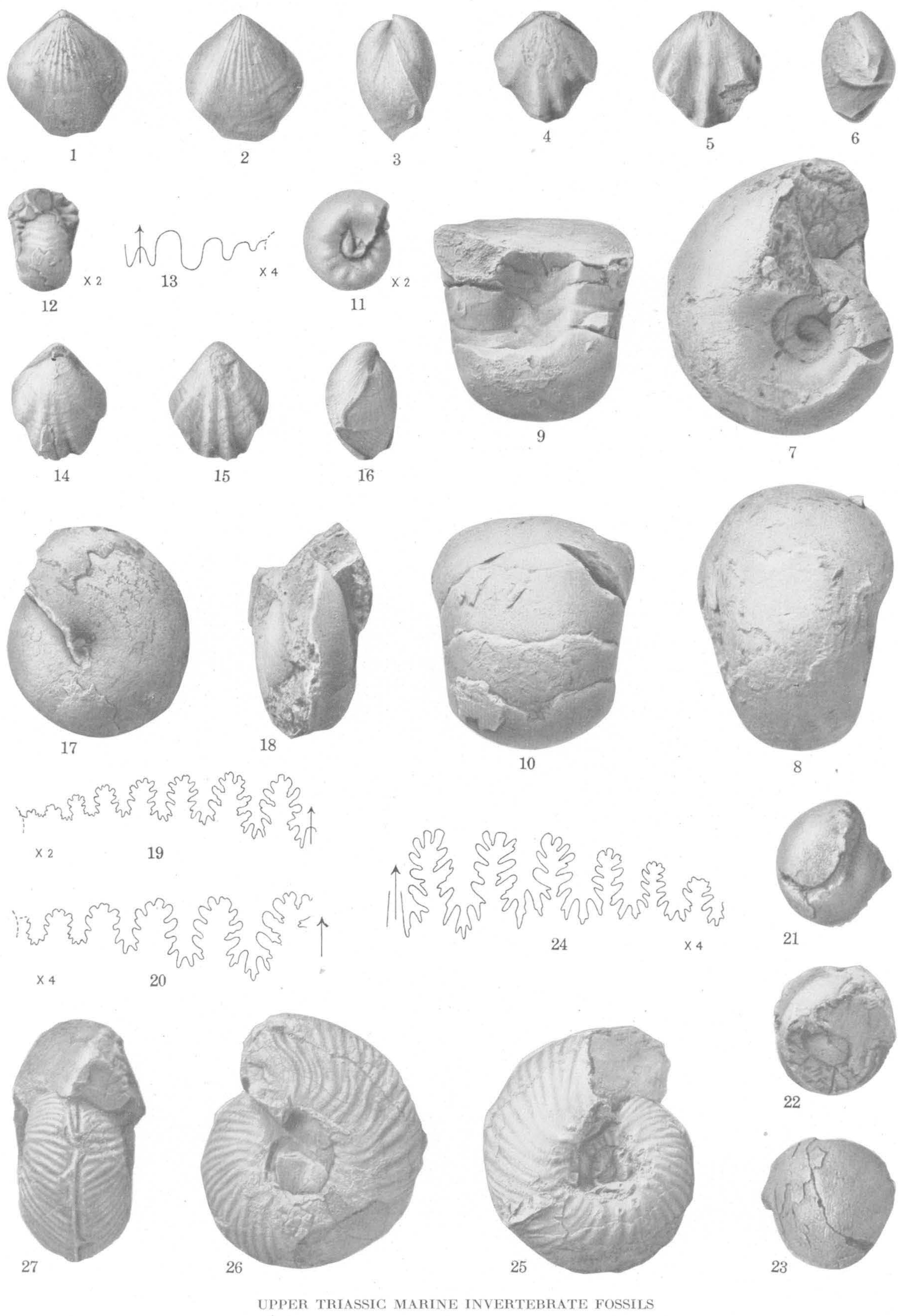
FIGURES 13, 14. *Spiriferina yukonensis* Smith, n. sp. (pp. 124–125). Type; locality 9385, same as Figure 9.

FIGURE 15. *Pleurophorus overbecki* Smith, n. sp. (p. 111). Type; same locality as Figure 9.

All specimens figured on this plate came from the Upper Triassic of Alaska. Collection of U. S. Geological Survey.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE CII

Figures 1–3. *Rhynchonella blackwelderi* Smith, n. sp. (p. 122). Type; locality 8895, south bank of Yukon River, 1 mile above mouth of Nation River, Alaska.

Figures 4–6. *Dielasma chapini* Smith, n. sp. (p. 123). Type; locality 9384, south bank of Yukon River opposite mouth of Nation River, Alaska.

Figures 7–10. *Germanonautilus brooksi* Smith, n. sp. (p. 105).

7, 8. Type; same locality as Figures 4–6.

9, 10. View showing septa; same locality as Figures 4–6.

Figures 11–13. *Nathorstites alaskanus* Smith, n. sp. (p. 67). Type; same locality as Figures 1–3.

Figures 14–16. *Dielasma hamiltonense* Smith, n. sp. (p. 123). Type; locality 4822, Hamilton Bay, Kupreanof Island, Alaska.

Figures 17–20. *Cladiscites martini* Smith, n. sp. (p. 70). Type; locality 9385, Yukon River one-third mile northeast of mouth of Nation River, Alaska.

Figures 21–24. *Cladiscites mendenhalli* Smith, n. sp. (p. 70). Type; locality 10304, Canning River, Alaska.

Figures 25–27. *Tropites stantoni* Smith, n. sp. (p. 38). Type; locality 6319, Copper River region, Alaska.

All specimens figured on this plate came from the *Halobia*-bearing beds of Karnic age in Alaska. Collection of U. S. Geological Survey.

PLATE CIII

FIGURES 1–3. *Margarites moffiti* Smith, n. sp. (p. 48). Type; *Juvavites* subzone of *Tropites subbullatus* zone, locality 4810, Houghton, Alaska.

FIGURES 4–6. *Discophyllites patens* Mojsisovics (p. 100). *Juvavites* subzone, locality 8848, point at north entrance to Herring Bay, Admiralty Island, Alaska.

FIGURES 7, 8. *Sirenites hayesi* Smith, n. sp. (p. 82). Type; beds of Karnic age, locality 8479, middle fork of White River, Alaska.

FIGURES 9, 10. *Protorcula alaskana* Smith, n. sp. (p. 109).

9. Type; beds of Karnic age, locality 10093, Copeland Creek, Alaska.

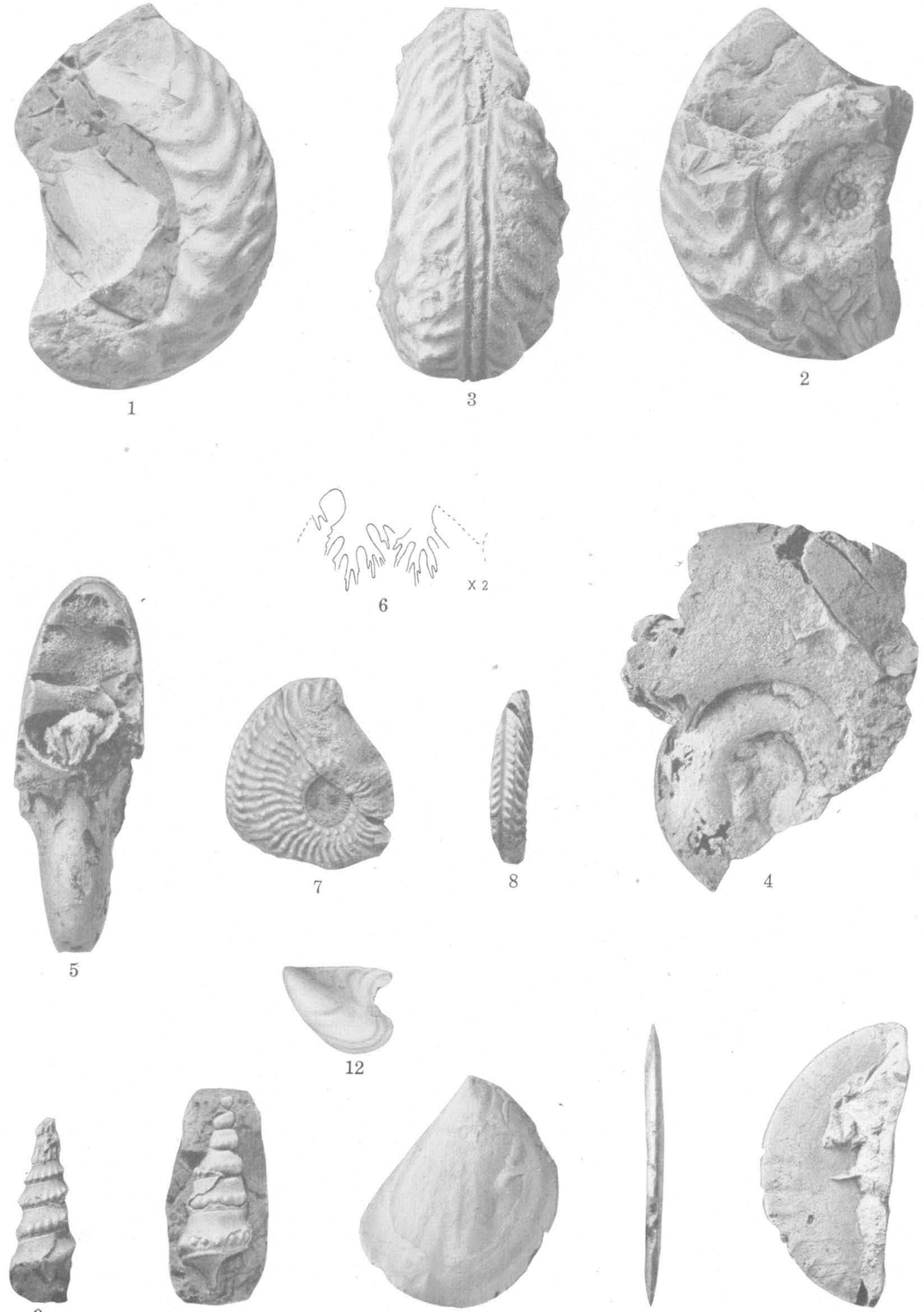
10. View showing aperture; same locality as Figure 9.

FIGURE 11. *Lima blackburnei* Smith, n. sp. (p. 122). Type; same locality as Figure 9.

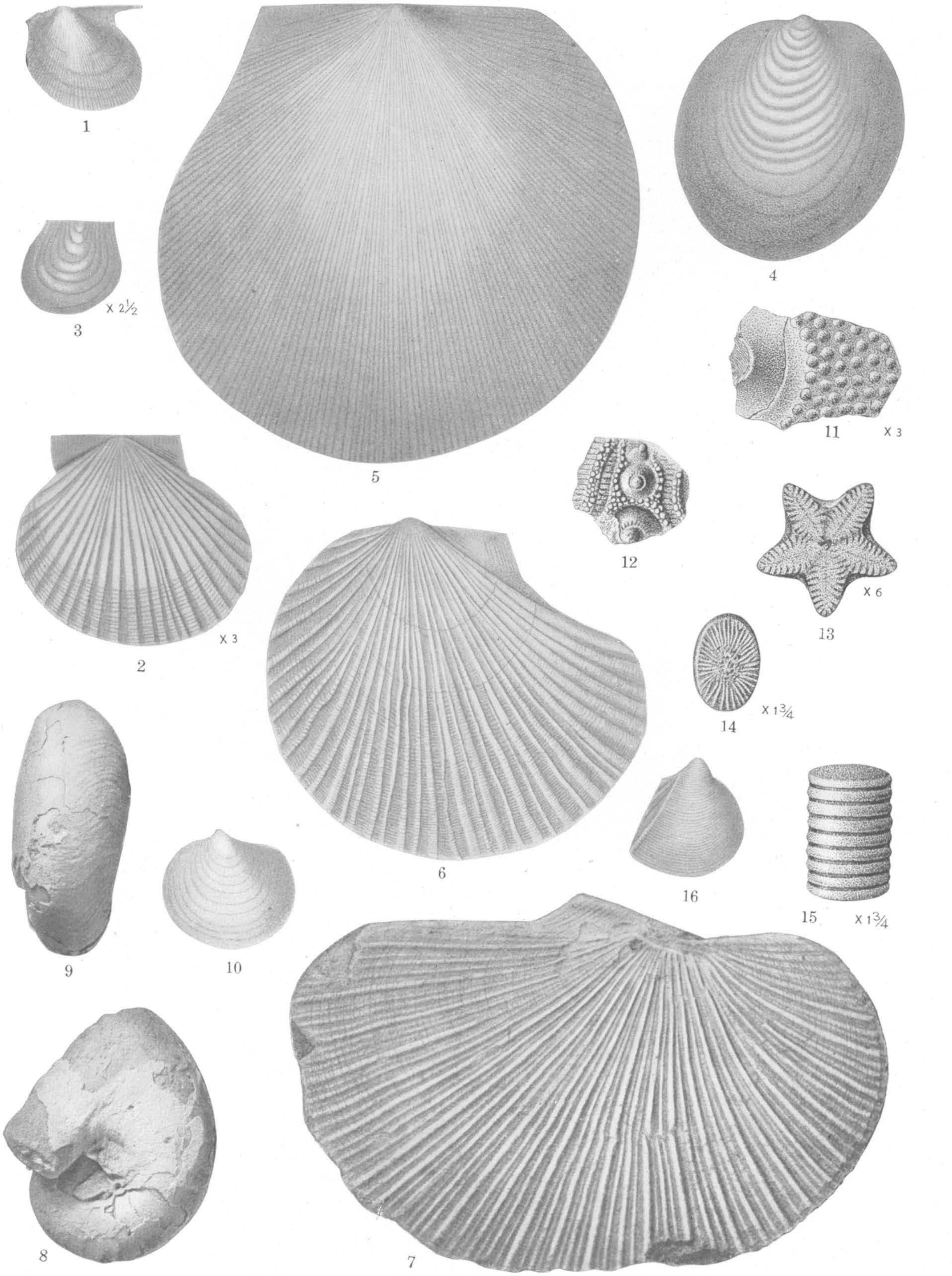
FIGURE 12. *Avicula soperi* Smith, n. sp. (p. 112). Limestone of lower Noric age, locality 8946, Rock Creek near Strelna Creek, Alaska.

FIGURES 13, 14. *Pinacoceras* cf. *P. rex* Mojsisovics (p. 75). *Juvavites* subzone, same locality as Figures 4–6.

All specimens figured on this plate came from the Upper Triassic of Alaska. Collection of U. S. Geological Survey.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE CIV

FIGURE 1. *Avicula mucronata* Gabb (pp. 111–112). *Pseudomonotis* zone of Swearinger slate, Plumas County, Calif. (Copied from California Geol. Survey, Paleontology, vol. 1, pl. 5, fig. 27.)

FIGURE 2. *Pecten deformis* Gabb (p. 121). Same locality as Figure 1. (Idem, pl. 6, fig. 34.)

FIGURE 3. *Posidonia daytonensis* Gabb (p. 112). *Pseudomonotis* zone near Dayton, El Dorado Canyon, Nev. (Idem, pl. 6, fig. 32.)

FIGURE 4. *Posidonia blatchleyi* Gabb (p. 112). *Pseudomonotis* zone, New Pass, near Austin, Nev. (Copied from Am. Jour. Conchology, vol. 5, pl. 6, fig. 12.)

FIGURE 5. *Pseudomonotis circularis* Gabb (p. 120). *Pseudomonotis* zone at New Pass, near Austin, Nev. (Idem, vol. 5, pl. 7, fig. 14.

FIGURES 6, 7. *Pseudomonotis subcircularis* Gabb (pp. 120–121).

6. *Pseudomonotis* zone of Swearinger slate, Plumas County, Calif. (Copied from California Geol. Survey, Paleontology vol. 1, pl. 6, fig. 29.)

7. *Pseudomonotis* zone of Brock shale, 1 mile south of Mewittipom Mountain, Redding quadrangle, Calif. (Copied from Martin, G. C., Geol. Soc. America Bull., vol. 27, pl. 30, fig. 2.)

FIGURES 8, 9. *Syringoceras spurri* Smith, n. sp. (p. 106). Type; *Pseudomonotis* zone of Star Peak formation, Muttleberry Canyon, West Humboldt Range, Nev. Collection of J. P. Smith.

FIGURE 10. *Posidonia stella* Gabb (p. 113). *Pseudomonotis* zone of Star Peak formation, Star Canyon, West Humboldt Range, Nev. (Copied from California Geol. Survey, Paleontology, vol. 1, pl. 6, fig. 31.)

FIGURE 11. *Cidaris shastensis* Clark (p. 125). Round Mountain, Shasta County, Calif. Upper Triassic. (Copied from Clark and Twitchell, U. S. Geol. Survey Mon. 54, pl. 1, fig. 5.)

FIGURE 12. *Cidaris dilleri* Clark (p. 125). Same locality as Figure 11. (Idem, pl. 1, fig. 6.)

FIGURE 13. *Isocrinus californicus* Clark (p. 125). Same locality as Figure 11. (Idem, pl. 1, fig. 2a.)

FIGURES 14, 15. *Encrinus hyatti* Clark (p. 125). Same horizon as Figure 11; near Longville, Plumas County, Calif. (Idem, pl. 1, figs. 3a, 3b.)

FIGURE 16. *Myophoria alta* Gabb (p. 109). Upper Triassic of Dun Glen, East Range, Nev. (Copied from California Geol. Survey, Paleontology, vol. 1, pl. 6, fig. 33.)

PLATE CV

FIGURE 1. *Thecosmilia fenestrata* Reuss (p. 128). (Copied from Clapp, C. H., and Shimer, H. W., Boston Soc. Nat. Hist. Proc., vol. 34, No. 12, pl. 41, fig. 15, 1911.)

FIGURE 2. *Myophoria suttonensis* Clapp and Shimer (p. 110). Type. (Idem, pl. 41, fig. 14.)

FIGURE 3. *Confusastrea cowichanensis* Clapp and Shimer (p. 129). (Idem, pl. 41, fig. 11.)

FIGURE 4. *Thecosmilia delicatula* Frech (p. 127). (Idem, pl. 42, fig. 17.)

FIGURES 5, 6. *Choristoceras suttonense* Clapp and Shimer (p. 98). (Idem, pl. 40, figs. 4 and 6.)

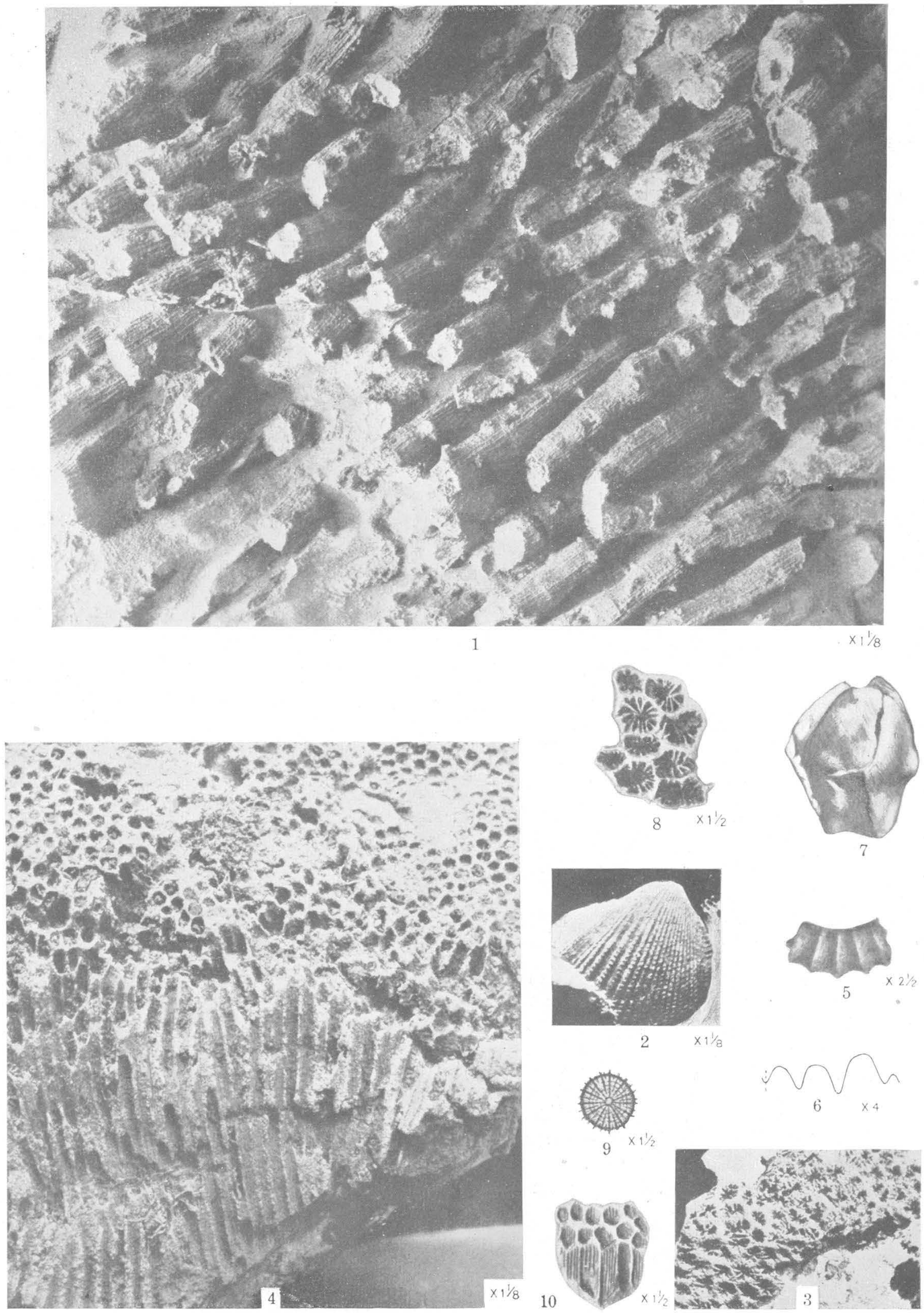
FIGURE 7. *Dielasma suttonense* Clapp and Shimer (p. 124). (Idem, pl. 40, fig. 3.)

FIGURE 8. *Isastrea profunda* Reuss (p. 128). (Idem, pl. 40, fig. 9.)

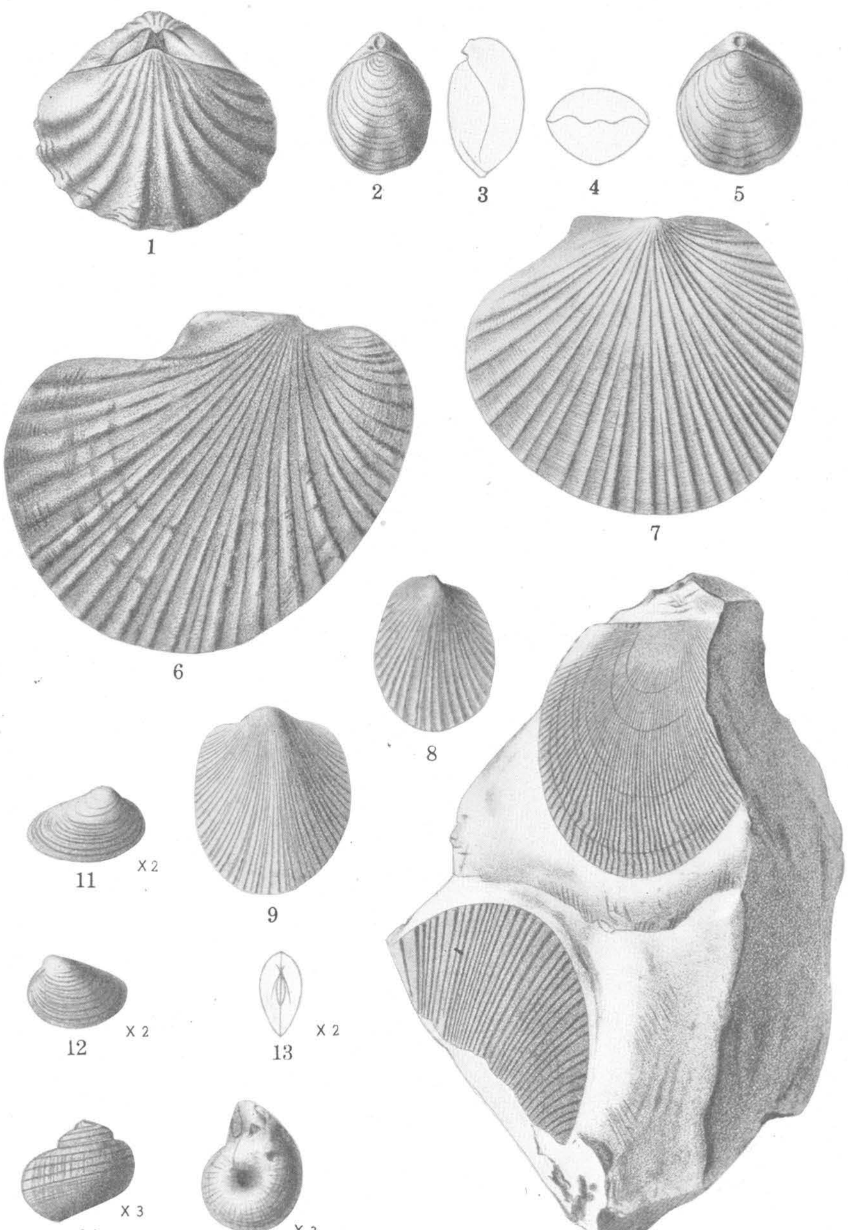
FIGURE 9. *Thecosmilia fenestrata* Reuss (p. 128). Cross section. (Idem, pl. 40, fig. 5.)

FIGURE 10. *Isastrea vancouverensis* Clapp and Shimer (pp. 128–129). Type. (Idem, pl. 40, fig. 8.)

All specimens figured on this plate came from the Upper Triassic beds of lower Noric age at Cowichan Lake, Vancouver Island, British Columbia.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE CVI

FIGURE 1. *Spiriferina borealis* Whiteaves (p. 124). Dorsal view of the type of the species.

FIGURES 2–5. *Dielasma liardense* Whiteaves (p. 123).

2. Dorsal view of one of the most perfect specimens of the narrowly ovate and most usual form of this species.
3. Profile view of the same specimen, in outline only.
4. Front view of the same, also, in outline only.
5. Dorsal view of a broad and nearly circular form of the species.

FIGURES 6, 7. *Pseudomonotis subcircularis* Gabb (pp. 120–121).

6. Right valve of an obliquely subovate specimen of this species, from Fossil Point, on Peace River.
7. Right valve of another specimen, of more nearly circular outline, from the same locality.

FIGURE 8. *Pseudomonotis ovalis* Whiteaves (p. 120). Left valve of the type of this species.

FIGURES 9, 10. *Halobia occidentalis* Whiteaves (p. 117).

9. Left valve of the type specimen.
10. Small piece of rock, partly covered by the basal portion of a left valve and a nearly entire right valve of a shell which is somewhat doubtfully referred to this species.

FIGURES 11–13. *Trigonodus? productus* Whiteaves (p. 110).

11. Right valve.
12. Left valve of another specimen, from the same locality.
13. Dorsal view of the closed valves of a third specimen, in outline only.

FIGURES 14, 15. *Margarita triassica* Whiteaves (p. 109).

14. Dorsal view of one of the most perfect specimens collected.
15. Basal view of the same.

All figures on this plate copied from Whiteaves, J. F., Contr. Canadian Paleontology, vol. 1, pt. 2, pl. 17, 1889.

PLATE CVII

FIGURES 1, 2. *Paranautilus liardensis* Whiteaves (p. 102).

1. Side view of the type.
2. Front view of the same specimen.

FIGURES 3–5. *Nathorstites mcconnelli* Whiteaves (p. 67).

3. Side view of a specimen of the typical form.
4. Front view of the same specimen, in outline.
5. Portion of the sutural line of another specimen.

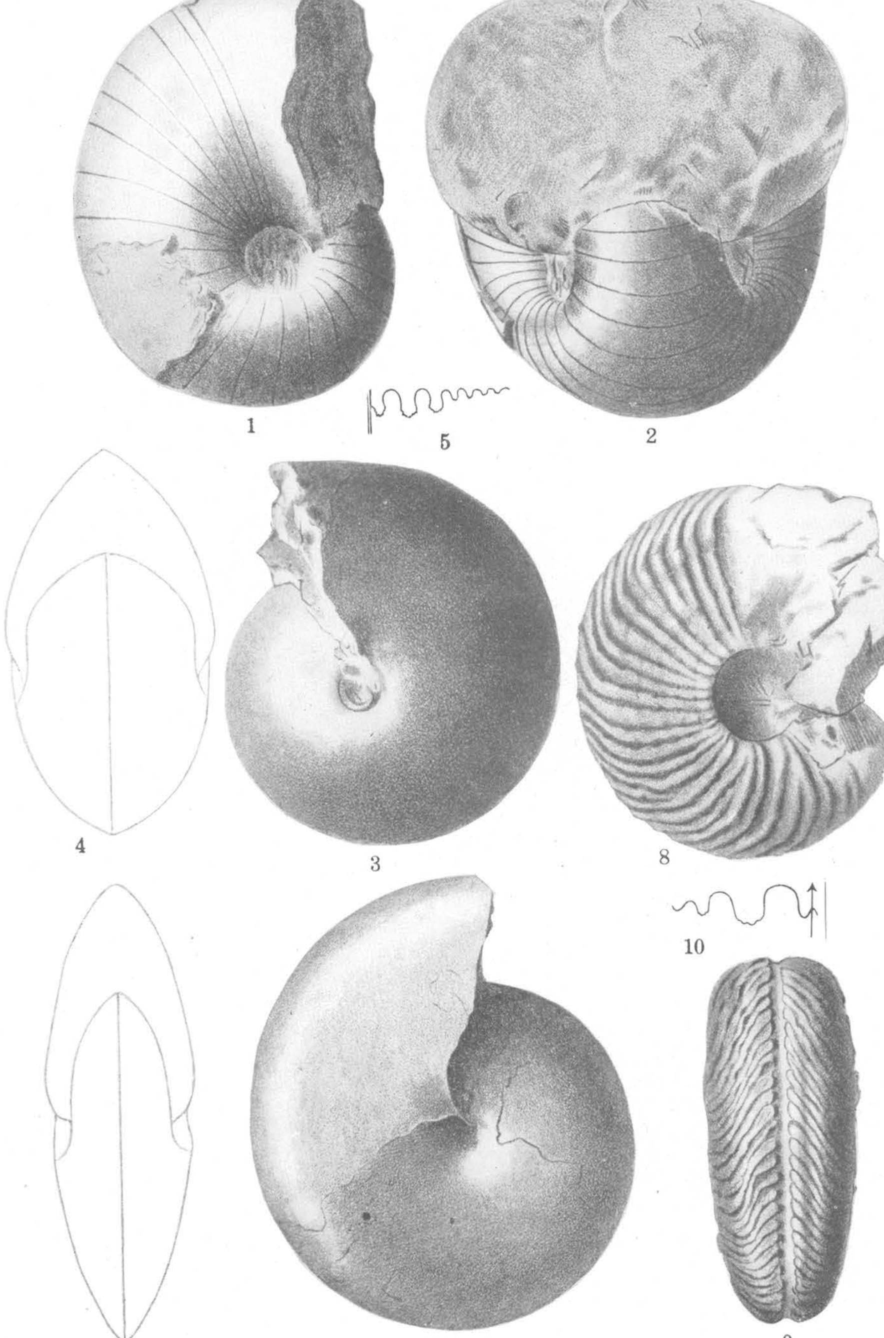
FIGURES 6, 7. *Nathorstites lenticularis* Whiteaves (p. 67).

6. Side view.
7. Front view of the same specimen, in outline.

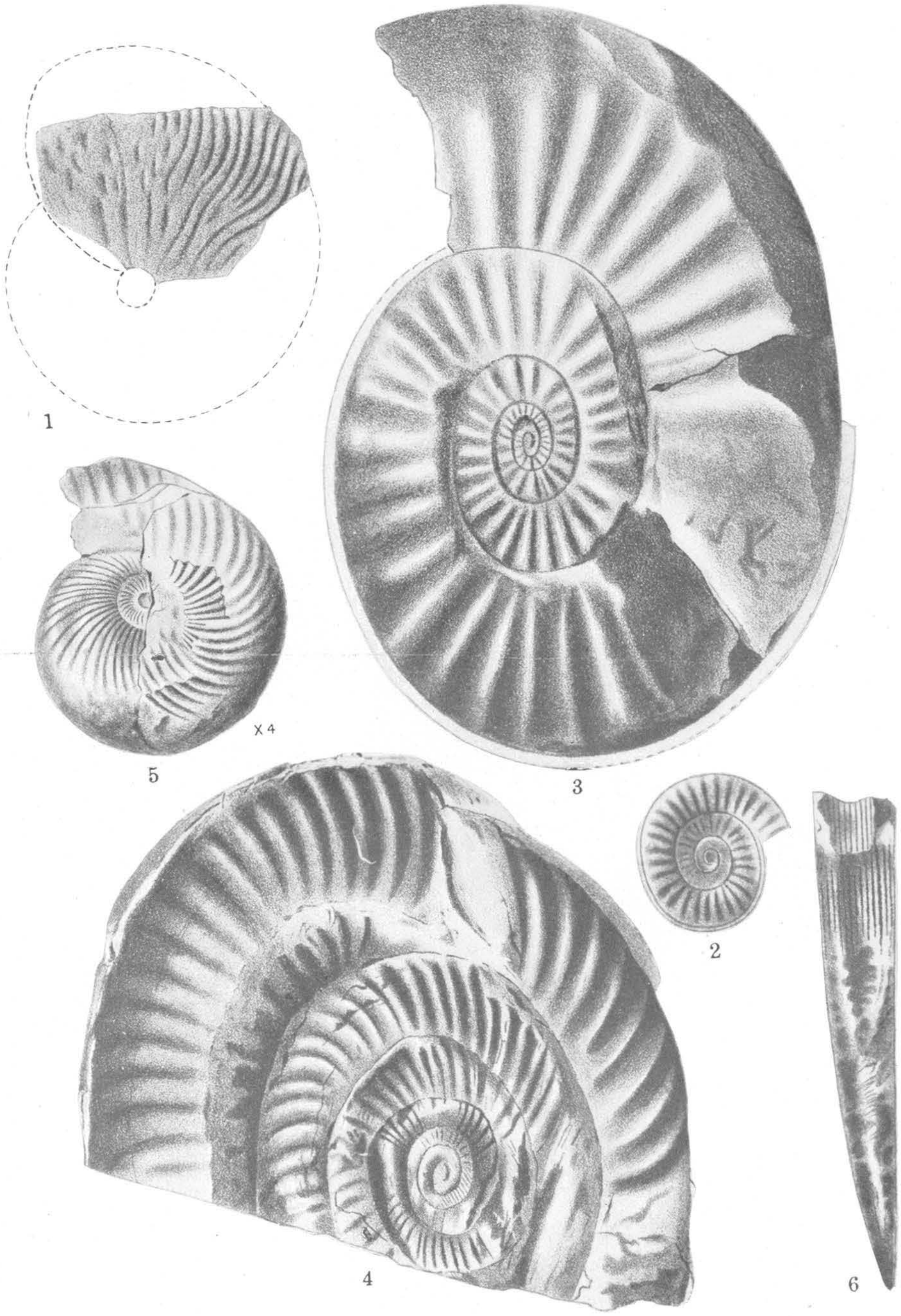
FIGURES 8–10. *Clionites* (*Dawsonites*) *canadensis* Whiteaves (pp. 92–93).

8. Side view of the type.
9. Front view of the same specimen, showing the groove in the center of the abdominal region.
10. Portion of the sutural line of the same specimen.

All figures on this plate copied from Whiteaves, J. F., Contr. Canadian Paleontology, vol. 1, pt. 2, pl. 18, 1889.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE CVIII

FIGURE 1. *Juvavites? carlottensis* Whiteaves (p. 54). Side view of the larger of the two fragments upon which this species is based. The dotted lines indicate the probable outline of the shell.

FIGURE 2. *Arniotites vancouverensis* Whiteaves (p. 51). Side view of the type.

FIGURE 3. *Arniotites* sp.? Side view of the largest and most perfect specimen from Robson Island.

FIGURE 4. *Arniotites* or *Celtites* sp.? Side view of the large specimen from Forward Inlet.

FIGURE 5. *Badiotites? carlottensis* Whiteaves (pp. 98–99). Side view of the type.

FIGURE 6. *Aulacoceras carlottense* Whiteaves (p. 101). Guard of the most perfect specimen of this species known.

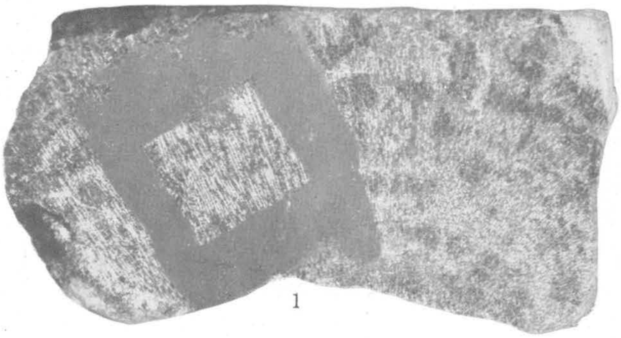
All figures on this plate copied from Whiteaves, J. F., Contr. Canadian Paleontology, vol. 1, pt. 2, pl. 19, 1889.

PLATE CIX

FIGURES 1–6. *Heptastylis aquilae* Smith, n. sp. (p. 134).

1. Longitudinal section of the type.
2. End section of the type, same specimen as Figure 1.
3. Portion of longitudinal section of the type.
4. Portion of end section of the type.
5. Broken specimen, showing radiating divergent rods.
6. Polished face, showing radial divergent rods, $\times$ 2.

All specimens figured on this plate came from the Upper Triassic coral zone of lower Noric age at Martin Bridge on Eagle River, Blue Mountains, Baker County, Oreg. Collection of U. S. Geological Survey.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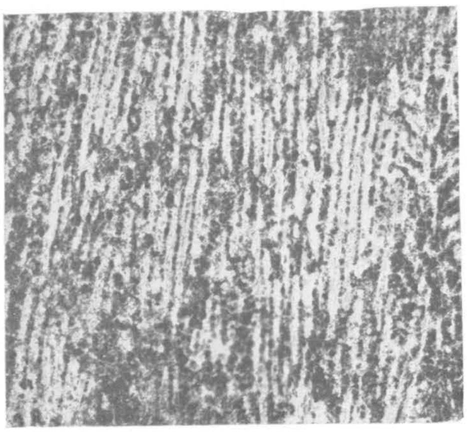
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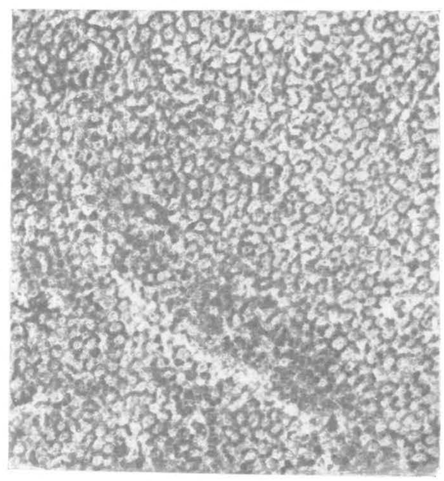
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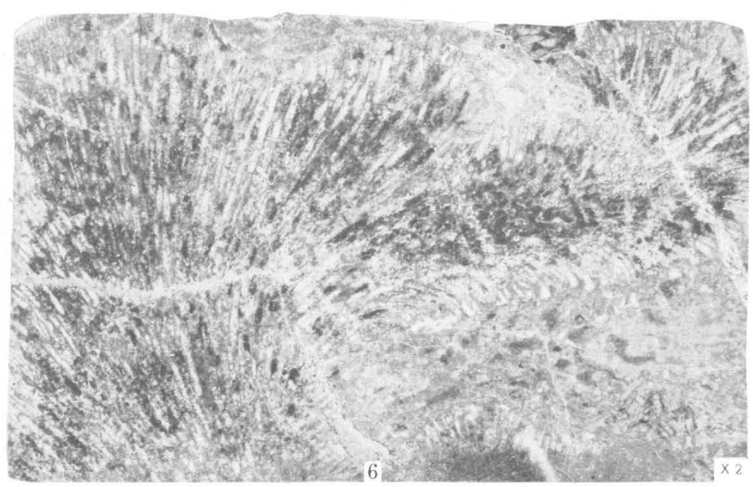
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UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

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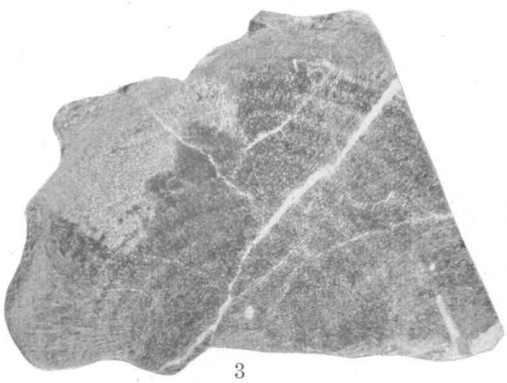

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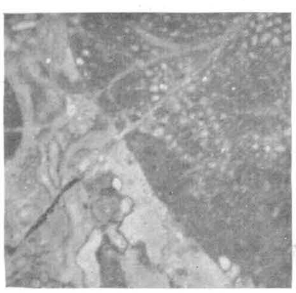

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UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE CX

FIGURES 1–5. *Heptastylis oregonensis* Smith, n. sp. (p. 134).

1. Type; coral zone of lower Noric age at Martin Bridge, Blue Mountains, Oreg.
2. Portion of surface of type, showing polyps.
3. Transverse section of another specimen, showing the radial rods and concentric apophyses; same locality as Figure 1.
4. Portion of specimen shown on Figure 3.
5. Thin section of another specimen, same locality as Figure 1.

All specimens figured on this plate are in the collection of the U. S. Geological Survey.

PLATE CXI

FIGURES 1–4. *Thecosmilia norica* Frech (p. 128).

1, 2. End and longitudinal sections.

3. Polished face, showing numerous sections.

4. Polished face, showing sections.

FIGURE 5. *Heptastylis aquilae* Smith, n. sp. (p. 134). End section showing irregular calyces.

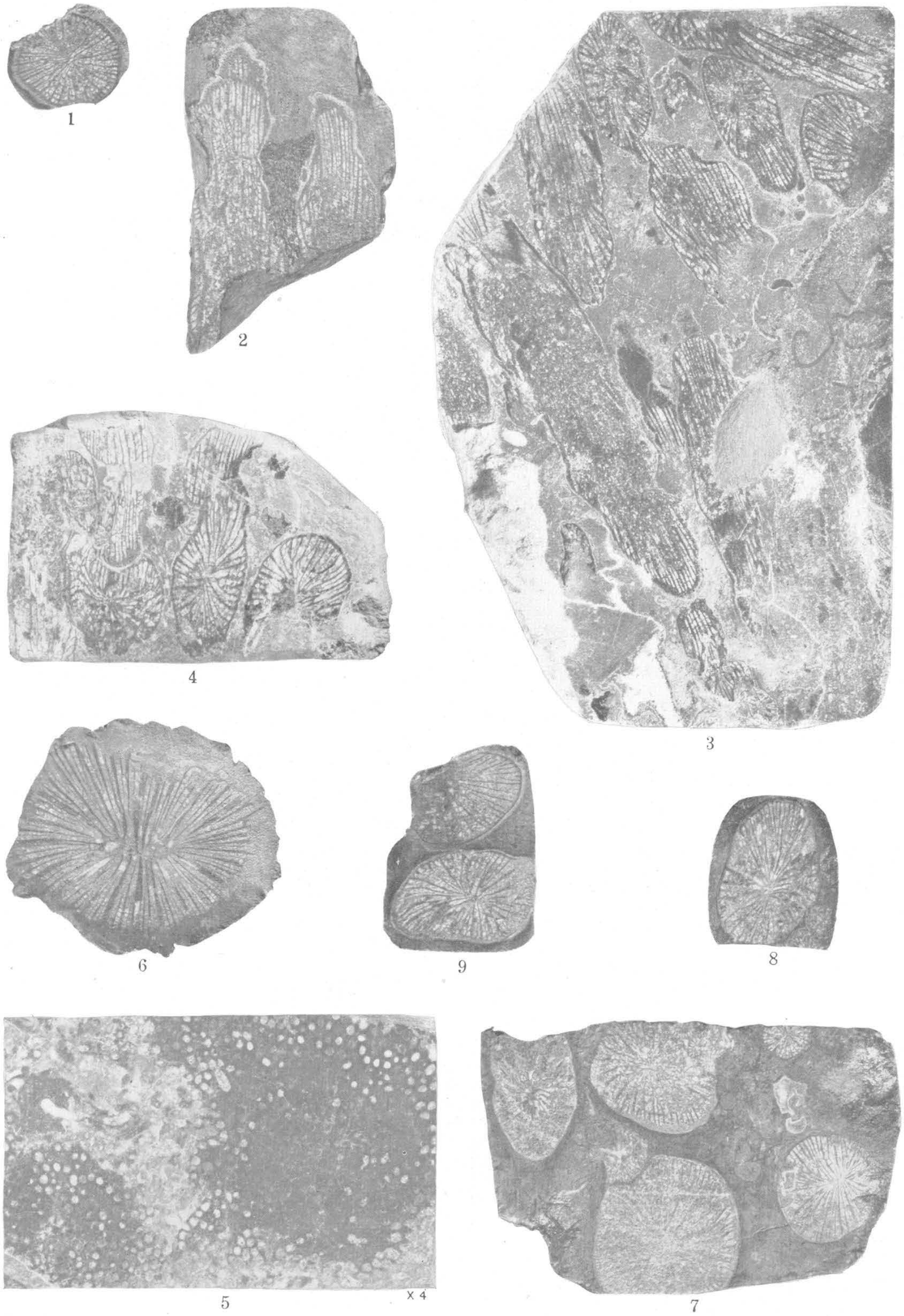
FIGURE 6. *Montlivaultia norica* Frech (pp. 126–127). End section.

FIGURES 7–9. *Stylophyllopsis zitteli* Frech (p. 127).

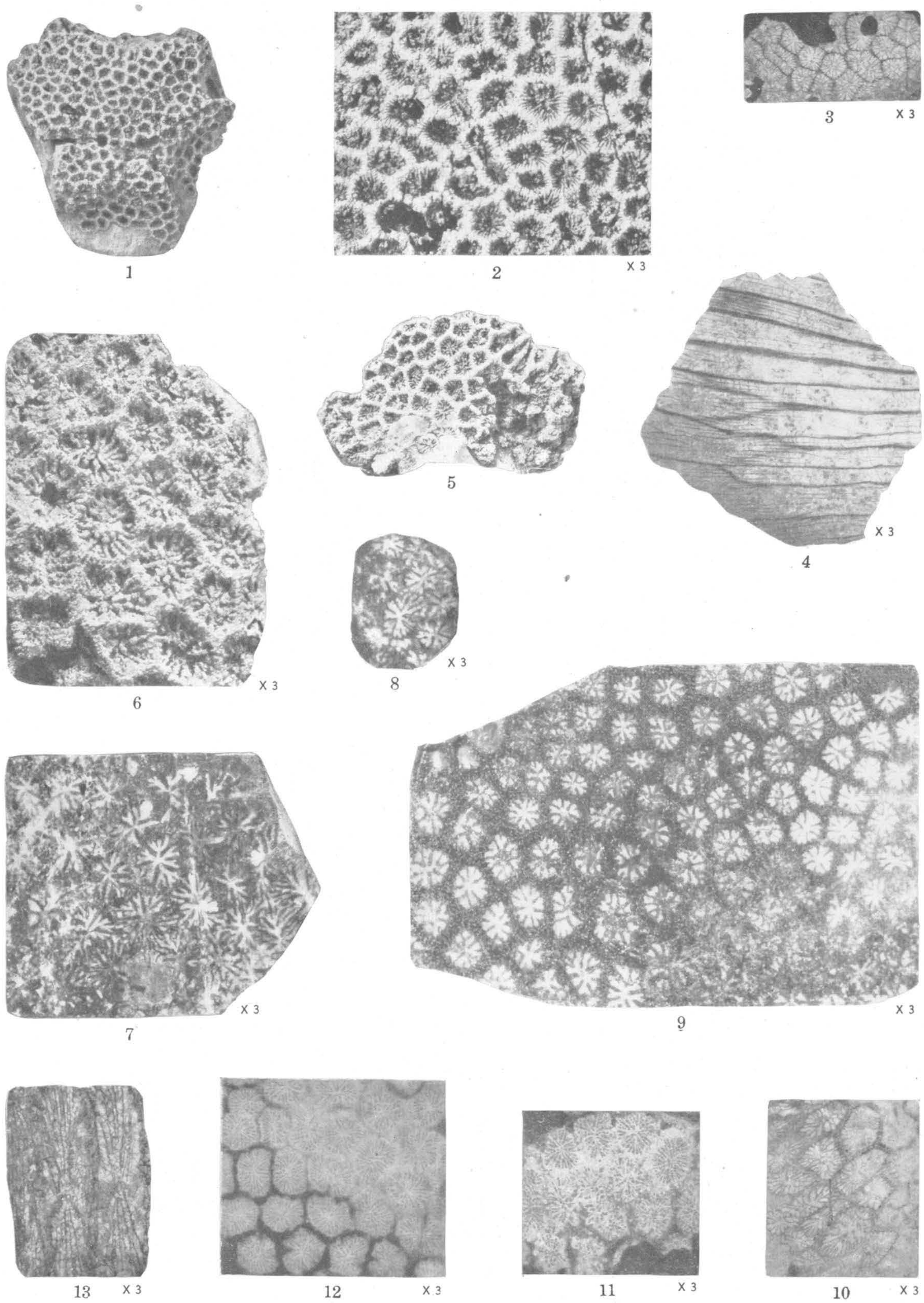
7. End sections.

8, 9. Sections at right angle to Figure 7, same block.

All specimens figured on this plate came from the coral zone of lower Noric age at Martin Bridge on Eagle River, Blue Mountains, Oreg. Collection of U. S. Geological Survey.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE CXII

FIGURES 1–4. *Isastrea vancouverensis* Clapp and Shimer (pp. 128–129).

1. From north end and east side of Brock Mountain (Devil Rock), Shasta County, Calif.
2. Same specimen, portion of cells.
3. Thin transverse section; same locality as Figure 1.
4. Thin longitudinal section; same locality as Figure 1.

FIGURES 5, 6. *Isastrea profunda* Reuss (p. 128).

5. Same locality as Figure 1.
6. Same specimen, portion of cells.

FIGURES 7–10. *Stephanocoenia juvavica* Frech (p. 132).

7. Polished section; North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.
8. Thin section; north end and west side of Brock Mountain, Shasta County, Calif.
9. Polished section; same locality as Figure 8.
10. Thin section; junction of Cedar Creek and Little Cow Creek 3 miles east of Ingot, Shasta County, Calif.

FIGURES 11–13. *Astrocoenia shastensis* Smith, n. sp. (p. 132).

11. Thin section of type; north end and west side of Brock Mountain (Devil Rock), Shasta County, Calif.
12. Polished face of type; same locality as Figure 11.
13. Longitudinal section of type; same specimen as Figure 11.

All specimens figured on this plate came from the coral zone, of lower Noric age, in the Upper Triassic Hosselkus limestone, on or near Brock Mountain, in the neighborhood of Squaw Creek, Shasta County, Calif. Collection of U. S. Geological Survey.

PLATE CXIII

FIGURES 1–6. *Thamnastraea rectilamellosa* Winkler (p. 131).

1. Polished face, near junction of Cedar Creek and Little Cow Creek, 3 miles northeast of Ingot, Shasta County, Calif.

2, 3. Same specimen as Figure 1, portion of polished face.

4. Another specimen, polished face; same locality as Figure 1.

5, 6. Weathered specimens; same locality as Figure 1.

FIGURE 7. *Confusastrea decussata* Frech (p. 130). Silicified specimen exposed by weathering. Bear Cove, north end and east side of Brock Mountain, between Squaw Creek and Pit River Shasta County, Calif.

FIGURES 8, 9. *Latimaeandra eucystis* Frech (pp. 130–131).

8. Silicified specimen, exposed by weathering, same locality as Figure 7.

9. Polished face, North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

All specimens figured on this plate came from the coral zone of lower Noric age in the Upper Triassic Hosselkus limestone in the region on or near Squaw Creek, Brock Mountain, Shasta County, Calif. Collection of U. S. Geological Survey.

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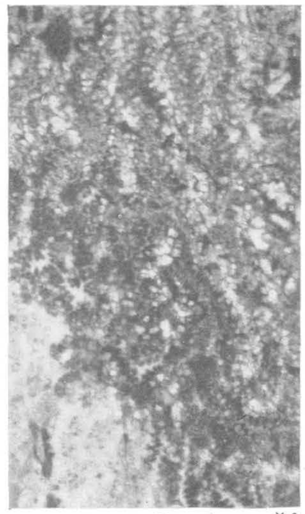

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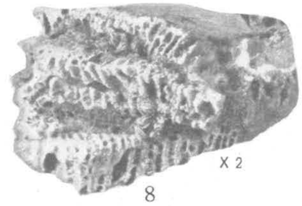

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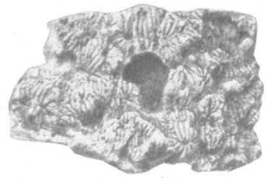

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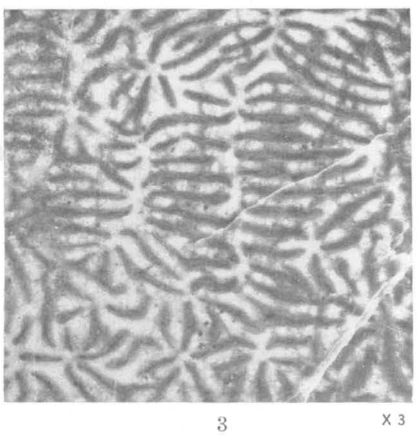

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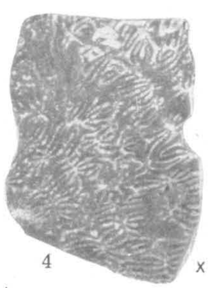

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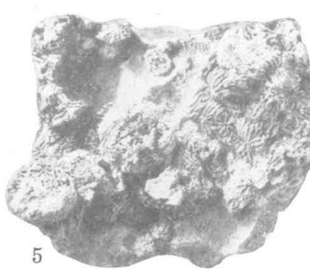

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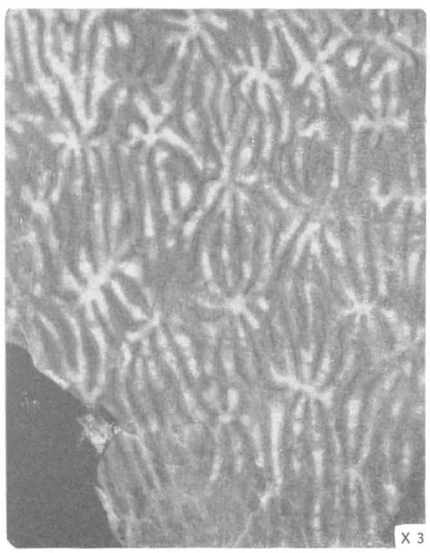

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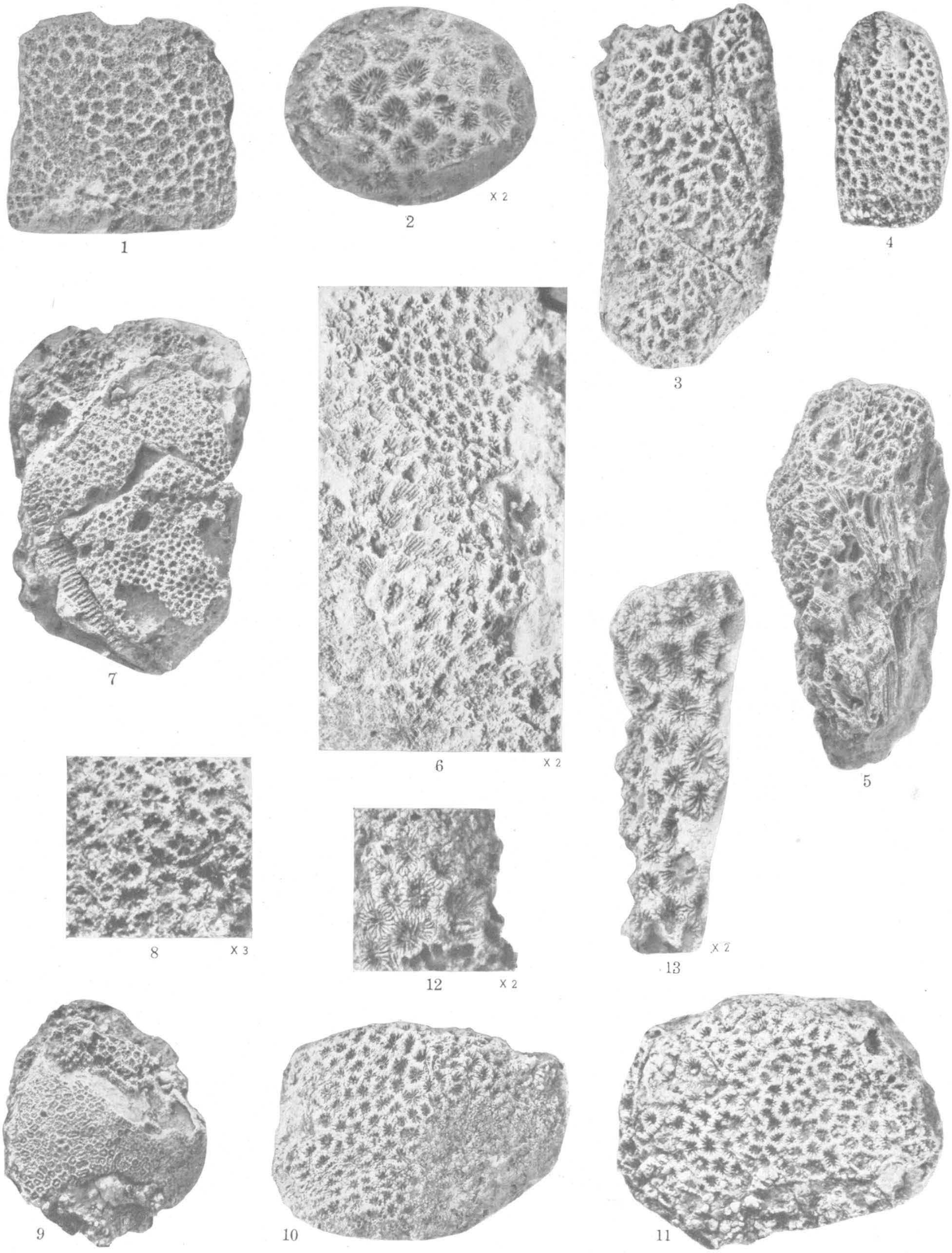
UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE CXIV

FIGURES 1–3. *Isastrea profunda* Reuss (p. 128).

1. Threemile Cove, Gravina Island, Alaska (locality 9900, U. S. Geological Survey).
2. North arm of Threemile Cove, Gravina Island, Alaska.
3. Same locality as Figure 1.

FIGURES 4–6. *Isastrea vancouverensis* Clapp and Shimer (pp. 128–129).

4. North arm of Threemile Cove, Gravina Island, Alaska (locality 8835, U. S. Geological Survey).
5. View showing length of cells; same locality as Figure 4.
6. Portion of a stock; same locality as Figure 4.

FIGURES 7–9. *Isastrea parva* Smith, n. sp. (p. 128).

7. Type; Threemile Cove, Gravina Island, Alaska. Collected by T. E. Bassett, Stanford University.
8. Portion of the same specimen.
9. Small stock; same locality as Figure 4.

FIGURES 10–13. *Confusastrea cowichanensis* Clapp and Shimer (p. 129).

10. Coral reef, same locality as Figure 4.
11. Another portion of the same stock.
12. Portion of a small stock; locality 8834, north arm of Threemile Cove, Gravina Island, Alaska.
13. Another portion of the same stock.

All specimens figured on this plate came from the Upper Triassic coral zone of lower Noric age at Threemile Cove near Dall Head, Gravina Island, Alaska. Collection of U. S. Geological Survey except Figure 7.

PLATE CXV

FIGURES 1–3. *Confusastrea decussata* Reuss (p. 130).

1, 2. Small stock, viewed from above; Threemile Cove, Gravina Island, Alaska.

3. Another stock, showing the weathered lower surface, size. Threemile Cove, Gravina Island, Alaska (locality 8835, U. S. Geological Survey).

FIGURE 4. *Confusastrea grandissima* Frech (p. 130). Small stock, west coast of Gravina Island, 7 miles north of Dall Head, Alaska (locality 9536).

FIGURE 5. *Astrocoenia martini* Smith, n. sp. (p. 132). Type; south arm of Threemile Cove, Gravina Island, Alaska (locality 8830).

FIGURES 6–10. *Thamnastraea borealis* Smith, n. sp. (p. 131).

6, 7. Type; 7 miles north of Dall Head, west side of Gravina Island, Alaska (locality 9537).

8, 9. Another stock; Threemile Cove, Gravina Island, Alaska (locality 9900).

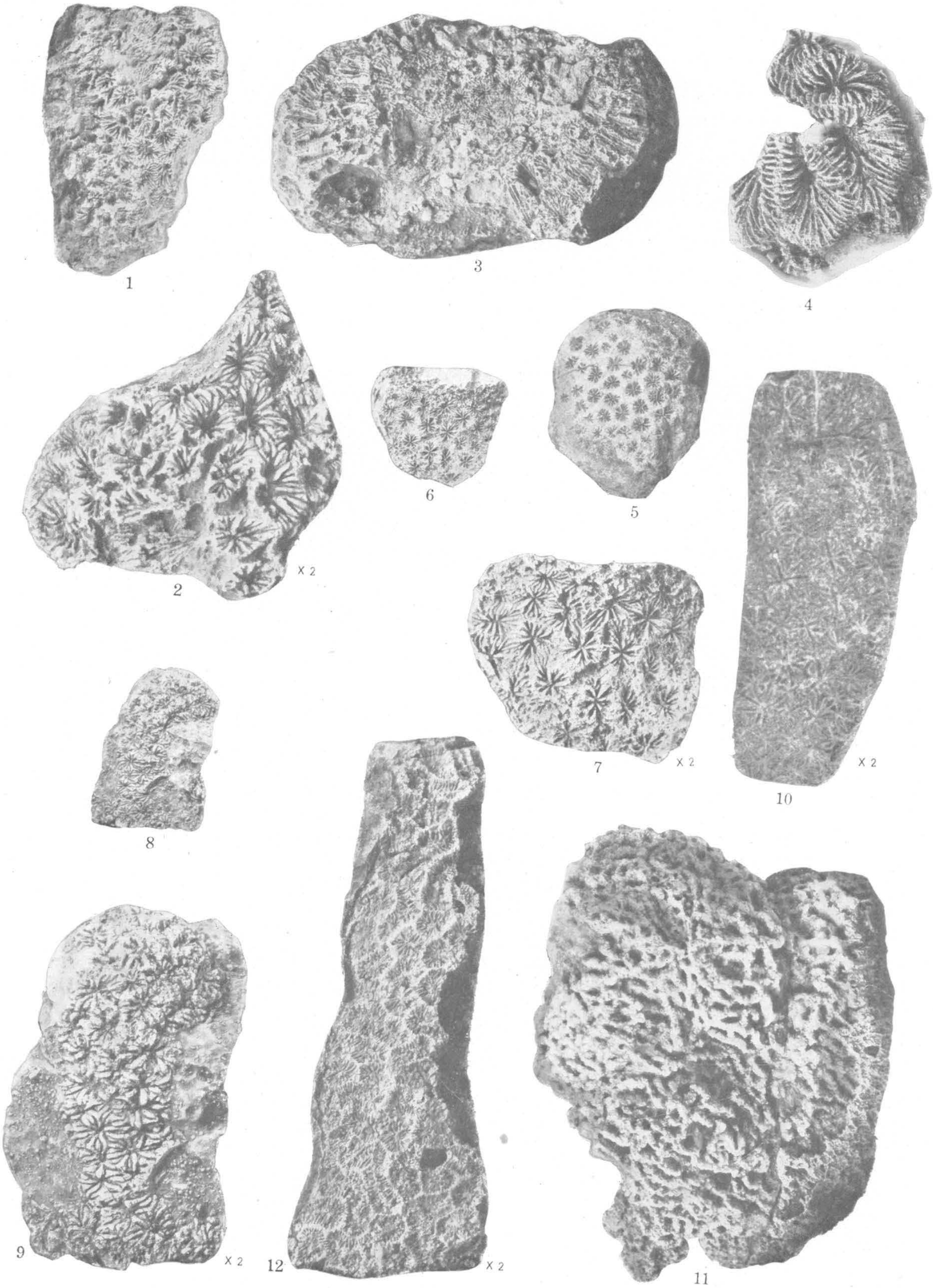
10. Polished face; same locality as Figure 8.

FIGURES 11, 12. *Latimaeandra alaskana* Smith, n. sp. (p. 130).

11. Type; Threemile Cove, Gravina Island, Alaska (locality 10097).

12. Portion of same stock.

All specimens figured on this plate came from the Upper Triassic coral zone of lower Noric age near Threemile Cove, Gravina Island, Alaska. Collection of U. S. Geological Survey, except Figures 1–2, which are in the collection of Stanford University.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

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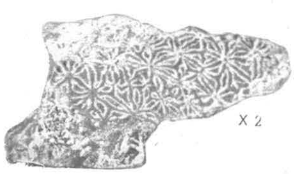

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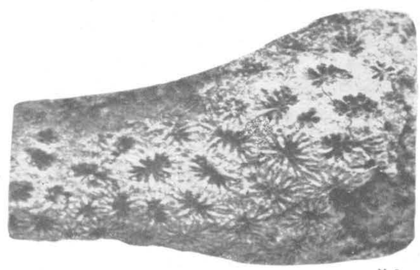

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UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE CXVI

FIGURES 1, 2. *Confusastrea borealis* Smith, n. sp. (p. 129).

1. Type.
2. Portion of the same specimen.

FIGURE 3. *Thamnastraea rectilamellosa* var. *minor* Frech (p. 131). Portion of small stock.

All specimens figured on this plate came from the Upper Triassic coral zone of lower Noric age at Threemile Cove, on Gravina Island, Alaska. Collection of Stanford University.

PLATE CXVII

Spongiomorpha (*Heptastylopsis*) *dendriformis* Smith, n. sp. (p. 133). Large branching stock. Upper Triassic Hosselkus limestone, coral zone of lower Noric age, near junction of Cedar Creek and Little Cow Creek, 3 miles northeast of Ingot, Shasta County, Calif. Collection of U. S. Geological Survey.

UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE CXVIII

FIGURES 1, 2. *Spongiomorpha* (*Heptastylopsis*) *dendriformis* Smith, n. sp. (p. 133).

1. Type; Hosselkus limestone, Bear Cove, east side of Brock Mountain, Shasta County, Calif.
2. Portion of same specimen.

FIGURE 3. *Spongiomorpha* (*Heptastylopsis*) *tenuis* Smith, n. sp. (p. 133). Type; Hosselkus limestone, North Fork of Squaw Creek, 3 miles north of Kelly's ranch, Shasta County, Calif.

FIGURE 4. *Stromatomorpha californica* Smith, n. sp. (p. 134). Polished face of stock; Hosselkus limestone, Brock ranch, on Pit River, mouth of Brock Creek, Shasta County, Calif.

FIGURES 5, 6. *Thamnastraea rectilamellosa* var. *minor* Frech (p. 131).

5. Polished face of stock; same locality as Figure 1.
6. Same specimen.

FIGURES 7–9. *Heterastridium conglobatum* Reuss (p. 135). East fork of Chulitna River, Alaska (locality 10241).

7. Section through a stock, showing radial cells.
8. Outside section of same specimen.
9. Transverse section of another specimen.

FIGURE 10. *Stylophyllopsis mojsvari* Frech (p. 127). Cross section; Hosselkus limestone, north end and west side of Brock Mountain (Devil Rock), between Squaw Creek and Pit River, Shasta County, Calif.

All specimens figured on this plate came from the Upper Triassic coral zone of lower Noric age. Collection of U. S. Geological Survey.

PLATE CXIX

Stromatomorpha californica Smith, n. sp. (p. 134). Type; Upper Triassic Hosselkus limestone, coral zone of lower Noric age mouth of Brock Creek, east side of Brock Mountain, 6 miles east of U. S. forest ranger station, Shasta County, Calif. Collection of U. S. Geological Survey.

UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

PLATE CXX

FIGURES 1–3. *Spongiomorpha (Heptastylopsis) gibbosa* Frech (p. 133).

1. Cross section; locality 9900.
2. Cross section; locality 8835.
3. Fractured specimen showing radial and concentric structure, also the surface structure near the outside of the stock; locality 9536, Fivemile Cove, Gravina Island.

FIGURES 4, 5. *Spongiomorpha (Heptastylopsis) ramosa* Frech (p. 133). Small stock; locality 8835.

FIGURE 6. *Stromatomorpha californica* Smith, n sp. (p. 134). Cross section; Threemile Cove, Gravina Island, Alaska.

FIGURES 7, 8. *Halomitra triadica* Smith, n. sp. (p. 131). Type; locality 10097, Threemile Cove.

All specimens figured on this plate came from the Upper Triassic coral zone of lower Noric age, near Threemile Cove, west side of Gravina Island, Alaska. Collection of U. S. Geological Survey.

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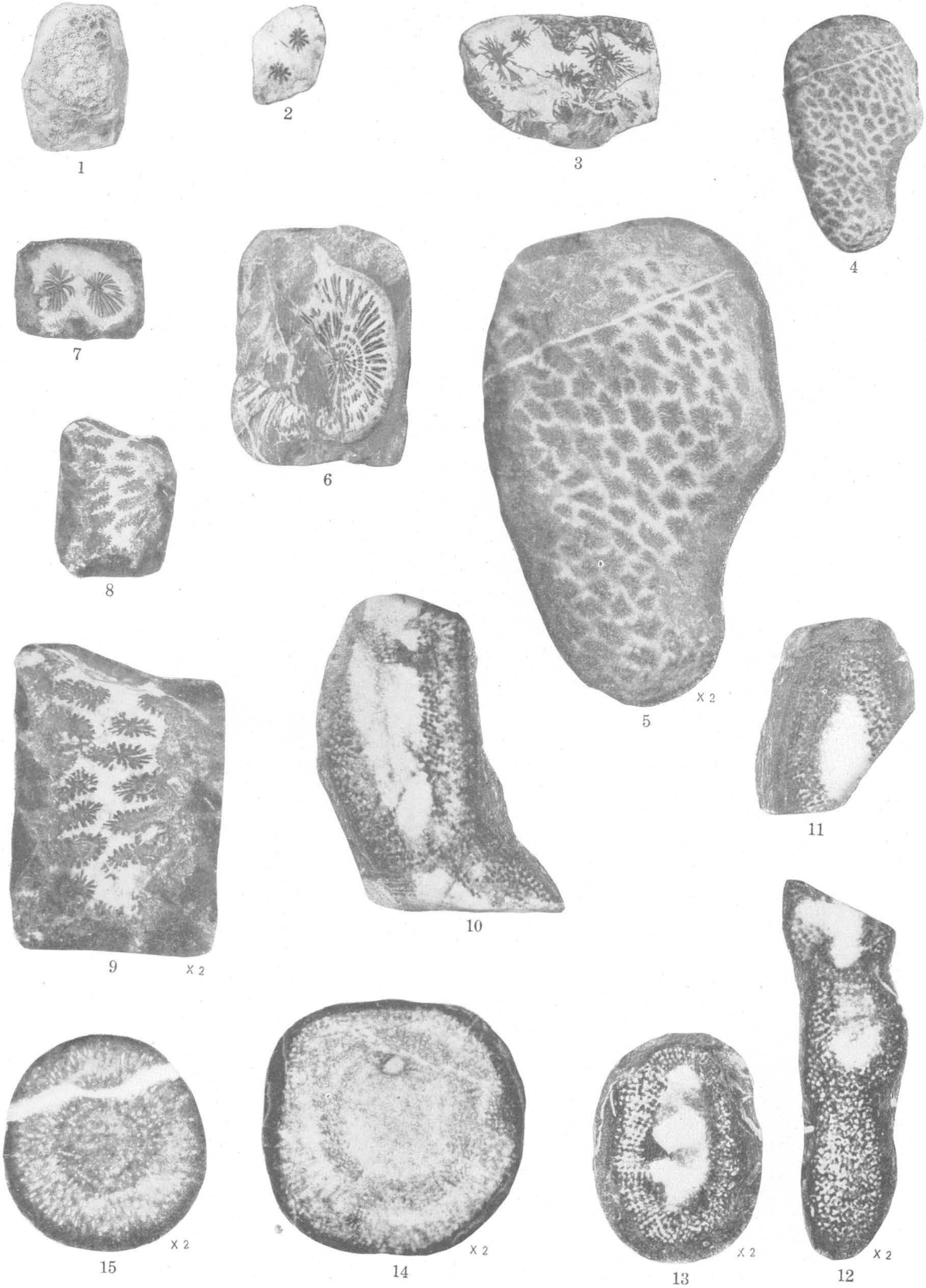
PLATE CXXI

FIGURE 1. *Confusastrea cowichanensis* Clapp and Shimer (p. 129).
FIGURE 2. *Confusastrea decussata* Reuss (p. 130). Weathered face.
FIGURE 3. *Confusastrea incrassata* Reuss (p. 130). Weathered face of stock.
FIGURES 4, 5. *Isastrea vancouverensis* Clapp and Shimer (pp. 128–129).
4. Weathered face of stock.
5. Same specimen.
FIGURE 6. *Montlivaultia martini* Smith, n. sp. (p. 126). Type.
FIGURE 7. *Thecosmilia* cf. *T. caespitosa* Reuss (p. 127). Cross section.
FIGURES 8, 9. *Confusastrea* cf. *C. decussata* Reuss (p. 130).
8. Weathered face.
9. Same specimen.
FIGURES 10–13. *Spongiomorpha* (*Heptastylopsis*) *ramosa* Frech (p. 133).
10. Longitudinal section.
11. Cross section of same specimen.
12. Longitudinal section of another specimen.
13. Cross section of specimen shown in Figure 12.
FIGURES 14, 15. *Spongiomorpha* (*Heptastylopsis*) *gibbosa* Frech (p. 133).
14. Cross section.
15. Cross section of another specimen.

All specimens figured on this plate came from the Upper Triassic coral zone of lower Noric age, on Iliamna Lake, near Cook Inlet, Alaska, locality 6484. Collection of U. S. Geological Survey.



UPPER TRIASSIC MARINE INVERTEBRATE FOSSILS

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