Middle Jurassic (Bajocian) Ammonites from Eastern Oregon

GEOLOGICAL SURVEY PROFESSIONAL PAPER 756

Middle Jurassic (Bajocian) Ammonites from Eastern Oregon

By RALPH W. IMLAY

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Bajocian ammonites of eastern Oregon greatly resemble those of Alaska and Europe, indicate marine connections with Europe, and permit accurate zonal dating in the Pacific Coast region

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MIDDLE JURASSIC (BAJOCIAN) AMMONITES FROM EASTERN OREGON

By Ralph W. Imlay

ABSTRACT

Jurassic ammonites of Bajocian age occur throughout 1,100 to 2,000 feet of strata exposed in five inliers in east-central Oregon. These inliers are spaced over a distance of about 120 miles from near Paulina on the west to the Snake River on the east. All the Bajocian strata contain much volcanic material except in the westernmost area, probably represent continuous deposition from Early Jurassic to early late Bajocian time, and were deposited in a sea that transgressed eastward into the western interior of the continent.

The lower Bajocian (Aalenian) in east-central Oregon is represented only by the ammonites *Tmetoceras, Praestrigites,* and *Eudmetoceras.*

The middle Bajocian is well represented by many ammonites that furnish accurate correlations with several European ammonite zones. Beds equivalent to the lower part of the *Sonninia sowerbyi* zone include the ammonites *Sonninia* (*Euhoploceras*), *S.* (*Papilliceras*), *Witchellia* (*Latiwitchellia*) n. subgen., *Asthenoceras, Eudmetoceras, Fontannesia, Hebetoxyites, Praestrigites, Strigoceras, Pelekodites* and *Docidoceras.* Of these, *Sonninia* (*Euhoploceras*) is represented by species identical with species in Europe. Beds equivalent to the upper part of the *Sonninia sowerbyi* zone include the ammonites *Witchellia, Sonninia* (*Papilliceras*), *Asthenoceras* and *Stephanoceras,* and basally include the ammonite *Fontannesia.*

Beds equivalent to the European *Otoites sauzei* zone include the ammonites *Witchellia, Sonninia* (*Papilliceras*), *Asthenoceras, Pelekodites, Lissoceras, Emileia, Parabigotites, Stephanoceras, Otoites* and *Normannites.* The last two occur only near the top of the ranges of *Witchellia, Sonninia* (*Papilliceras*), and *Emileia.*

Beds equivalent to the European *Stephanoceras humphriesianum* zone contain the ammonites *Dorsetensia, Pelekodites, Poecilomorphus, Chondroceras, Sphaeroceras, Normannites, Stephanoceras, Teloceras, Stemmatoceras?* and probably *Zemistephanus.* Of these, the last three plus *Chondroceras* occur above the local range of *Dorsetensia* and are equivalent to the upper part of the *Stephanoceras humphriesianum* zone.

The lower part of the upper Bajocian is represented by the ammonites *Leptosphinctes, L.* (*Prorsisphinctes?*), *Spiroceras, Sphaeroceras, Normannites, Stephanoceras, Teloceras?, Zemistephanus?,* the new genus, *Lupherites* and *Megasphaeroceras.*

Close faunal resemblances of the Bajocian ammonites of eastern Oregon with those of Alaska and Europe show that marine connections existed with both regions. A marine connection with Europe via the Arctic region seems reasonable. Another marine connection southward also seems reasonable during early middle Bajocian and late Bajocian times when the ammonite faunules of eastern Oregon had greater affinities to those of Europe than of Alaska.

New taxa described herein include one new genus *Lupherites,* one new subgenus *Witchellia* (*Latiwitchellia*), and 18 new species. The species are named *Asthenoceras delicatum, Fontannesia costula, F. intermedia, Witchellia* (*Latiwitchellia*) *evoluta, Dorsetensia oregonensis, D. diversistriata, Pelekodites webergi, P. silviesensis, P. dobsonensis, Poecilomorphus varius, Lissoceras hydei, Docidoceras lupheri, D. warmspringsense, D. sparsicostatum, Emileia buddenhageni, Stephanoceras mowichi, S.* (*Phaulostephanus?*) *oregonense,* and *Lupherites senecaensis.*

INTRODUCTION

The Bajocian ammonites described herein from eastern Oregon are from thick dominantly volcaniclastic sequences exposed in several inliers that are alined along an eastward-trending belt nearly 120 miles long (pl. 48). The westernmost and largest inlier extends from about 12 miles east of Paulina to a few miles east of Seneca, a distance of about 40 miles (Buddenhagen, 1967, figs. 1, 2). It contains mostly nonmetamorphosed rocks and is fairly fossiliferous. Other inliers occur farther east in areas south of Ironside and Brogan and near Huntington, just west of the Snake River. They contain slightly to moderately metamorphosed rocks and few well-preserved fossils. This scarcity of fossils reflects both lack of time spent collecting and the difficulty of finding identifiable fossils in somewhat metamorphosed beds.

Study of the ammonites from these inliers demonstrates that the Bajocian ammonite succession is virtually the same in Oregon as in Europe and that some species are identical with European species. Documentation of this evidence permits accurate dating of fossiliferous beds of Bajocian age anywhere in the Pacific Coast region, in terms of the standard European zonal succession, and aids field geologists in areas that are structurally complicated. Thus a broad synclinal structure for the thick Jurassic sequence in the southern half of the Huntington 15-minute quadrangle is now evident on the basis of ammonites collected by Howard C. Brooks and Norman S. Wagner of the Oregon

Department of Geology and Mineral Industries and by U.S. Geological Survey geologists.

The Bajocian ammonites from eastern Oregon total about 2,100 specimens and were obtained from 262 localities. The largest collections were made by R. L. Lupher from 1926 to 1937 and by R. W. Imlay from 1949 to 1969. Important collections were also made in the Suplee and Izee areas by J. H. Buddenhagen in 1949, 1959, 1961 and 1965, by W. R. Dickinson in 1956, 1957, 1959, and 1960, by L. W. Vigrass in 1956 and 1957, and by W. O. Ross in 1965, 1966, and 1969. Important collections were made in the Juniper Mountains of Malheur County and the Huntington area of Baker County by N .S. Wagner from 1960 to 1969 and by H. C. Brooks and R. W. Imlay from 1961 to 1969. Some collections in the Suplee-Izee-Seneca areas were made by J. H. Beeson in 1956 and 1957, J. A. Calkins in 1955, Reed Christner in 1958, A. K. Guard in 1927, S. W. Muller in 1956 and 1957, John McIntyre in 1949, and R. E. Wallace in 1955. Minor collections in Malheur County were made by George Kasch and Jacob Nir in 1961 and in the Bridgeport 15-minute quadrangle west of Huntington by Ernest Wolff in 1958. The only identifiable Jurassic fossils from the Ironside quadrangle were collected by W. D. Lowry in 1957.

The writer was aided in the field by all of these geologists except A. K. Guard, J. A. Calkins, and R. E. Wallace. Leo J. Hertlein and Dallas Hanna, of the California Academy of Sciences, granted permission to study the excellent collections made by Ralph Lupher. Similar permission was granted by S. W. Muller of Stanford University to study the collections made by him, W. R. Dickinson, L. W. Vigrass, and John H. Beeson.

Especial thanks are given to Ralph Lupher for the opportunity afforded the writer to study his collections, for his supplying stratigraphic data, and for his orienting the writer stratigraphically in the field in 1949 and 1957. This was extremely considerate of him because he had devoted much time to collecting and identifying the ammonites and for many years had planned to describe both the Jurassic stratigraphy and the fossils. For the record, his published stratigraphic work is sound and made possible the more refined work of Dickinson and Vigrass based on more accurate maps than were available earlier. Likewise, most of his generic and specific fossil determinations are identical, or similar, to those made herein by the writer.

The writer is grateful to Dr. Arnold Zeiss of Erlangen, West Germany, for information concerning the stratigraphic range of *Dorsetensia*, and to Dr. Raymond Casey of the British Institute of Geological Sciences for his aid in obtaining a plaster replica of the lectotype of *Asthenoceras nannodes* Buckman.

The writer also greatly appreciates the friendliness and consideration of the ranchers in allowing him access to their property many times over many years. Such ranchers include Emil Hyde, Wm. Hyde, J. H. Harris, J. Robertson, Carl Schnabele, H. H. Trowbridge, and Melvin Weberg.

In this paper the words "*Otoites sauzei*" denote a zone, as in the "Treatise on Invertebrate Paleontology" (Arkell and others, 1957, p. L125) instead of a subzone, as in some recent British publications (Wilson and others, 1958, p. 69; Torrens, in Cope and others, 1969, table A–1, opposite p. A 21). This is done because the zones of the early Middle Jurassic are being revised in Britain (Callomon and others, 1969, "Notes on Zones and Sources," opposite p. 8) and because "doubt exists about the distinction and positions of some subzones" of the Bajocian, including the usage of *Otoites sauzei* (Torrens, in Cope and others, 1969, table A–1).

Similarly, the term "Aalenian" is not used herein as a stage name, as recommended in Luxemburg in 1962 at the Colloquium on the Jurassic, because such usage has not yet been approved by the International Commission on Stratigraphy.

Abbreviations in the plate descriptions in the text include CAS for the California Academy of Sciences, USNM for the U.S. National Museum, and USGS for U.S. Geological Survey Mesozoic locality.

BIOLOGIC ANALYSIS

The eastern Oregon ammonites of early Middle Jurasic (Bajocian) age described herein number 2,139 specimens. Their distribution by families, subfamilies, genera, and subgenera is shown in table 1. This table shows that the Sonninidae, Hildoceratidae, and Stephanoceratidae are the dominant families and include, respectively, 36, 29, and 18 percent of the total number of specimens. Next in declining numbers are the Otoitidae, Phylloceratidae, Hammatoceratidae, Sphaeroceratidae, Spiroceratidae, Haploceratidae, Strigoceratidae, Perisphinctidae, and Oppeliidae. The most common genus is *Asthenoceras*. Next most common in decreasing order are *Sonninia*, *Dorsetensia*, *Stephanoceras*, *Pelekodites*, and *Tmetoceras*. All other genera are represented by fewer than 100 specimens, and eight are represented by fewer than four specimens per genus.

TABLE 1.—*Ammonite genera and subgenera of Bajocian age in eastern Oregon, showing biological relationships and number of specimens available for study*

Family	Subfamily	Genus and subgenus	Number of specimens
Phylloceratidae	Phylloceratinae	*Phylloceras*	2
	Calliphylloceratinae	*Calliphylloceras*	4
		Holcophylloceras	50
Spiroceratidae		*Spiroceras*	42
Hildoceratidae	Grammoceratinae	*Asthenoceras*	380
		Fontannesia	95
	Tmetoceratinae	*Tmetoceras*	158
Hammatoceratidae		*Eudmetoceras (Euaptetoceras)*	38
		Planammatoceras?	14
Sonniniidae		*Sonninia*	4
		(*Euhoploceras*)	185
		(*Papilliceras*)	74
		Witchellia	39
		(*Latiwitchellia*)	54
		Dorsetensia	200
		Pelekodites	150
		Poecilomorphus	68
Strigoceratidae		*Praestrigites*	7
		Strigoceras	4
		Hebetoxyites	8
Haploceratidae		*Lissoceras*	30
		Lissoceras?	1
Oppeliidae		*Oppelia*	1
Otoitidae		*Docidoceras*	34
		Emileia	11
		Otoites	35
Sphaeroceratidae		*Chondroceras*	35
		Sphaeroceras	10
		Megasphaeroceras	4
Stephanoceratidae		*Normannites*	24
		(*Itinsaites*)	39
		(*Epalxites*)	1
		(*Masckeites?*)	2
		Stephanoceras	67
		(*Skirroceras*)	145
		(*Phaulostephanus?*)	9
		Stemmatoceras	9
		Teloceras	3
		Zemistephanus?	2
		Lupherites n. gen	85
Perisphinctidae		*Leptosphinctes*	2
		(*Prorsisphinctes?*)	7
		Parabigotites	7

The characters of most of the genera and subgenera listed agree very well with the definitions of those taxa in the "Treatise on Invertebrate Paleontology" (Arkell and others, 1957). Certain of them deserve comment, however, because they are new, unusually abundant or unusually rare, or because they are represented by species that appear to be identical with species in Europe.

The family Spiroceratidae is represented by two species of *Spiroceras* that are identical with species widespread elsewhere in the world in beds of late Bajocian age.

The Oregon specimens of *Asthenoceras* bear septate whorls that greatly resemble the type specimens of *Asthenoceras nannodes* (Buckman) (1889, p. 213, pl. 33, figs. 13–16). Their body whorls differ, however, in having stronger and more projected ribs of which some bifurcate near the middle of the flanks. Their apertures, as preserved on several small specimens, terminate in lateral lappets, but as preserved on some larger specimens apparently terminate in a simple sinuous manner. Their suture lines have a very broad first lateral saddle and a general pattern similar to that on species of *Grammoceras* and *Pseudogrammoceras* as illustrated by Buckman (1889, pl. 26, fig. 10, pl. 31, fig. 2, pl. 33, fig. 7).

The family Hildoceratidae is represented by the genera *Tmetoceras*, *Fontannesia*, and *Asthenoceras*. Of these, *Tmetoceras* is represented by the worldwide species *T. scissum* (Benecke) of early Bajocian (Aalenian) age. *Fontannesia* is placed here rather than in the Sonniniidae because of its close resemblance to *Grammoceras* (Arkell, 1954, p. 564, 597; Westermann and Getty, 1970, p. 240). *Asthenoceras* is of biologic interest because in Oregon it occurs in great abundance in beds that correlate with the *Sonninia sowerbyi* zone, whereas it is rather rare elsewhere in the world. Previously described occurrences include about 20 specimens from the *Sonninia sowerbyi* zone of the Alaska Peninsula (Westermann, 1969, p. 61–63, pl. 14, figs. 1–7) and two specimens from the *Ludwigia murchisonae* zone of England (Buckmann, 1889, pl. 33, figs. 13–16).

The genus, *Athenoceras*, as described by Buckman (1899, p. XLIX), has a small highly compressed shell; thin whorls; a wide shallow umbilicus; a high, sharp, laterally sulcate, hollow-floored keel; and fine closely spaced falcoid ribs and striae. Buckman did not know the characteristics of the adult body whorl or of the suture line.

The characteristics of *Asthenoceras* show that its taxonomic position is near *Grammoceras* as indicated by Buckman (1889, p. 214) and by Arkell (Arkell and others, 1957, p. L261). A generic status for *Asthenoceras*, rather than a subgeneric status under *Grammoceras*, is justified by its much smaller size, by bifurcation of some ribs on its body chamber, by the presence of radial swellings on some septate whorls, by the presence of ventral furrows bordering the keel, and by its distinctly different stratigraphic range. Its apertural characteristics suggest that both male and female shells are included in the generic concept (Westermann, 1969, p. 59, 60).

The genus *Fontannesia*, defined by Buckman (1905, p. CLXXXVII) and Arkell (1954, p. 563), consists of small to medium-sized shells that have fairly evolute to highly evolute coiling; a compressed subovate to subquadrate whorl section; an inclined umbilical wall that rounds evenly into the flanks; a narrow flattened to fastigate venter; a low to prominent, hollow unfloored keel that may become very weak or disappear on the body chamber; weak to strong, mostly simple, falcoid ribs that are strongest on the middle and upper parts of the flanks, may be faint on the lower parts, and vary from strong to faint to indistinct on the body chamber. *Fontannesia* differs from *Dorsetensia* in having a rounded instead of a sharp or abrupt umbilical edge, a broader venter, and a longer, more slender first lateral lobe. *Fontannesia* greatly resembles the late Toarcian genus *Grammoceras*, as discussed by Arkell (1954, p.

564), but apparently differs by the presence of some forked ribs on the lower part of its flanks and of some short ribs on the upper part.

The family Hammatoceratidae is represented mostly by three narrowly umbilicate species of *Eudmetoceras* that are similar to, and probably in part identical with, species from Eurasia and South America. In addition, the family is represented by a few fragments that are questionably referred to *Planammatoceras.* These genera have been discussed in considerable detail recently by Elmi (1963a, p. 60, 1963b, p. 82–90, 101–103), Westermann (1964a, p. 407–412; 1969, p. 63–72), and Geczy (1966, p. 29–33).

The Sonninidae is represented in eastern Oregon by eight genera and subgenera, of which the subgenus *Latiwitchellia* is new and is known only from eastern Oregon. The other taxa are widespread and include species in common with other parts of the world. For example, the subgenus *Sonninia* (*Euhoploceras*) includes five species in common with western Europe. The subgenus *S. Papilliceras*) includes three species that are closely similar to described species from South America and Europe. *Witchellia* includes one species, and *Dorsetensia* four species that appear to be identical with species from western Europe. Major differences between the Sonninidae of eastern Oregon and those of western Europe include an absence of the genera *Shirbuirnia* and *Fissilobiceras* in the Oregon collection and an absence or rarity of species resembling true *Sonninia,* such as *S. propinquans* (Bayle) (Arkell and others, 1957, p. L268) and *S. sowerbyi* (Sowerby) (Arkell, 1956, pl. 34, fig. 2.)

As used herein, true *Sonninia* (*Sonninia*) comprises planulates characterized by moderately evolute coiling; subovate moderately compressed whorls; a narrow venter; a single high to fairly high hollow keel; more or less prominent lateral tubercles or swellings on inner and intermediate-sized whorls; strong irregular, flexuous to sickle-shaped ribs that may divide into two or more secondary ribs, and a more or less smooth body chamber. *Sonninia* proper in Europe is most common in the upper part of the *Sonninia sowerbyi* zone and in the *Otoites sauzei* zone, but it has been recorded in the lower part of the *Sonninia sowerbyi* zone.

The subgenus *Euhoploceras* differs from *Sonninia* proper in having more evolute coiling on its outer whorls; a compressed subovate to subquadrate to round whorl section; a broader and flatter venter; a lower keel; much more variable development of tubercles and spines; more highly variable ribbing that is commonly rursiradiate on the lower parts of the flanks; fewer secondary ribs; and generally more ornamentation on its body chamber. *Euhoploceras* in England ranges from the upper part of the *Graphoceras concavum* zone into the *Shirbuirnia trigonalis* subzone of the *Sonninia sowerbyi* zone (Buckman, 1893, pl. 90, figs. 7–9; Morton, 1965, p. 199).

This great variability in form and sculpture among specimens of *Euhoploceras* has made specific recognition difficult. In England near Bradford Abbas, 65 species of *Euhoploceras* were recognized by Buckman (1892–94, p. 313–440, pls. 48–103 in part) from many well-preserved specimens obtained from a single bed only seven inches thick (Buckman, 1893, p. 485). These species, as well as 9 other species described from England and Germany, were later considered by Westermann (1966) to be morphological variants of a single species for which he chose the oldest available name *Sonninia* (*Euhoploceras*) *adicra* (*Waagen*) (1867, p. 591, pl. 25, figs. 1a,b). In France the presence of several species of *Euhoploceras* has been recorded (Arkell, 1956, p. 78, 100). In Germany, the taxon *Euhoploceras* has not been recognized as distinct even subgenerically from *Sonninia* by the paleontologists who have monographed the sonninid ammonites (Dorn, 1935; Hiltermann, 1939; Oechsle, 1958). They have, however, recognized some of the species that Buckman referred to *Euhoploceras* and have grouped many others under such names as *Sonninia sowerbyi* (Sowerby), *S. adicra* (Waagen), *S. polyacantha* (Waagen), and *S. modesta* Buckman. Their concepts of species within *Euhoploceras* evidently are between those of Buckman and Westermann.

Westermann's (1966, p. 309, 310) recognition of only one species of *Euhoploceras* in western Europe is based partly on his graphic analysis (1966, text figs. 1–10) of more than 100 illustrated ammonites from a seven inch bed within the Inferior Oolite near Bradford Abbas in southern England (Buckman, 1892–94; 1893, p. 485). It is based partly on Westermann's conclusion (1966, p. 291) that this thin bed is not a condensed deposit and hence that the ammonites now found in it all lived together. It is substantiated, in his opinion, by several similar occurrences of highly variable ammonite genera (Reeside and Cobban, 1960; Silberling, 1959, p. 43–46; Westermann, 1964a, p. 374).

Overall, the analysis by Westermann impressively depicts the variation possible within a single ammonite subgenus and demonstrates relations between shape and ornamentation, but does not show conclusively the number of species or subspecies represented, or whether the ammonites lived together rather than being buried together. In this regard the geologists who have studied the Bajocian rocks from Bradford Abbas southward to the coast conclude that the entire Inferior Oolite in that area is thin and condensed compared with areas farther north, includes many nonsequences or disconformities, and that locally some thin conglomerate beds contain water-worn fossils derived from two or more ammonite zones (Wilson and others, 1958, p. 68, 72; Torrens in Cope, Hallam and Torrens, 1969, p. A21–A29). Evidently speciation within *Euhoploceras* needs to be studied in collections from other localities in England and in continental Europe where sedimentation was more continuous and where the beds containing the subgenus have an appreciable thickness.

In eastern Oregon it is as difficult as it is in Europe to divide the subgenus *Euhoploceras* into distinctive, easily recognized species acceptable as valid by other paleontologists. The 162 specimens available show variations in form and sculpture that almost duplicate the variations in specimens of *Euhoploceras* from western Europe. Some of the Oregon specimens are virtually identical in appearance with specimens from England or Germany; others are slightly different, but the range of variation is the same. Evidently the same specific name, or names, should be applied to Oregon and European specimens of *Euhoploceras.*

Determination of the specific status of the Oregon specimens of *Euhoploceras* has involved repeated study of the subgenus and determination of the stratigraphic ranges of the various morphological groups that are recognizable. As a result, the Oregon specimens are now placed in five species and possibly one subspecies whose morphological characteristics and differences are summarized in table 2, as well as in the Systematic Descriptions. Stratigraphic differences include the earlier appearance in Oregon of *Sonninia* (*Euhoploceras*) *modesta* Buckman, *S.* (*E.*) *dominans* Buckman, and *S.* (*E.*) *polyacantha* (Waagen) than of the other three species, which is true in England for *S.* (*E.*) *dominans* Buckman (Morton, 1965, p. 199). Numerically the six species listed in table 2 are represented, from top to bottom, by 70, 43, 16, 15, 16, and 2 specimens, respectively. Evidently, both *S.* (*E.*) *modesta* (Buckman) and *S.* (*E.*) *dominans* Buckman in Oregon are much more common than the other taxa which is true also in England (Buckman, 1892, p. 323, 326).

Biologically these five morphological groups, herein called species, show marked but variable differences in form and sculpture. *S.* (*E.*) *modesta* Buckman and *S.* (*E.*) *crassispinata* Buckman are the most distinctive and are not apt to be confused with the others. *S.* (*E.*) *dominans* Buckman, by contrast, shows resemblances to both *S. adicra* and *S. polyacantha.* Conceivably it could have given rise to the stratigraphically younger *S.* (*E.*) *adicra* (Waagen) by the development of spines and variably strong ribbing on small and intermediate-sized septate whorls. Similarly it could have developed into *S.* (*E.*) *polyacantha* (Waagen), which appears later in Europe, by the development of prominent spines on outer whorls. If these developments can be proved by stratigraphic collecting in Europe and elsewhere, then *S.* (*E.*) *adicra* (Waagen), which has priority, could be used as the specific name and the other names could be considered as subspecies for practical stratigraphic as well as biologic reasons. One difficulty with such usage is that the development of spines occurs in reverse order in *S.* (*E.*) *polyacantha* (Waagen) than in *S.* (*E.*) *adicra* (Waagen). It is difficult to visualize *S. polyacantha* developing from *S. adicra*, whereas *S. polyacantha* can easily be visualized as a subspecies, or even as a spinose variant of *S. dominans.*

The writer feels that separate names for the five morphological groups of *Euhoploceras* of eastern Oregon are useful in discussing biological and stratigraphic relations. Subspecific names might be as biologically serviceable, but certainly would be more cumbersome. Relegation of any of these morphological groups to subspecies, or to varieties, should await coordinated stratigraphic and biologic studies in several places, such as are now being conducted in Scotland (Morton, 1965, p. 199).

The subgenus *Papilliceras* differs from *Sonninia* in having more evolute coiling; a higher, thinner whorl section; a median row of lateral tubercles on all or most septate whorls and on some body chambers; simpler, straighter, more uniform ribs that trend nearly radially on the lower parts of the flanks and generally curve slightly forward on the upper parts; strigation on some specimens; and tendency for the body chamber to become smooth. These characteristics in combination and their persistence during growth separate *Papilliceras* from the highly variable subgenus *Euhoploceras* with which *Papilliceras* is associated in Oregon in its earliest occurrences.

The genus *Witchellia* has involute to fairly evolute coiling; compressed and fairly high whorls; a rounded umbilical margin; a narrow tabulate venter that bears a low keel bordered by furrows; weak to fairly strong flexuous ribs that arise singly and in pairs at the base of the flanks, trend radially or slightly forward on the flanks, and may weaken or fade out on the body chamber; and tubercles only on the smallest septate whorls. *Witchellia* is readily distinguished from *Sonninia* and its subgenera by furrows on its venter and by the tendency of its ribs to arise in pairs.

The new subgenus *Witchellia* (*Latiwitchellia*) resembles *Witchellia* in having a bisulcate carinate venter and some rib furcation at the base of the flanks. It differs in having more evolute coiling, stouter whorls that do not become compressed adorally, stronger ribs on the

TABLE 2.—*Morphological comparisons of the various species of* Sonninia (Euhoploceras) *in eastern Oregon*

Species	Coiling	Whorl shape	Umbilical wall	Ribbing			Tubercles and spines	Ranges		Distinguishing features
				Inner septate whorls	Outer septate whorls	Body whorl		Oregon	Europe	
Sonninia (*Euhoploceras*) *modesta* Buckman	Changing from fairly involute to fairly evolute.	Elliptical to subquadrate, much higher than wide.	Low, vertical to very steep, rounds abruptly into flanks.	Variably weak, closely spaced.	Variably weak, arises singly and in pairs. May become fairly strong near adult body chamber.	Simple, flexuous, widely spaced, inclined forward. Varies from broad and faint to fairly strong.	Weak tubercles present only on smallest whorls at diameters less than 15 mm.	Upper two-thirds of Weberg Member.	In England from *Discites* subzone. In Germany from lower part of *sowerbyi* zone.	High, compressed whorls; vertical umbilical wall; abrupt umbilical edge; weak ribs on septate whorls; some low to fairly strong ribs on body whorl; tubercles absent on most whorls.
S.(*E.*)*dominans* Buckman	Moderately to fairly evolute.	Subovate, a little higher than wide.	Low, steep, rounds evenly into flanks.	Fairly strong. Most ribs arise singly.	Strong, mostly simple.	Becomes much stronger adorally, is strongest near middle of flanks.	Tubercles occur rarely at diameters greater than 25 mm.	-----do-----------	In Great Britain from upper part of *concavum* zone and overlying *Discites* subzone.	Differs from *S. modesta* in having more evolute inner whorls, stouter whorls, a rounded umbilical edge, and much stronger ribbing.
S.(*E.*)*polyacantha* (Waagen)	Moderately evolute.	-----do-------	Low, steeply inclined, rounds evenly into flanks.	Variably weak to fairly strong, closely to moderately spaced.	Becomes stronger and more widely spaced adorally.	Fairly strong; widely spaced. Secondary ribs arise singly or in pairs from spines, or between spines.	Weak tubercles on inner whorls. Spines occur on all whorls at diameters more than 70–100 mm.	-----do-----------	In England from *Discites* subzone. In Germany from lower part of *sowerbyi* zone.	Differs from *S. dominans* by presence of prominent spines on large septate whorls and on body chamber.
S. (*E.*) *adicra* (*Waagen*) (=*S. acanthodes* Buckman)	Moderately to fairly evolute.	-----do-----------	-----do-----------	Fairly strong spinose ribs are separated by one or more weak ribs.	Adorally becomes stronger, sparser, more uniform in size.	Strong, nonspinose, highest near middle of flanks. May trend backward low on flanks. May fade out on venter.	Prominent lateral spines persist to diameters of 100 to 120 mm.	Upper part of Weberg Member and mostly near top.	In England from *Discites* and *Trigonalis* subzones. In Germany from lower part of *sowerbyi* zone.	Differs from *S. dominans* by presence of spines and variable ribbing on whorls at diameters of less than 100 to 120 mm.
S. (*E.*) *crassispinata* Buckman	Fairly evolute.	Broadly ovate to circular.	Moderately high, steep to vertical, rounds evenly into flanks.	-----do-----------	Adorally becomes much stronger and sparser. Some paired at spines. Fades on venter.	Adorally becomes stronger and more widely spaced.	Prominent lateral spines at all growth stages.	Upper part of Weberg Member.	-----do-----------	Differs from *S. adicra* in having a rounder whorl section, stronger spines that persist onto body whorl, and much coarser and more widely spaced ribs.
S. (*E.*) cf. *S.* (*E.*) *crassispinata* Buckman	-----do-----------	-----do-----------	-----do-----------	Mostly flexuous, weak, closely spaced. Sparse, strong, spinose ribs at diameters above 45 mm.	Largest whorl bears only coarse spinose ribs.	Unknown--------	Spines as on *S. crassispinata* but absent on some small whorls.	-----do-----------		Differs from *S. crassispinata* in having small whorls bearing weaker, denser ribbing and fewer spines.

body chamber, and blunt nodes high on the flanks on some specimens. It is associated in eastern Oregon with genera that indicate a correlation with the lower part of the *Sonninia sowerbyi* zone of Europe and is older, therefore, than the oldest occurrences of *Witchellia* in Europe.

The genus *Dorsetensia* has fairly evolute coiling; a high compressed whorl section; a narrow, sharp, keeled venter; a vertical umbilical wall; a sharp or abruptly rounded umbilical edge; and weak to fairly strong ribs that are mostly simple, are straight to gently flexuous, trend nearly radially on the flanks, curve forward on the venter, and weaken appreciably on the penultimate whorl, or on the body chamber. The ribs on some species may alternate with striae or pass adorally into striae. *Dorsetensia* differs from *Witchellia* in lacking ventral furrows bordering the keel, in having a sharper umbilical edge, in bearing mostly simple, unforked ribs on its intermediate and outer whorls, and in a tendency for its outer whorls to become smoother at an earlier growth stage. *Dorsetensia* in Europe is most common in the lower part of the *Stephanoceras humphriesianum* zone (Dorn, 1935, p. 96) but is fairly common in the *Otoites sauvei* zone (Dorn, 1935, p. 120; Westermann, 1954, p. 22, 25–28). It is not known from the *Sonninia sowerbyi* zone or from the upper Bajocian.

The genus *Pelekodites* includes small to dwarf ammonites that have a moderately compressed shell; evolute to highly evolute coiling; an ovate whorl section; a low umbilical wall that rounds evenly into the flanks; a narrow to fairly narrow venter; a low blunt keel that is bordered by narrow smooth areas; elongate lateral lappets; and weak to strong, mostly simple, rursiradiate to biconcave ribs that become stronger ventrally and adorally. The presence of lateral lappets on all specimens whose apertures are preserved contrasts with the apertural characteristics of *Asthenoceras* and suggests that *Pelekodites* is a microconch of larger sonninid ammonites such as *Witchellia* or *Dorsetensia* (Callomon, 1963, p. 31; Westermann, 1969, p. 115). *Pelekodites* differs from *Asthenoceras* in having a rursiradiate instead of a falcoid rib pattern, generally coarser ribbing on its septate whorls, and a lower and blunter keel that is not bordered by furrows. It shows much resemblance to *Poecilomorhphus* but differs in having more evolute coiling, a more compressed whorl section, rursiradiate instead of falcate ribbing, a simple instead of a bisulcate keeled venter, and apparently much more elongate lappets.

Pelekodites, as herein defined, is represented in western Europe by the following described species, of which some are probably synonyms of others (See Huf, 1968, p. 31–44):

Pelekodites pelekus Buckman (1923, pl. 399)
Nannoceras nannomorphum Buckman (1923, pl. 445)
Spatulites spatians Buckman (1928, p. 12, pl. 765)
Macerites aurifer Buckman (1928, p. 11, pl. 766)
Fontannesia curvata Buckman (1905, p. CLXXXIX; 1892, pl. 47, figs. 1–5, pl. 67, figs. 6, 7)
boweri Buckman (1905, p. CXC, pl. 24, figs. 1–4)
aurita Buckman (1905, p. CXCI, pl. 24, figs. 5, 6)
Poecilomorphus macer Buckman (1889, p. 116, pl. 22, figs. 23–29)
Witchellia deltafalcata (Quenstedt) (Dorn, 1935, p. 114, pl. 3, figs. 2a, b)
Sonninia deltafalcata pinguoides Hiltermann (1939, p. 175, pl. 12, fig. 7)
(*?Poecilomorphus*) *schlumbergeri* Haug (1893, p. 296, pl. 8, figs. 6a, b)
buckmani Haug (1893, p. 292, pl. 9, fig. 4)

All the above-listed species are from the *Sonninia sowerbyi* and *Otoites sauzei* zones. Species from the basal subzone of *Hyperlioceras discites* include those listed above under *Fontannesia* and *Nannoceras*. *Pelekodites pelekus* is apparently from the next higher subzone of *Shirbuirnia trigonalis* (Davies in Buckman, 1930, v. 7., p. 36). *Macerites aurifer* and *Spatulites spatians* are from the overlying subzone of *Witchellia laeviuscula* (Davies in Buckman, 1930, v. 7, p. 35). *Poecilomorphus macer* occurs in the zone of *Otoites sauzei* as well as in the underlying subzone (Morton, 1965, p. 198). This range of *Pelekodites* in Europe is the same as its range in eastern Oregon.

The genus *Poecilomorphus* includes small to dwarf ammonites that have a stout to moderately compressed shell; involute to moderately involute coiling; an ovate to nearly round whorl section; an evenly rounded umbilical margin; a tabulate venter; a low blunt ventral keel that is bordered by distinct furrows; small lateral lappets; fine to coarse falcate ribs of which some bifurcate below the middle of the flanks and all become stronger ventrally and adorally.

Poecilomorphus, as herein defined, is represented in Europe by the following species of which some are probably synonyms of others:

Ammonites cycloides d'Orbigny (1845, p. 370, pl. 121, figs. 1, 2; Buckman, 1889, p. 115, pl. 22, figs. 15, 16; 1927, p. 10)
Poecilomorphus regulatus Buckman (1927, p. 10, pl. 746)
cf. *P. regulatus* Buckman (1927, p. 10; 1889, pl. 22, figs. 1, 2, 7, 8)
umbilicatus Buckman (1927, p. 10; d'Orbigny, 1846, pl. 121, figs. 4, 5)
evolutus Buckman (1927, p. 10; 1889, pl. 22, figs. 21, 22)
primiferus Buckman (1927, p. 10, pl. 756)
fasciatus Buckman (1927, p. 10; 1889, pl. 22, figs. 17, 18)
asper Buckman (1927, p. 10; 1889, pl. 22, figs. 3, 4)
inclusus Buckman (1927, p. 10; 1889, pl. 22, figs. 5, 6)
angulinus Buckman (1927, p. 10, pl. 757)

capillaceus Buckman (1927, p. 10; 1889, pl. 22, figs. 11, 12)
minutus (Parona) (Sturani, 1964, p. 26, pl. 4, fig. 3)
buckmani Maubeuge (1955, p. 36, pl. 7, figs. 3a-c)
cf. *P. cycloides* d'Orbigny (Maubeuge, 1955, p. 36, pl. 7, figs. 2a, b)

All the above-listed species are from the *Stephanoceras humpriesianum* zone except for the last species which is recorded by Maubeuge (1955, p. 36) from the *Sonninia sowerbyi* zone. The above data are presented to facilitate comparisons between *Pelekodites* and *Poecilomorphus* which have been placed in a single genus by Huf (1968, p. 37).

The Strigoceratidae is represented in eastern Oregon by poorly preserved specimens of *Praestrigites*, *Strigoceras*, and *Hebetoxyites* that closely resemble species of those genera from the *Sonninia sowerbyi* zone of Europe. In Oregon all three genera are associated with other ammonites that in Europe occur in the lower subzone of the *Sonninia sowerbyi* zone, but *Praestrigites* in Oregon occurs also with *Tmetoceras* which has never been found in beds younger than the *Graphoceras concavum* zone.

The Haploceratidae is represented by two species. One resembles the genotype of *Lissoceras psilodiscus* (Schloenbach) but occurs in older beds. The other resembles *L. semicostulatum* (Buckman), a species intermediate in characteristics between *Bradfordia* and *Lissoceras*.

The Oppeliidae is represented by a single specimen of *Oppelia* similar to the genotype species. The genus in Europe ranges from the upper part of the *Otoites sauzei* zone into the upper Bajocian.

The Otoitidae are represented in Oregon by species of *Docidoceras* and *Emileia* that are similar to species from Europe and by one species of *Otoites* that is identical with *O. contractus* (J. de C. Sowerby) from Europe. With one exception, the Oregon species of *Docidoceras* are markedly different from the Alaskan representatives of that genus.

The Stephanoceratidae is represented by six genera and five subgenera. Of these, the genera *Normannites* and *Stephanoceras* show as much diversity in form and sculpture as they do in Alaska, Canada, and Europe, and include species in common with those areas. In addition, *Stephanoceras* is represented by one species that probably belongs to the rare subgenus *Phaulostephanus*. Also present in Oregon are a few specimens of *Stemmatoceras*, *Zemistephanus* (?), and *Teloceras* that are identical with, or closely related to, species in Canada and Alaska. Finally the family is represented by a new genus, *Lupherites*, that bears a general resemblance to *Polyplectites*.

The Sphaeroceratidae is not well represented in eastern Oregon. Biologically significant species include *Chondroceras allani* McLearn, known elsewhere from Canada and Alaska; *Sphaeroceras* cf. *S. brongniarti* (J. de C. Sowerby) which is probably identical with the European species of that name; and *Megasphaeroceras rotundum* Imlay, which occurs elsewhere in the Cook Inlet region of Alaska and probably also in the western interior of the United States.

The Perisphinctidae is represented by a few specimens referable to *Leptosphinctes* cf. *L. leptus* Buckman, *L.* (*Prorsisphinctes?*) spp., and *Parabigotites crassicostatus* Imlay from Alaska. The last-named species has been found previously only in Alaska in beds that are correlated with the *Otoites sauzei* zone (Imlay, 1964a, p. B54).

In addition, the ammonites are represented in eastern Oregon in beds of middle Bajocian age by about 60 aptychi, of which most belong to the form genus *Lamellaptychus*. As such aptychi are considered to represent parts of ammonites belonging to the Haploceratidae and Oppeliidae (Arkell in Arkell and others, 1957, p. L437), they could be paired in eastern Oregon with *Lissoceras* or with *Oppelia*.

Other megafossils collected from the Bajocian beds in eastern Oregon include fish remains from various parts of the sequence, brachiopods from the Weberg and Warm Springs Members of the Snowshoe Formation, many pelecypods from the Weberg Member, and few pelecypods from higher units. In the Weberg Member the common pelecypods include *Ostrea*, *Gryphaea*, *Homomya*, *Pleuromya*, *Pholadomya*, *Trigonia*, *Gervillia*, *Astarte*, *Isocyprina*, *Protocardia*, *and Camptonectes*. In higher beds, as well as in shaly beds equivalent to the Weberg Member, the pelecypods are represented by a few poorly preserved pectinids that are questionably assigned to *Camptonectes*, a few small nondescript oysters, some *Inoceramus* similar to specimens from Japan (Hayami, 1960, pl. 15), and many specimens of *Bositra buchii* (Römer), which has generally been referred to *Posidonia ornata* Quenstedt.

STRATIGRAPHY

STRATIGRAPHIC SUMMARY

Bajocian rocks in eastern Oregon range in thickness from 1,100 to at least 2,650 feet and probably are several thousand feet thick in the Seneca and Huntington areas. They consist mostly of marine clastic volcanic material ranging from coarse fragmental conglomerate to siltstone and mudstone but locally include submarine lava flows and volcanic breccias. Nonvolcanic sedimentary material includes organic matter, beds of limestone, clastic particles derived from older sedimentary rocks, and probably much of the mudstone and claystone. All sedimentary rock units change laterally within short distances and consequently the sequence of units in one area may be very different than in another area only 10 to 15 miles away. Such changes for the westernmost two areas, as illustrated by Dickinson and Vigrass (1965, fig. 21 on p. 45 and pl. 3), seem remarkable, considering the short distance involved but have been proved by actual tracing of beds and by ammonite correlations. Because of these marked changes, none of the local units merit more than member rank under a broadly defined formation.

Consequently, for the Suplee and Izee area Dickinson and Vigrass (1965, p. 44–59) use the term Snowshoe Formation of Lupher (1941, p. 259–261) in a comprehensive sense to include as members some lithologic units that had been called formations by Lupher (1941, p. 248–250). Their usage is followed herein except that the term Snowshoe Formation is used also for the Seneca area because the formation crops out extensively between Izee and Seneca. Also, the term Shaw Member of the Snowshoe Formation of Dickinson and Vigrass (1965, p. 57, pl. 1) is not used herein because unpublished field studies by H. J. Buddenhagen (written commun., October 1968 and March 1970) show that the "Shaw Member" exposed in the type locality along Shaw Creek and in areas to the southwest is in part lithologically identical with the Callovian Trowbridge Formation of Lupher (1941, p. 263) and in the southern part of the Suplee area contains early Callovian ammonites (Mesozoic locs. 29798–29800). These include *Lilloettia stantoni* Imlay and *Xenocephalites vicarius* Imlay, which in the Izee area range from the upper part of the Snowshoe formation to near the top of the Lonesome Formation (Imlay, 1964b, p. D7).

The marked facies changes in Bajocian rocks in eastern Oregon are demonstrated by several sequences of the Snowshoe Formation exposed in the westernmost inlier between Suplee and Seneca (fig. 1). In the Suplee area, which is farthest west, the formation consists of three lithologically distinct members which from bottom to top are named Weberg, Warm Springs, and Basey (Lupher, 1941, p. 248–250; Dickinson and Vigrass, 1965, p. 51–56). The Weberg Member is characterized by hard sandy limestone and calcareous sandstone, the Warm Springs Member by soft dark-gray, calcareous, thinly laminated claystone and mudstone, and the Basey Member by massive units of volcanic fragmental rocks and interbedded lava.

In the Izee area, which is separated from the Suplee area by the Mowich upwarp (Dickinson and Vigrass, 1965, p. 12, 86), the Snowshoe Formation is represented by three unnamed members which consist mostly of soft dark-gray to black claystone and siltstone. The lower member is virtually identical with the Warm Springs Member. The middle member is differentiated from the lower member mainly by the presence of thin beds of green, volcanic-rich siltstone and sandstone and by its eastward gradation into marine clastic volcanic sandstone and conglomerate that is called the Silvies Member of the Snowshoe Formation. The upper member of the Snowshoe Formation differs from the middle member in containing thick beds of gray sandstone.

Relationships between the members of the Snowshoe Formation in the Suplee and Izee areas are clearly demonstrated by lateral tracing of beds around the south side of the Mowich upwarp (Lupher, 1941, p. 228; Dickinson and Vigrass, 1965, p. 45, 51, 54, 56) and by correlations based on ammonites. The Weberg Member in the eastern part of the Suplee area passes eastward into dark-gray to black shales which in turn pass eastward in the Izee area into shales in the middle part of the lower member of the Snowshoe Formation. The Warm Springs Member persists eastward unchanged into the upper part of the lower member. The Basey Member passes eastward into the finely clastic middle member of the Snowshoe Formation.

The boundary relationships of the Snowshoe Formation differ remarkably between the Suplee and Izee areas. In the Suplee area the Weberg Member rests unformably on rocks ranging in age from Early Jurassic (Pliensbachian) to Paleozoic, but this unconformity disappears eastward within a few miles. In contrast, in the Izee area the lower part of the lower member of the Snowshoe Formation contains ammonites of Toarcian and early Bajocian age, distinctly older than the ammonites of the Weberg Member, and grades downward into still older Lower Jurassic rocks. In the Suplee area the Basey Member is apparently separated from overlying beds of Callovian age by an unconformity involving late Bajocian and Bathonian times. In the Izee area the upper member of the Snowshoe Formation contains ammonites of late Bajocian age near its base, of Bathonian or early Callovian age in its upper part, and is overlain unconformably by the Trowbridge Formation of Lupher (1941) of early Callovian age.

The relationships between the members of the Snowshoe Formation in the Izee area and the Seneca area are not well known because of lack of detailed mapping. Nonetheless the Silvies Member has been traced eastward toward Seneca (Dickinson and Vigrass, 1965, p. 59) where it apparently passes into conglomerate, sandstone, and mudstone exposed in the northern part of Silvies Canyon. The lower part of the upper member of the Snowshoe Formation is correlated with mudstone and siltstone exposed near and west of Seneca on the

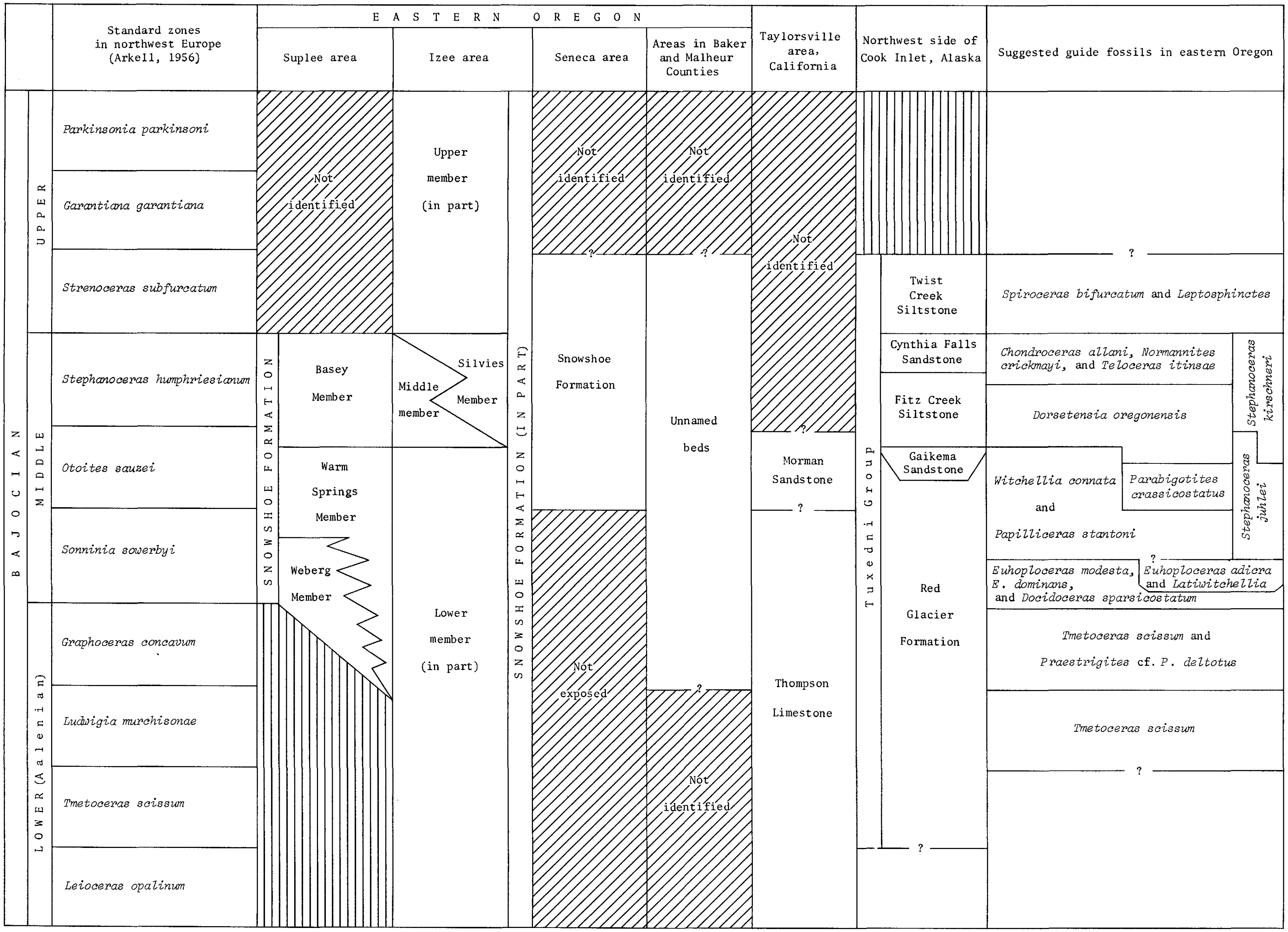

Figure 1.—Correlation of some Middle Jurassic (Bajocian) formations in eastern Oregon, California, and Alaska.

presence of *Leptosphinctes*. Both the Warm Springs Member of the Suplee area as well as the upper part of the lower member of the Snowshoe Formation near Izee, are correlated lithologically and faunally with hard, black, thinly laminated mudstone exposed in the southern part of Silvies Canyon. In general, the Bajocian rocks near Seneca differ from those in the Izee area in being harder, much less calcareous, and in containing more coarse clastic material. At least the greater hardness can be ascribed to intrusion by igneous bodies.

The Bajocian rocks of Malheur and Baker Counties in easternmost Oregon consist of metavolcanics similar to those in the Snowshoe Formation between Suplee and Seneca. They differ mainly in being slightly metamorphosed, locally somewhat sheared, and generally less calcareous.

SNOWSHOE FORMATION OF SUPLEE AREA

WEBERG MEMBER

Definition.—The Weberg Member of the Snowshoe Formation consists mostly of gray to brownish-gray silty to sandy limestone and calcareous sandstone, from 50 to at least 250 feet thick, that rest sharply and unconformably on various formations of Early Jurassic, Late Triassic, and Paleozoic ages (Lupher, 1941, p. 248–252; Dickinson and Vigrass, 1965, p. 51–54, 94) and is overlain gradationally by the Warm Springs Member. The type section, selected and described by Dickinson and Virgrass (1965, p. 51, 94), is on the north side of a gully that trends southwestward from the SW¼SE¼ sec. 19, into the NE corner of the NW¼NE¼ sec. 30, T. 18 S., R. 26 E., Grant County, Oregon. At this gully the Weberg Member rests with angular unconformity on Upper Triassic beds and consists from bottom to top of 3 feet of pebbly calcareous sandstone, 110 feet of gray calcareous sandstone and 90 feet of gray silty to finely sandy limestone.

Lithologic and stratigraphic features.—The Weberg Member, as described previously (Lupher, 1941, p. 248; Dickinson and Vigras, 1965, p. 51, 52), generally has two lithologic divisions. The lower division consists mostly of gray to brown calcareous sandstone that locally is pebbly and locally at or near its base contains sandy conglomerate composed of chert and limestone pebbles. Brachiopods and pelecypods, including oysters, are common, but cephalopods are not very common. The upper division consists mostly of gray to yellowish-gray, silty to sandy limestone. It contains many ammonites and some brachiopods, pelecypods, echinoderms, ichthyosaur vertebrae, and carbonized wood. Both divisions change markedly laterally within short distances, depending on the characteristics of the underlying rocks, and locally either division may comprise all or nearly all the member. Thus, the Weberg Member contains much clastic material where it overlies coarse clastic sediments of Triassic or Paleozoic ages and consists mostly of limestone and fine-grained calcareous sandstone where it overlies shaly beds of Early Jurassic or Triassic ages. Partial lateral equivalence of the two facies, as suggested by these relationships (Lupher, 1941, p. 248; Dickinson and Vigrass, 1965, p. 52), is upheld by the stratigraphic distribution of ammonites, discussed later under "Ammonite Faunules and Correlations."

The characteristics of the Weberg Member near the southwestern end of the Mowich upwarp are excellently shown in three closely spaced gulches that drain westward into Warm Springs Creek in the NE¼ sec. 30 and the SE¼ sec. 19, T. 18 S., R. 26 E. and in a fourth gulch that drains northward into Warm Springs Creek across the eastern part of the NW¼ of sec. 19. A section measured along the second gulch from the south has been described by Lupher (1941, p. 250) and by Dickinson and Vigrass (1965, p. 94). Another section measured by the writer in the southernmost gulch is described herein. Both sections are illustrated in columnar form in figure 2, along with a rather poorly exposed but very fossiliferous section measured by R. L. Lupher on the east side of North Ammonite Hill in sec. 29, about half a mile east of the southernmost gulch (unpublished notes on p. 2 and 20 in Lupher's locality book deposited at California Academy of Sciences). These columnar sections show the twofold lithologic divisions of the Weberg Member and the stratigraphic positions of some fossil collections.

Weberg Member of Snowshoe Formation in gulch slightly northeast of old Washburn place near center of E½NE¼ sec. 30, T. 18 S., R. 26 E., Grant County, Oreg.

	Feet
7. Limestone, thin-bedded to shaly, poorly exposed, yellowish-gray. At top contains *Sonninia* (*Euhoploceras*) cf. *S.* (*E.*) *polyacantha* (Waagen) (Mesozoic loc. 29829). Grades upward into Warm Springs Member	40
6. Limestone, thin-bedded, upper 40 feet contains some hard limestone ledges, lower 20 feet is softer and rather poorly exposed. Limestone beds from 40 to 50 feet above base contain *Sonninia* (*Euhoploceras*), *Witchellia* (*Latiwitchellia*), *Fontannesia*, *Docidoceras*, and *Asthenoceras* (Mesozoic loc. 29828)	60
5. Sandstone, calcareous, medium-gray to yellowish-gray, mostly thin-bedded, fairly well exposed. Upper 10 feet contains many pelecypods and brachiopods and a few cephalopods, including *Sonninia dominans* Buckman (Mesozoic loc. 29826)	40
4. Sandstone, ledge-forming, medium-yellowish-gray, contains many pelecypods and brachiopods	8
3. Sandstone, calcareous, medium-gray to yellowish-gray, mostly thin-bedded, poorly exposed, contains	

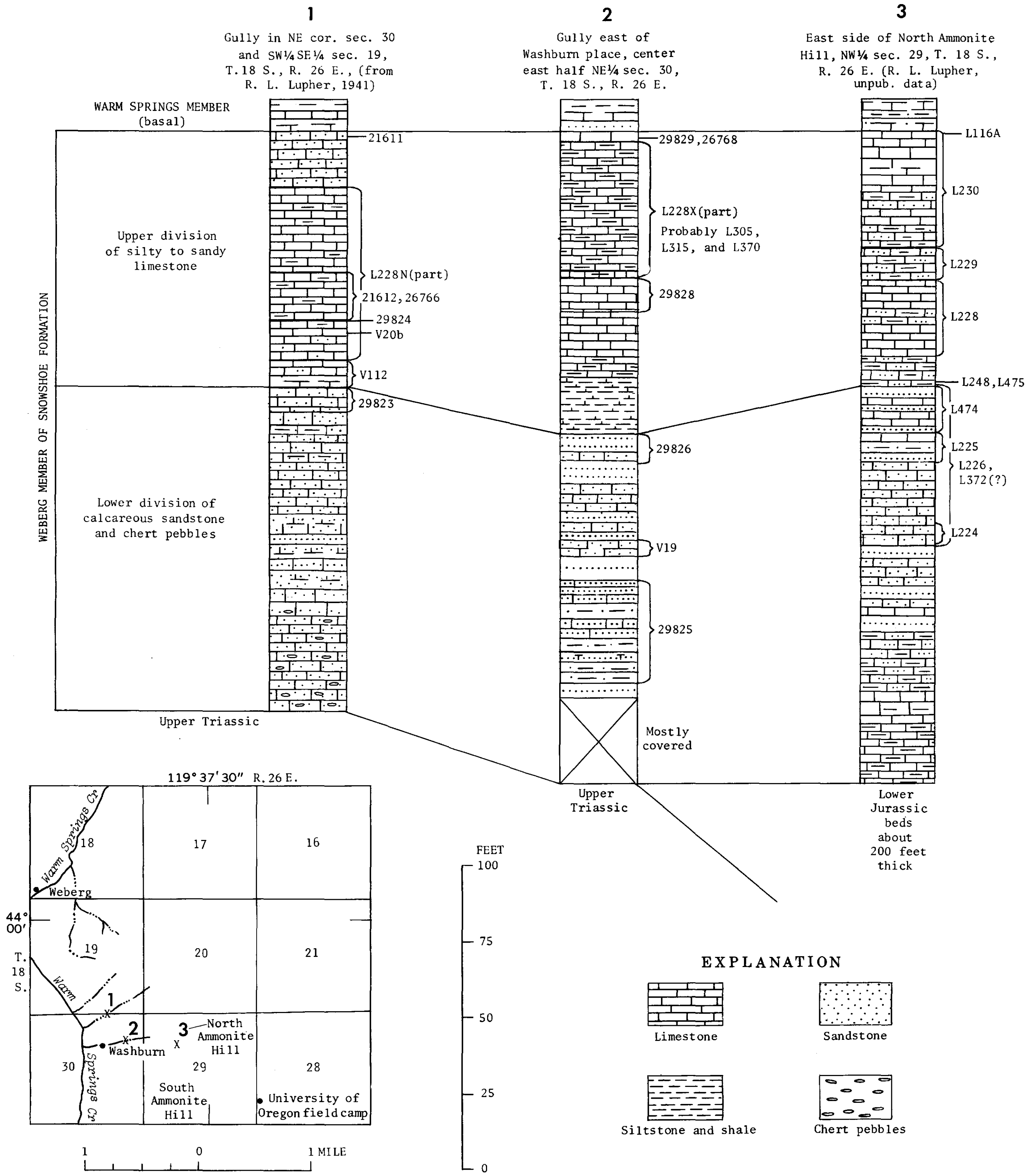

FIGURE 2.—Columnar sections of the Weberg Member of the Snowshoe Formation on the east side of Warm Springs Creek, Suplee area, Grant County, Oreg. Numbers are collectors' field numbers or USGS Mesozoic locality numbers.

many pelecypods and brachiopods and a few cephalopods. *Sonninia modesta* Buckman and *Docidoceras* obtained at Mesozoic loc. 29825	34
2. Sandstone, ledge-forming, medium-bedded, hard, gray	5
1. Mostly covered. Float consists of yellowish-brown calcareous sandstone. Overlies vertically dipping Triassic conglomerate	28
Total thickness	215

The thickness of the Weberg Member varies considerably throughout its extent, owing to westward onlap over an irregular surface and to gradational facies changes upward and eastward into shales of the onlapping Warm Springs Member (Dickinson and Vigrass, 1965, p. 51, 52, 58). Maximum thicknesses are attained along a belt of outcrops extending northeast from sec. 19, east of Warm Springs Creek, to secs. 3 and 4, T. 18 S., R. 26 E., near Swamp Creek (Lupher, 1941, p. 250, 252; Dickinson and Vigrass, 1965, p. 51). Eastward from these places the member disappears completely within 3 to 4 miles by changing into dark shales of the Warm Springs Member. Westward from these places it thins to 60 feet or less within 6 to 8 miles owing to the pinching out of the lower part of the member that is characterized by the ammonite *Tmetoceras.*

WARM SPRINGS MEMBER

Definition.—The Warm Springs Member of the Snowshoe Formation consists mostly of soft, dark-gray, calcareous silty claystone and mudstone that thickens eastward from 100 to 300 feet, grades into the underlying Weberg Member, and at most places grades into the overlying Basey Member (Lupher, 1941, p. 249; Dickinson and Vigrass, 1965, p. 54–57). The gradational upper contact with the Basey Member is covered in most places but is fairly well exposed on the west side of the road along the west fork of Freeman Creek in the west-central part of sec. 34, T. 18 S., R. 26 E.,, Grant County and in the NW¼ sec. 3, T. 19 S., R. 26 E., Harney County.

A type section for the Warm Springs Member has not been selected previously because of incomplete exposures, but a type area was designated by Lupher (1941, p. 249) as the east side of Warm Springs valley in sections 19, 20, 29, and 30. Furthermore, he noted (1941, p. 250) that the best exposures of the lower and middle parts of the member are on the south side of the type area along the county road, which extends eastward across the west-central part of sec. 29, T. 18 S., R. 26 E. (See geologic map in Dickinson and Vigrass, 1965, pl. 1.) As these exposures are easily accessible and are in the type area they are herein considered as the type section.

Lithologic and stratigraphic features.—The Warm Springs Member is characterized by dark-gray thinly laminated claystone but includes mudstones and some siltstones that fracture into nodular or blocky fragments (Dickinson and Vigrass, 1965, p. 54). Other rock types include thin beds of limestone and fine-grained sandstone at or near the base of the member where it grades into the underlying Weberg Member. Their presence commonly makes arbitrary the selection of a boundary between the members. The Warm Springs Member must likewise contain some fine volcanic material because its upper part in most places grades upward into the volcanic Basey Member (Dickinson and Vigrass, 1965, p. 57). Faunally the member is characterized by an abundance of ammonites and of the pelecypod *Bositra buchii* (Römar). Rare fossils include fish bones (Mesozoic loc. 29395), rhynchonellid brachiopods, small nondescript oysters and *Inoceramus.*

Generally the Warm Springs Member can be recognized easily by its stratigraphic position, by its characteristic dark thinly laminated beds, and by an abundance of *Bositra buchii* (Römer). The mere presence of that species is not a valid criterion for the member, however, because the species occurs throughout the Snowshoe Formation in dark shaly beds ranging in age from late Toarcian (Imlay, 1968, p. C7, C14) to early Callovian and is even present in the slightly younger Lonesome Formation of Lupher (1941) (Imlay, 1964b, p. D13, D14).

BASEY MEMBER

Definition.—The term Basey Member of the Snowshoe Formation, as proposed by Dickinson and Vigrass (1965, p. 54–56, 94, 95) includes 2,500 feet, or less, of interbedding andesitic lava and fragmental volcanic rocks overlying the Warm Springs Member. The type locality is designated as the west-central part of the Suplee area in secs. 1, 12, and 13, T. 18 S., R. 25 E., Crook County, Oreg.

Lithologic and stratigraphic features.—The Basey Member, as described by Dickinson and Vigrass (1965, p. 56, 57) consists characteristically of massive units of volcanic fragmental rocks, but at its type locality includes andesitic lava flows at its base and about 1,000 feet above its base. It also includes some volcanic siltstone and mudstone that are most common from 500 to 1,000 feet above the base of the member and become more common eastward. East of Mowich Mountain at the south end of the Mowich upwarp the entire member lenses out into siltstone and mudstone that are called informally the middle member of the Snowshoe Formation. Northeast from the type locality the member thins within nine miles from 2,500 to 500 feet.

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The sharp lower contact of the Basey Member in the type locality is placed at the base of a flow of andesitic lava. Elsewhere the contact is gradational, is generally poorly exposed, and is placed between fragmental volcanic rocks above and dark-gray claystone and siltstone below. The upper contact with the "Shaw Member" of the Snowshoe Formation is probably disconformable, when one considers that the upper part of the Basey Member contains ammonites of late middle Bajocian age and that the "Shaw Member" contains ammonites of early Callovian age.

The Basey Member as a whole is sparsely fossiliferous, but some thin silty beds have furnished a fair number of ammonites, a few specimens of the pelecypods *Bositra buchii* (Römer) and *Inoceramus*, and rare fish bones (Mesozoic loc. 29818) and aptychi. *Bositra buchii* (Römer) is associated with the ammonites *Dorsetensia* and *Pelekodites* in the lower third of the member. (Mesozoic locs. 26769, 29812, 29818, and Dickinson's loc. 101). It is associated with *Dorsetensia*, *Poecilomorphus*, *Sphaeroceras*, and *Stephanoceras kirschneri* Imlay a little above the middle of the member (Mesozoic loc. 29816). *Lamellaptychus* and *Lamellaptychus*? occur in the lower two-fifths of the member in association with *Dorsetensia*, *Pelekodites*, and *Stephanoceras kirschneri* Imlay (Mesozoic locs. 29406, 29812, and 29818).

SNOWSHOE FORMATION OF IZEE AREA

Definition.—The Snowshoe Formation, as defined by Lupher (1941, p. 227, 259–261), consists of about 2,800 feet of poorly exposed soft black shale and fine-grained, dark-gray, laminated sandstone that rest comformably on the ridge-forming volcanic Hyde Formation of Lupher (1941) and is overlain uncomformably by the Trowbridge Formation of Lupher (1941). The type locality is in the valley of the South Fork of the John Day River near the Izee school house (Lupher, 1941, p. 259). The best exposed and most accessible exposures at the type locality are on the north side of the valley in sec. 29, T. 17 S., R. 28 E., Grant County, Oreg. The formation as described by Lupher crops out mainly along the southeastern side and south end of the Mowich upwarp, and in the Seneca area.

The Snowshoe formation, as redefined by Dickinson and Vigrass (1965, p. 44–47), also includes all rocks of Middle Jurassic age exposed in the Suplee area, as has been discussed. Furthermore, in the Izee area the Snowshoe Formation is divided by them into three distinctive but unnamed members. They include also in the Snowshoe Formation a thick unit of clastic volcanic rock named the Silvies Member (Dickinson and Vigrass, 1965, p. 49–51) that arises from the unnamed middle member in the northeastern part of the Izee area and apparently extends eastward to the Seneca area (Dickinson and Vigrass, 1965, p. 58–60). Owing to westward overlap of the upper member by the uncomformably overlying Trowbridge Formation of Lupher, the total thickness of the Snowshoe Formation decreases southwestward from about 3,600 feet to 1,600 feet.

Lithologic and stratigraphic features.—The lower member of the Snowshoe Formation in the Izee area ranges in thickness from 500 to 750 feet, consists mainly of soft, dark-gray to black claystone, siltstone and mudstone, is generally calcareous, and locally contains concretions and thin beds of limestone (Dickinson and Vigrass, 1965, p. 46, 47). It resembles the Warm Springs Member lithologically, in having an abundance throughout of the pelecypod *Bositra buchii* (Römer) and in having the same ammonites and aptychi in its upper two-thirds. The presence of ammonites of late Toarcian and early Bajocian (Aalenian) ages in the lower 200 feet of the lower member in the Izee area (Dickinson and Vigrass, 1965, p. 48, 49; Imlay, 1968, p. C14) shows that about one-third of that member is older than the Warm Springs Member of the Suplee area. Such evidence by itself would not prevent use of the term Warm Springs Member for the lower member of the Snowshoe Formation, provided the lower member had a mappable upper boundary.

The middle member of the Snowshoe Formation, as described by Dickinson and Vigrass (1965, p. 47), is about 1,000 feet thick. It consists of thin beds of dark-gray to black, generally calcareous claystone and siltstone, as in the lower member, that alternate with thin beds of gray to green sandy siltstone and fine-grained sandstone whose particles are of volcanic origin. It extends from Big Flat northeastward about 15 miles to the headwaters of Rosebud Creek, east of which it intertongues into conglomeratic volcanic rocks that have been named the Silvies Member of the Snowshoe Formation (Dickinson and Vigrass, 1965, p. 49–51). West of Flat Creek it grades laterally into the volcanic Basey Member of the Snowshoe Formation (Dickinson and Vigrass, 1965, p. 45, 47). Faunally the middle member is characterized by the same ammonites and aptychi that occur in the Basey Member and likewise contains the pelecypod *Bositra buchii* (Römer) in its lower part (Mesozoic locs. 26773, 26759, and 27578).

The Silvies Member of the Snowshoe Formation, as described by Dickinson and Vigrass (1965, p. 45, 49–51), consists of marine fragmental volcanic material that was deposited at the same time as the middle member of the Basey Member of the Snowshoe Formation. The Silvies Member is lithologically similar to the Basey Member but differs in a number of features, most noticeably the presence of conglomerate beds, pebbly sandstones, coarser grained sandstone, and conspicuous graded bedding. It is about 1,500 feet thick at its type locality which is at the juncture of secs. 21, 22, 27, and 28, T. 16 S., R. 29 E., Grant County, less than five miles northeast of its westernmost occurrences. The member is reported to thicken and coarsen eastward markedly toward Seneca (Dickinson and Vigrass, 1965, p. 51, 59). The only fossils found in the Silvies Member in the Izee area consist of fragments of ammonites from near the middle of the NE¼ sec. 32, T. 16 S., R. 29 E.

The upper member of the Snowshoe Formation, as described by Dickinson and Vigrass (1965, p. 47), thins southwestward from about 2,000 feet near the head of Lewis Creek to 1,200 feet along the South Fork of the John Day River and then disappears before reaching Big Flat, owing to overlap by the Trowbridge Formation of Lupher. It consists partly of thin beds of dark mudstone and siltstone as in the underlying members but differs by containing some thicker beds of gray calcareous sandstone. It is generally poorly exposed, but fairly good exposures occur in a roadcut along Lewis Creek in the west half of sec. 7, T. 17 S., R. 29 E., Grant County. The member has furnished one ammonite, *Leptosphinctes*, near its base just above the Silvies Member (Mesozoic loc. 26775) in the SW¼NE¼ sec. 32, T. 16 S., R. 29 E. Its upper 500 to 1,000 feet have also furnished ammonites of late Bathonian? to early Callovian age and the pelecypods *Ostrea* and *Bositra* (Imlay, 1964b, p. D7–D9). Apparently the member spans late Bajocian to early Callovian time or includes a disconformity that has not been recognized.

SNOWSHOE FORMATION OF EMIGRANT CREEK AREA

The Snowshoe Formation crops out in a small area north of Emigrant Creek in the northern parts of sec. 33 and 34, T. 20 S., R. 28 E., Sawtooth Creek quadrangle, Harney County, Oreg. The entire exposure is less than two miles long parallel to the creek and half a mile wide. The beds consist of noncalcareous, brownish to yellowish-gray, fairly hard, thin-bedded, laminated siltstone and sandy siltstone that break into blocky chunks from one quarter of an inch to three inches thick. Ammonites are fairly common and pelecypods are represented only by two pectinids and possibly represent *Camptonectes*.

SNOWSHOE FORMATION OF SENECA AREA

The Snowshoe Formation of Bajocian age in the Seneca area crops out irregularly from the southern margin of T. 16 S. near Seneca to the middle of T. 18 S., and from R. 30 E. to R. 32 E. Within these townships, as shown on a generalized geologic map of the Canyon City quadrangle (Brown and Thayer, 1966), the Snowshoe Formation occurs in the areas bearing the symbol for the Snowshoe Formation, as well as in most of the areas bearing the symbol for the Trowbridge and Lonesome Formations of Lupher. Actually, on the basis of many occurrences of Bajocian ammonites the Snowshoe Formation extends south as far as Flat Creek in T. 18 S., R. 31 where it is identified by the presence of *Normannites* (Mesozoic loc. 29415) just north of the creek in the SE¼ sec. 7, T. 18 S., R. 31 E. Just south of the creek, however, some pebbly sandstone exposed on a ridge has furnished the early Callovian ammonite *Xenocephalites vicarius* Imlay in the NW¼ sec. 17, T. 18 S., R. 31 E. (Lupher's loc. 53) and in the south-central part of sec. 16, T. 18 S., R. 31 E. (Mesozoic locs. 29419 and 29420). The only other ammonites not of Bajocian age that have been found near Seneca are from the eastern part of Antelope Valley in the NW¼SE¼ sec. 9, T. 17 S., R. 32 E., Grant County. These include *Harpoceras* and questionable *Grammoceras* (Mesozoic loc. 29409) and are definitely of Toarcian age.

Details of the geology of the Seneca area have not been published. Lithologically the Jurassic sequence consists mostly of noncalcareous dark-gray to brownish-gray mudstone and claystone but includes many units of noncalcareous dark-gray to greenish-gray, thick-bedded to massive sandstone and some beds of conglomerate (Lupher, 1941, p. 267). Most of the sandstone consists of fragmental volcanic material. Calcium carbonate was noted only in concretions and short lenses of limestone exposed in a large shale cut on the east side of U.S. Highway 395 about 0.6 mile south of Seneca. Stratigraphically the sequence of beds is difficult to determine because of tight folding, the lack of marker beds, the presence of prophyry intrusions as dikes and sills, and partial concealment by lava flows and soil cover. In most places the beds dip steeply northward at 60° or more, and in places are overturned according to Lupher (1941, p. 267), which is confirmed by Trantham's geologic map.

Faunally the oldest beds of Bajocian age occur near the southern end of the canyon of the Silvies River in secs. 23 to 26, T. 17 S., R. 31 E. The next younger beds occur about two miles to the south near Camp Creek (Mesozoic loc. 29413) as well as about 0.6 mile south of Seneca. The highest Bajocian beds occur near and west of Seneca along the southern margin of Bear Valley.

The fossils found in the Snowshoe Formation of the Seneca area consist mostly of ammonites and the pelecypod *Bositra buchii* (Römer) but include some fish bones (Mesozoic loc. 29790) and the pelecypod *Inoceramus* (Lupher's locs. 28 and 57 and Mesozoic loc. 29415). The pelecypod *Bositra* occurs throughout the sequence in beds correlating with the European *Otoites sauzei* zone (Lupher's loc. 57 and Mesozoic locs. 28026, 28027), the *Stephanoceras humphriesianum* zone (Lupher's loc. 28), and with basal upper Bajocian as identified by *Spiroceras* (Mesozoic loc. 28022).

UNNAMED BEDS IN CLOVER CREEK AREA

Middle Jurassic fossils have been collected from noncalcareous yellowish-gray metavolcanic siltstone at two places in the drainage of Clover Creek in the western part of Malheur County about 9 miles south of Ironside, Oreg. The westernmost occurrence (Mesozoic loc. 27393) is in metamorphosed, brittle rock exposed in a roadcut along Rail Canyon in the SW cor. sec. 11, T. 16 S., R. 38 E., Ironside Mountain 30-min. quadrangle. It includes *Bositra buchii* (Römer) and fragmentary ammonites referred questionably to *Phylloceras*, *Witchellia*, *Parabigotites*, and *Stephanoceras*. The other occurrence (Mesozoic loc. 28387) is about five miles to the east on the Ralph Duncan Ranch in the NE. cor. sec. 9, T. 16 S., R. 39 E., Clover Creek Ranch 15-min. quadrangle, and includes the ammonites *Fontannesia* and *Asthenoceras*. Both localities are in a Triassic-Jurassic sequence that appears to be thousands of feet thick. The sequence in the Ironside Mountain quadrangle has been mapped by Lowry (1968), who considers that the Middle Jurassic beds at Rail Canyon are followed several miles to the west by still younger Jurassic beds that resemble the Trowbridge Formation of the Izee area.

UNNAMED BEDS IN JUNIPER MOUNTAIN AREA

The Middle Jurassic (Bajocian) is represented by about 2,000 feet of mostly noncalcareous black to yellowish-gray shale, graywacke and conglomerate exposed along and south of Pole Creek on the southeastern and southern slopes of Juniper Mountain in secs. 5 to 8, T. 16 S., R. 41 E., Malheur County, Oreg. (Wagner and others, 1963). These beds are underlain by a much greater thickness of similar appearing beds that near their base have furnished fossils of probable Early Jurassic age. They are overlain by unfossiliferous dark gray to black shale, apparently many thousands of feet thick, that lithologically resembles the lower Callovian Trowbridge Formation of the Izee area (Lupher, 1941, p. 227, 259–266, Dickinson and Vigrass, 1965, p. 60–63) as well as some Callovian beds exposed near Mineral (abandoned) in westernmost Idaho (Imlay, 1964b, p. D2, D3).

The fossils found in the Middle Jurassic are mostly ammonites belonging to the genera *Tmetoceras*, *Eudmetoceras*, *Fontannesia*, *Asthenoceras*, *Stephanoceras*, *Spiroceras*, *Normannites*, and *Leptosphinctes*. Pelecypods include *Bositra buchii* (Römer) near the base of the Middle Jurassic (Mesozoic locs. 28380, 28381, 28373, 28374), *Isognomon?* and *Plicatula?* near the middle (Mesozoic loc. 28382), and *Inoceramus* near the top (Mesozoic loc. 28649).

UNNAMED BEDS IN HUNTINGTON AREA

Middle Jurassic beds of Bajocian age have been identified by ammonites, such as *Tmetoceras*, *Spiroceras*, and *Stephanoceras*, in the central and southwestern parts of the Huntington quadrangle. These beds, according to Howard Brooks (written commun., March 25, 1970), are part of a series, probably several thousand feet thick, that consists mostly of sheared and slightly metamorphosed massive to thin-bedded graywacke, tuffaceous sandstone, and siltstone. Minor amounts of interbedded water-laid tuff, conglomerate, quartzose sandstone, limestone, and a few lava flows are also present. This series rests conformably on several hundred feet of red to green conglomeratic beds which in turn rest discordantly on Upper Triassic volcanic and sedimentary rocks (Brooks, 1967). The conglomeratic unit has furnished ammonites of Early Jurassic, probably Sinemurian age (Mesozoic locs. 29846–29851). The overlying graywacke series near its base has furnished the ammonite, *Crucilobiceras*, of late Sinemurian age (Mesozoic locs. 29785, 29835). The graywacke series extends southwestward across the Huntington quadrangle into the southeastern part of the Bridgeport quadrangle.

AMMONITE FAUNULES AND CORRELATIONS

SNOWSHOE FORMATION IN THE SUPLEE AREA

WEBERG MEMBER

The stratigraphic distribution of ammonites in the Weberg Member (fig. 3) shows that the member contains two ammonite assemblages and that the upper assemblage is divisible into two faunules. The lower assemblage is characterized by *Tmetoceras scissum* (Benecke) in association with *Praestrigites* cf. *P. deltotus* (Buckman) (Lupher's locs. 207, 366, and 467) and *Eudmetoceras* (Lupher's loc. 207). The upper assemblage is characterized by *Sonninia* (*Euhoploceras*) *modesta* Buckman, *S.* (*E.*) *dominans* Buckman, and *Docidoceras sparsicostatum* Imlay, n. sp., which species extend through the entire Weberg Member above the *Tmetoceras*-bearing beds. In addition, the upper part of the beds containing these species may be distinguished from the lower part by the presence of *Witchellia* (*Latiwitchellia*) *evoluta* Imlay, n. sp., *Sonninia* (*Euhoploceras*) *adicra* (Waagen), *S.* (*E.*) *crassispinata* Buckman, and *Docidoceras lupheri* Imlay, n. sp.

Associated with *Sonninia modesta* Buckman in Oregon are other ammonites that have different ranges than the species listed above. These include certain species of

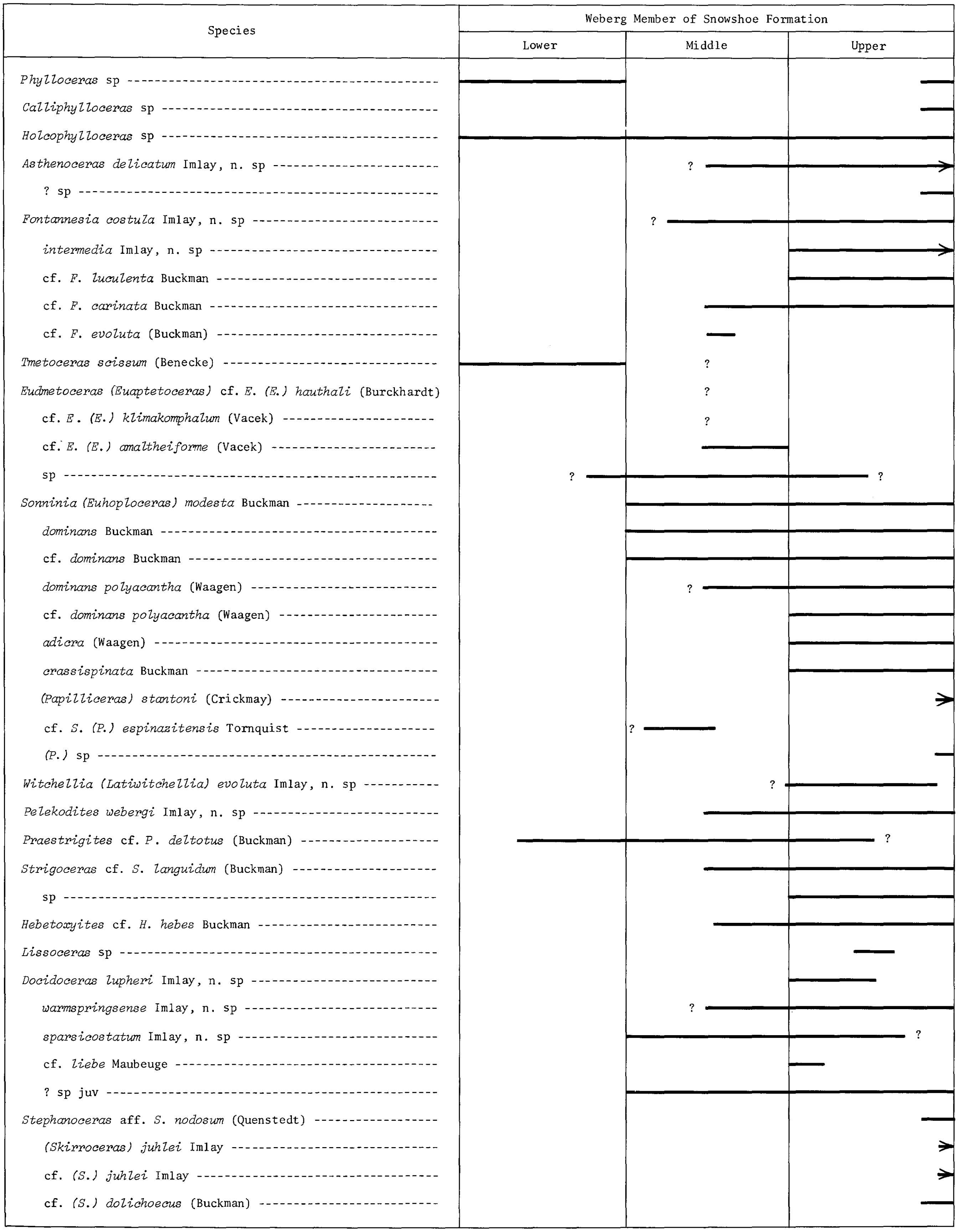

FIGURE 3.—Stratigraphic distribution of Bajocian ammonite species in the Weberg Member of the Snowshoe Formation in the Suplee area.

the genera *Asthenoceras*, *Eudmetoceras*, *Sonninia* (*Papilliceras*), *Fontannesia*, *Pelekodites*, *Praestrigites*, *Strigoceras*, *Hebetoxyites*, *Lissoceras*, *Docidoceras*, and *Stephanoceras*. Of these, *Eudmetoceras* and *Praestrigites* range upward from the beds characterized by *Tmetoceras scissum* (Benecke) into the beds characterized by *Witchellia* (*Latiwitchellia*) *evoluta* Imlay, n. sp. Species that begin above the base of the *Sonninia modesta* assemblage but range to its top include *Asthenoceras delicatum* Imlay, n. sp., *Fontannesia costula* Imlay, n. sp., *F.* cf. *F. carinata* Buckman, *Pelekodites webergi* Imlay, n. sp., *Strigoceras* cf. *S. languidum* (Buckman), *Hebetoxyites* cf. *H. hebes* Buckman, *Docidoceras warmspringsense* Imlay, n. sp., and *Stephanoceras* (*Skirroceras*) cf. *S.* (*S.*) *dolichoecus* Buckman. The genus *Lissoceras* is represented by a single specimen from the upper part of the zone. The subgenus *Sonninia* (*Papilliceras*) is represented by three specimens from the very top of the Weberg Member and by three specimens from near the middle of the member, apparently below the middle of the *Sonninia modesta* assemblage.

Tmetoceras scissum (Benecke) in the Weberg Member occurs in sandy beds in the lower part of the member on the east side of Dobson Creek (Vigrass' loc. 3) in the SE¼ sec. 28, T. 18 S., R. 26 E., and on the west side of Swamp Creek (Vigrass' loc. 121a) in the SW¼ sec. 34, T. 17 S., R. 26 E. At Dobson Creek *Tmetoceras* occurs 50 feet above the base of the member and is overlain 30 feet higher by *Docidoceras sparsicostatum* Imlay, n. sp. (Vigrass' loc. 86). Near Swamp Creek, *Tmetoceras* occurs in yellowish sandy limestone underlying gray limestone beds that contain *Sonninia modesta* Buckman and *Fontannesia*, as discussed under the description of *Tmetoceras scissum*. Northeast of Swamp Creek the sandy beds containing *Tmetoceras* continue for about 4 miles, but the overlying limestone beds are replaced laterally within a mile by dark shale of the Warm Springs Member (Dickinson and Vigrass, 1965, p. 52). Consequently for about 3 miles *Tmetoceras* occurs near the top of the Weberg Member. Nonetheless, the presence of *Docidoceras* from the upper part of the sandy beds in secs. 25 and 26, T. 17 S., R. 26 E., indicates that at least the basal part of the *Sonninia modesta* assemblage is represented.

Tmetoceras has not been found in the westernmost exposures of the Weberg Member west of Warm Springs Creek and the Pine Creek downwarp. Neither has it been found in the lower part of the Weberg Member in the exposures along the east side of Warm Springs Creek in secs. 19, 29, and 30, T. 18 S., R. 26 E., and could be represented there only by the lower 33 feet of the member (fig. 2). Its presence in the area, however, is indicated by an occurrence of a very small fragment of *Tmetoceras* that supposedly was obtained with a well-preserved specimen of *Sonninia* (*Papilliceras*) from the basal beds of the Warm Springs Member at Vigrass' locality 18. When one considers that these ammonites are preserved in a different matrix and that *Tmetoceras* occurs worldwide below *Sonninia*, their natural association in Oregon is most unlikely.

The *Sonninia modesta* assemblage is widely distributed in the Weberg Member. The lower faunule of the assemblage, however, below the range of *Witchellia* (*Latiwitchellia*), is well developed only in the area extending from North Ammonite Hill north and northeast to Swamp Creek, has not been recognized in the westernmost exposures of the Weberg Member west of Warm Springs Creek, and is poorly developed in the easternmost exposures of the Weberg Member. East of North Ammonite Hill the lower faunule is represented by sandy beds containing *Docidoceras* (Lupher's locs. 103 and 214, Vigrass' loc, 86, and Mesozoic loc. 27581) and *Sonninia modesta* Buckman (Lupher's loc. 108). It is possibly represented also by *Eudmetoceras* at the top of the Weberg Member exposed on the north site of Mowich Mountain near the eastern pinchout of the member (Mesozoic locs. 29400 and 29817). Northeast of Swamp Creek the lower faunule of the *Sonninia modesta* assemblage is probably represented by specimens of *Docidoceras* from the upper part of sandy beds (Lupher's loc. 366, Vigrass' loc. 158, and Mesozoic locs. 26764 and 27374) that there represent all, or nearly all, the Weberg Member.

The lower faunule of the *Sonninia modesta* assemblage on the east side of Warm Springs Creek occurs in 60 to 85 feet of light-gray to brownish-gray sandy limestone and calcareous sandstone that is locally pebbly. It is present in the third to sixth units below the top of the Weberg Member as described by Lupher (1941, p. 250), the third to fifth units of the member as described herein under Stratigraphy, and in most of the lower sandstone division as described by Dickinson and Vigrass (1965, p. 94). Within this 60 to 85 feet of beds the upper 45 to 60 feet contain at their top a unit bearing many terebratulid brachiopods, contain at their base a thin bed bearing many rhynchonellid brachiopods, contain many pelecypods throughout, and have furnished some ammonites belonging mainly to *Sonninia* (*Euhoploceras*), *Fontannesia*, *Docidoeras*, *Pelekodites*, and *Asthenoceras*. The lower 15 to 25 feet of the sequence contain many pelecypods and a few ammonites which include *Sonninia modesta* Buckman and *Docidoceras sparsicostatum* Imlay, n. sp. The pelecypods occurring in these sandy beds include *Ostrea*, *Gryphaea*, *Homomya*, *Pleuromya*, *Pholadomya*, *Trigonia*, *Gervillia*, *Astarte*, *Isocyprina*, *Protocardia*, and *Camptonectes*.

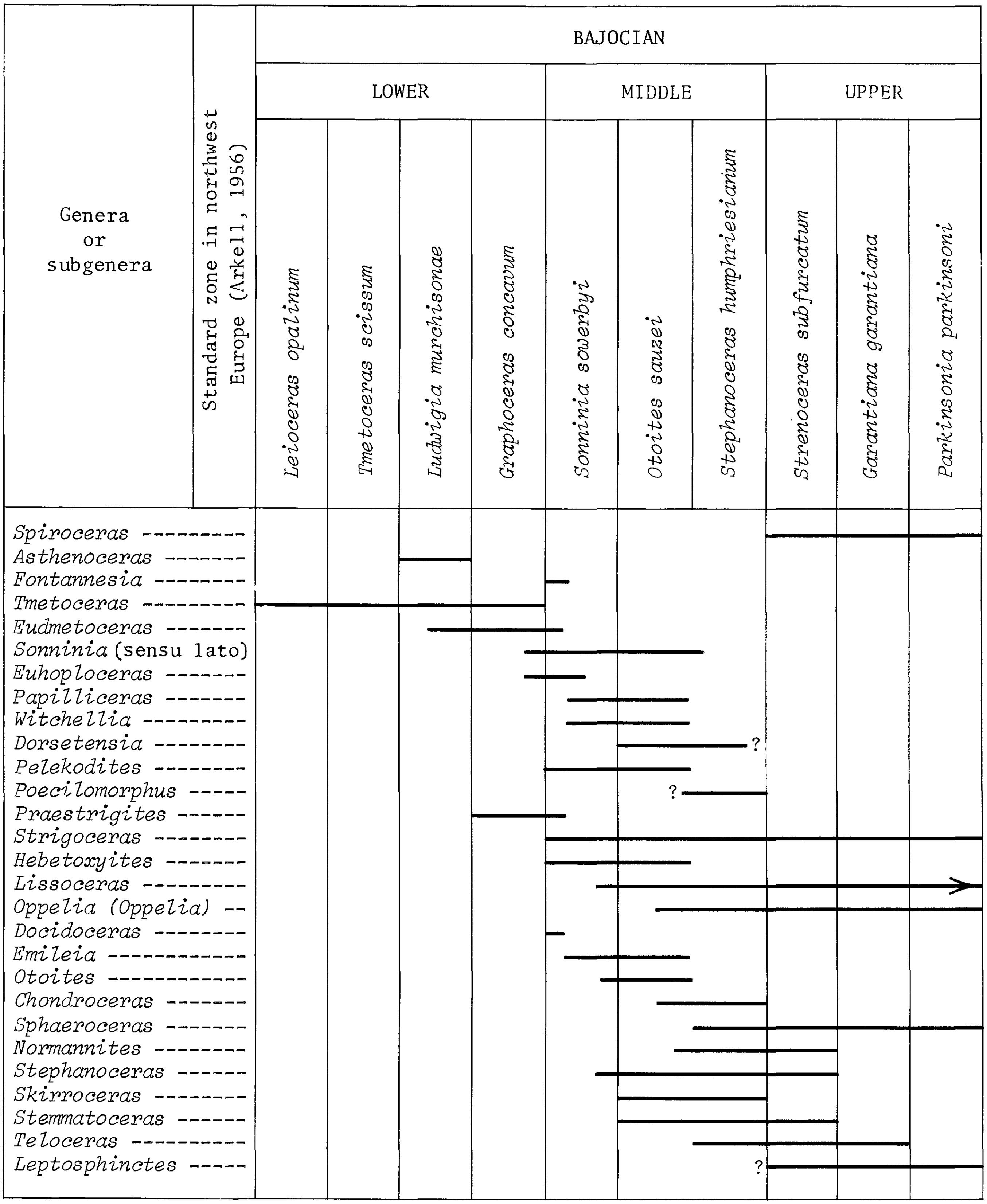

Figure 4.—European ranges of certain Bajocian ammonite genera present in eastern Oregon.

The upper faunule of the *Sonninia modesta* assemblage, characterized by *Witchellia* (*Latiwitchellia*), has the same areal distribution as the lower faunule in the area between North Ammonite Hill and Swamp Creek. It has not been recognized east of North Ammonite Hill or northeast of Swamp Creek. It has been recognized at many places in the westernmost outcrops of the Weberg Member west of Warm Springs Creek. It has furnished many ammonites but very few pelecypods or brachiopods.

The beds in the lower part of the Weberg Member that contain *Tmetoceras* in association with *Praestrigites* and *Eudmetoceras* (*Euaptetoceras*) correlate with the *Graphoceras concavum* zone of Europe (figs. 4, 5) because *Tmetoceras* does not range higher (Arkell, 1956, p. 34, Westermann, 1964a, p. 432–435; 1969, p. 61) and *Praestrigites* does not range lower (Arkell and others, 1957, p. L271). The presence of the subgenus *Eudmetoceras* (*Euaptetoceras*) merely shows that the beds are not younger than the lower part of the *Otoites sauzei* zone (Westermann, 1969, p. 18, 22) or older than the upper part of the *Ludwigia murchisonae* zone (Arkell, 1956, p. 33, 102; Arkell and others, 1957, p. L267; Westermann, 1964a, p. 347–349, 352, 408–411; Davies in Buckman, 1930, v. 7, p. 36, 37).

The beds in the middle and upper parts of the Weberg Member that are characterized by *Sonninia* (*Euhoploceras*) *modesta* Buckman and *Docidoceras lupheri* Imlay, n. sp. correlate mainly with the lower subzone of the European *Sonninia sowerbyi* zone. At their top, however, they may be as young as the *Shirbuirnia trigonalis* subzone as shown by the association of the ammonites *Eudmetoceras*, *Sonninia* (*Euhoploceras*), *S.* (*Papilliceras*), *Fontannesia*, *Pelekodites*, *Praestrigites*, *Strigoceras*, *Hebetoxyites*, *Docidoceras*, and *Stephanoceras* (figs. 4 and 5). Most of these ammonites are excellent evidence for correlation with only the *Hyperlioceras discites* subzone at the base of the *Sonninia sowerbyi* zone. Thus, in Europe *Docidoceras* is known only and *Fontannesia* mainly from that subzone, *Eudmetoceras* and *Praestrigites* are not known higher, and two species of *Sonninia* (*Euhoploceras*) present in the Weberg Member are identical with species that in Europe are known only in the *H. discites* subzone. These include *S.* (*E.*) *modesta* Buckman and *S.* (*E.*) *polyacantha* Buckman.

Against such a precise correlation with only the *Hyperlioceras discites* subzone are several faunal considerations. First, such Oregon species as *Sonninia* (*Euhoploceras*) *adicra* (Waagen) and *S.* (*E.*) *crassispinata* Buckman are known in England from both the *H. discites* subzone and the overlying *Shirbuirnia trigonalis* subzone (Buckman, 1892, p. 322, 325; 1926, pl. 669; Morton, 1965, p. 199). Second, the ranges of some Jurassic ammonite genera in western North America are slightly different than in Europe (Westermann, 1969, p. 18). Third, such ammonites as *Stephanoceras* and *Papilliceras* in Europe have not been found as low as the *H. discites* subzone. For example, in England *Papilliceras* occurs mainly in the *Otoites sauzei* subzone, and the oldest known species, *Sonninia* (*Papilliceras*) *arenata* (Quenstedt) in Buckman (1927, pl. 709) is recorded from the *Shirbuirnia trigonalis* subzone (Davies, in Buckman, 1930, v. 7, p. 36). *Stephanoceras* in Europe ranges from the middle part of the *Sonninia sowerbyi* zone into the lower part of the upper Bajocian and attains its greatest development in the *Stephanoceras humphriesianum* zone (Arkell, 1956, p. 232, 264, 300; 1952a, p. 74). Apparently the oldest species of *Stephanoceras* in England is *S. mollis* (Buckman) (1922, pl. 344) from the base of the *Witchellia laeviuscula* subzone (Davies, in Buckman, 1930, v. 7, p. 35), a little higher than the oldest occurrence of *Papilliceras*.

When one considers these ranges of *Stephanoceras* and *Papilliceras* in Europe, the uppermost beds of the Weberg Member, where that member is fully developed, could be a little younger than the *Hyperlioceras discites* subzone. This statement could apply to all occurrences of *Stephanoceras* (Vigrass' locs. 16, 130, 162) and to three occurrences of *Papilliceras* (Vigrass' loc. 16, Lupher's loc. 210, Mesozoic loc. 21611) at or near the top of the member in beds transitional into the Warm Springs Member.

Against such a younger age are the association of *Stephanoceras* with species typical of the *Witchellia* (*Latiwitchellia*) *evoluta* faunule at Vigrass' locality 16 and of *Papilliceras* with that faunule at USGS Mesozoic locality 21611. These two associations, unless they result from mixing of specimens from different levels, may be of age significance as far as *Stephanoceras* is concerned. It is of no age significance, however, as regards *Papilliceras* because four specimens of that genus, described herein under *Sonninia* (*Papilliceras*) *cf. S.* (*P.*) *espinazitensis* Tornquist, were found at three localities (Lupher's loc. 360, Vigrass' loc. 120, Mesozoic loc. 26763) in the lower part of the beds characterized by the *Sonninia modesta* assemblage near or below the middle of the Weberg Member. These occurrences are proved authentic by their independent discovery by three different geologists at different times and places. Their low stratigraphic position is excellent evidence that *Papilliceras* in Oregon occurs in beds equivalent to the basal part of the European *Sonninia sowerbyi* zone.

In summation, the lower part of the Weberg Member that contains *Tmetoceras* in association with *Praestrig-*

Stage	Substage	Standard zones in northwest Europe (Arkell, 1956)	Subzones in southern England (Arkell, 1956)	Characteristic fossils in eastern Oregon	Characteristic fossils in southern Alaska
BAJOCIAN	UPPER	*Parkinsonia parkinsoni*			
		Garantiana garantiana		?	
		Strenoceras subfurcatum		*Spiroceras bifurcatum*, *Leptosphinctes*, *Megasphaeroceras*, *Normannites*, and *Stephanoceras* *Sphaeroceras*	*Megasphaeroceras rotundum*, *Normannites vigorosus*, *Sphaeroceras*, *Leptosphinctes*, and *Liroxyites* ?
	MIDDLE	*Stephanoceras humphriesianum*	*Teloceras blagdeni* *Stephanoceras humphriesianum*	*Chondroceras*, *Normannites*, and *Teloceras* *Dorsetensia* spp. *Poecilomorphus varius* *Stephanoceras kirschneri* *Sphaeroceras*	*Chondroceras allani*, *Normannites crickmayi*, *Zemistephanus richardsoni*, and *Teloceras itinsae* ? *Stephanoceras kirschneri*
		Otoites sauzei		*Witchellia* and *Emileia* *Otoites* and *Normannites* *Parabigotites* *Stephanoceras juhlei*	*Papilliceras*, *Witchellia*, *Dorsetensia*, *Otoites*, *Emileia*, and *Bradfordia* *Normannites* *Parabigotites crassicostatus*, *Dorsetensia adnata*, and *Stephanoceras juhlei* ?
		Sonninia sowerbyi	*Witchellia laeviuscula* *Shirbuirnia trigonalis* *Hyperlioceras discites*	*Papilliceras* throughout *Fontannesia* at base ? *Euhoploceras*, *Papilliceras*, *Fontannesia*, *Eudmetoceras*, *Hebetoxyites*, *Praestrigites*, *Strigoceras*, and *Docidoceras*	*Witchellia sutneroides* *Sonninia (Euhoploceras)* and *S. (Alaskoceras)* *Docidoceras*? *paucinodosum* *Docidoceras (Pseudocidoceras) widebayense* *Pseudolioceras* *Eudmetoceras*
	LOWER (Aalenian)	*Graphoceras concavum*		*Tmetoceras scissum*, *Praestrigites*, and *Eudmetoceras*	*Erycitoides howelli*, *Erycites*, and *Tmetoceras*
		Ludwigia murchisonae		*Tmetoceras scissum* ?	*Tmetoceras scissum* ?
		Tmetoceras scissum			
		Leioceras opalinum			

FIGURE 5.—Correlation of Bajocian ammonite faunas in eastern Oregon, Alaska, and Europe.

ites is correlated with the European *Graphoceras concavum* zone at the top of the lower Bajocian (Aalenian). The middle and upper parts of the Weberg Member that contain an association of *Sonninia* (*Euhoploceras*), *Docidoceras*, *Eudmetoceras*, *Praestrigites*, and *Fontannesia* correlate mostly or entirely with the *Hyperlioceras discites* subzone at the base of the *Sonninia sowerbyi* zone. The highest beds locally are probably as young as the next younger *Shirbuirnia trigonalis* subzone based mainly on the appearance of *Stephanoceras*. Such an age is suggested, also, by the resemblance of the new subgenus *Latiwitchellia* to *Zugophorites* Buckman (1922, p. 341) and by the fact that *Euhoploceras* in England ranges into the *S. trigonalis* subzone.

WARM SPRINGS MEMBER

The Warm Springs Member as a whole is characterized by the presence of *Sonninia* (*Papilliceras*) *stantoni* (Crickmay) and *Witchellia connata* (Buckman) (fig. 6). In association with these throughout the member are *Asthenoceras delicatum* Imlay, n. sp., *Holcophylloceras* sp., and *Stephanoceras* sp., which also occur above and below the member. The species *S.* (*Papilliceras*) *stantoni* is recorded also from transitional beds at the top of the Weberg Member.

The lower part of the Warm Springs Member is characterized by the appearance of *Witchellia connata* (Buckman) and by the absence of a number of genera and subgenera that are common in the upper part of the underlying Weberg Member. Such taxa include *Eudmetoceras*, *Sonninia* (*Euhoploceras*), *Witchellia* (*Latiwitchellia*), *Praestrigites*, *Hebetoxyites*, and *Docidoceras*. *Fontannesia* also, except for two specimens, has been found only in the Weberg member. The absence of these genera even in places where the basal Warm Springs Member appears to be the lateral equivalent of the upper part of the Weberg Member, as in secs. 26 and 27, T. 17 S., R. 26 E., is probably related to unfavorable facies and to poor exposures.

The middle part of the Warm Springs Member is characterized by the abrupt appearance of *Dorsetensia*, *Emileia*, *Parabigotites*, and *Pelekodites silviesensis* Imlay, n. sp. Of these *Emileia* and *Parabigotites* range upward to near the top of the member and the other taxa range still higher.

The upper part of the Warm Springs Member is characterized by the presence of *Lissoceras hydei* Imlay, n. sp., *Emileia buddenhageni* Imlay, n. sp., *Otoites contractus* (J. de C. Sowerby), and *Parabigotites crassicostatus* Imlay, by the lowest occurrences of *Normannites*, and by a greater abundance of *Dorsetensia* and *Stephanoceras* than in lower beds. The upper part also contains *Stephanoceras* (*Skirroceras*) *juhlei* Imlay, which ranges upward from the top of the Weberg Member into the base of the Basey Member.

The Warm Springs Member, on the basis of its ammonites, correlates roughly with the middle and upper parts of the European zone of *Sonninia sowerbyi* and with the *Otoites sauzei* zone. Such a correlation is shown by the presence of *Witchellia* throughout the member, the end of occurrences of *Witchellia* and *Papilliceras* at its top, the presence of *Emileia* and *Dorsetensia* in its upper two thirds, the presence of *Normannites* near its top, and the presence of *Fontannesia* near its base.

The lower part of the Warm Springs Member, where the Weberg Member is fully developed east of Warm Springs Creek, is not older than the *Shirbuirnia trigonalis* subzone as confirmed by the presence of true *Witchellia* and *Stephanoceras* and by the fact that the older *Hyperlioceras discites* subzone is well represented in the underlying Weberg Member (figs. 4 and 5). Its basal beds are not much younger, however, than the *discites* subzone as shown by the presence of *Fontannesia* (Lupher's loc. 232 and Vigrass' loc. 18), which in Europe occurs mainly in the *discites* subzone but has been recorded slightly higher in southeast France (Pavia and Sturani, 1968, p. 311). The topmost beds of the lower part must be nearly as young as the *Otoites sauzei* zone, as shown by the lowest appearance of *Dorsetensia* in fair abundance in the overlying middle part of the member. Both faunally and stratigraphically, therefore, the lower part of the Warm Springs Member correlates approximately with the *Shirbuirnia trigonalis* and *Witchellia laeviuscula* subzones of the *Sonninia sowerbyi* zone. This does not exclude correlation of the highest beds of the Weberg Member at least locally with the *S. trigonalis* subzone.

The middle part of the Warm Springs Member probably correlates with the lower part of the *Otoites sauzei* zone, as suggested by its stratigraphic position directly below several hundred feet of beds containing ammonites strongly indicative of the *Otoites sauzei* zone and by the presence of *Dorsetensia* throughout. That genus in Europe is most common in the lower part of the *Stephanoceras humphriesianum* zone, is fairly common in the underlying *Otoites sauzei* zone (Buckman, 1892, p. 203; Dorn, 1935, p. 120; Huf, 1968, p. 16, 72–110; Arkell, 1952b, p. 269, 295), and is not definitely known from older beds.

Dorsetensia has been recorded from older beds in southern Germany but all such records appear to be erroneous (Arnold Zeiss written commun., July 1970). For example, one specimen of *Dorsetensia* listed by Dorn (1935, pl. 19, fig. 1) as from the *Sonninia sowerbyi* zone is actually from the *Stephanoceras humphriesianum*

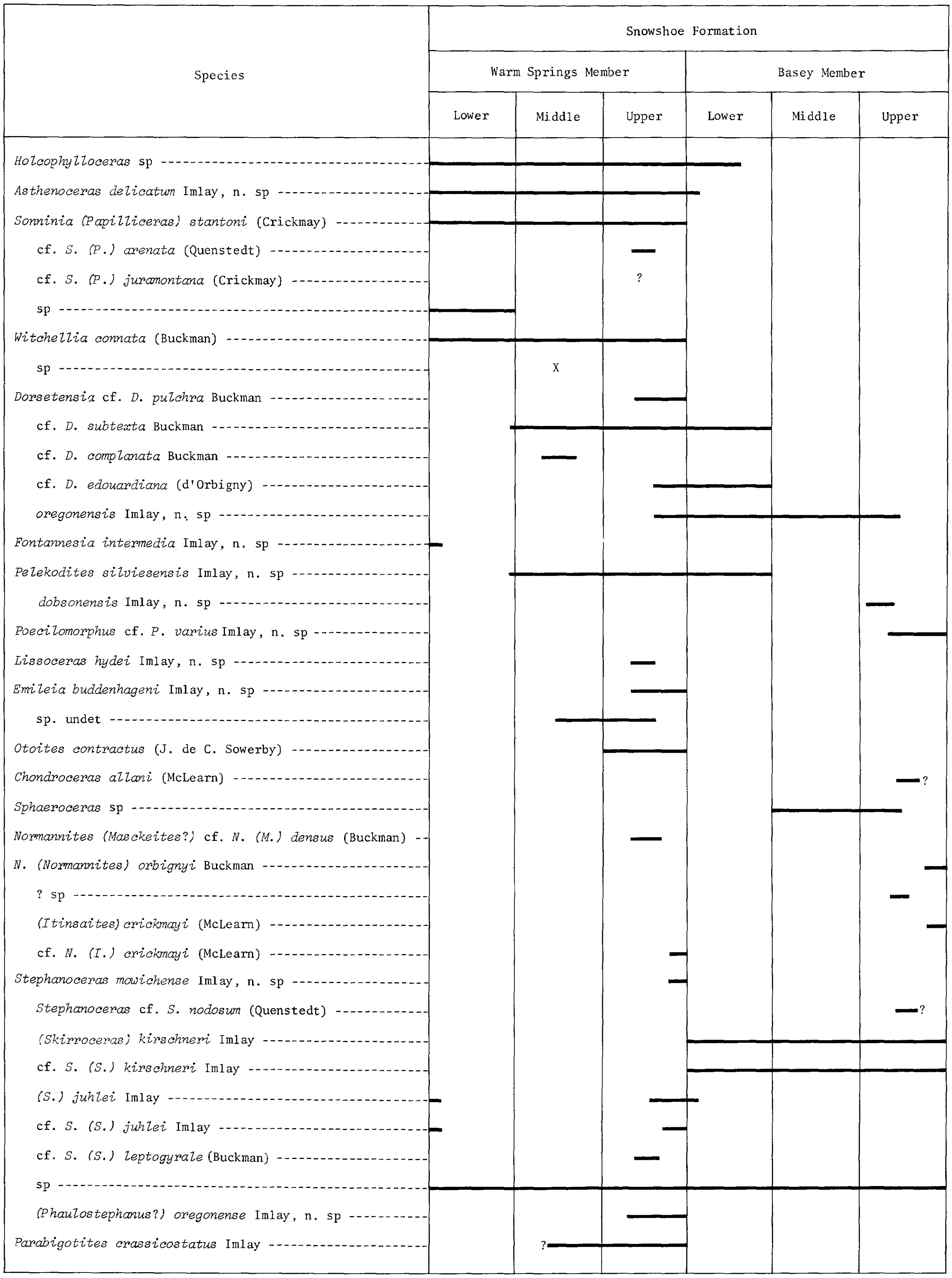

FIGURE 6.—Stratigraphic distribution of Bajocian ammonite species in the Warm Springs and Basey Members of the Snowshoe Formation in the Suplee area.

zone (Huf, 1968, p. 98, 102). Also, two specimens identified as *Dorsetensia* by Dorn (1935, pl. 24, fig. 5, pl. 26, figs. 1a, b) and listed from the '*Witchellia*' *pinguis* zone (Dorn, 1935, p. 96, 105, 120; Westermann, 1967, p. 160) actually belong to *Sonninia stephani* Buckman, according to Oechsle (1958, p. 86, 106) and Huf (1968, p. 98, 110). That species is typical of the genus *Shirbuirnia* according to Arkell (1933, pl. 33, fig. 1) and differs markedly in whorl shape from *Dorsetensia.*

The upper part of the Warm Springs Member is definitely correlated with the European *Otoites sauzei* zone because it marks the top of the local range of *Papilliceras*, *Witchellia*, *Emileia*, and *Otoites*, which in Europe do not range higher (fig. 5). It marks the base of the local range of *Normannites*, which in Europe does not occur below the upper part of the *sauzei* zone and is uncommon below the *Stephanoceras humphriesianum* zone. It contains *Otoites contractus* (J. de C. Sowerby) which is characteristic of the *sauzei* zone. It contains *Parabigotites crassicostatus* Imlay which is known elsewhere only in southern and southwestern Alaska in beds that are correlated mainly with the lower part of the *Otoites sauzei* zone (Imlay, 1964a, p. B7, B11, B18, B54). In particular in south-central Alaska *Parabigotites* occurs from 300 to 1,400 feet below the top of the Red Glacier Formation in association with many ammonites indicative of the *sauzei* zone. As the upper part of the Red Glacier Formation above these occurrences of *Parabigotites* also contains ammonites characteristic of the *sauzei* zone, the genus *Parabigotites* in Alaska does not represent the highest part of that zone.

BASEY MEMBER

The Basey Member as a whole is characterized by the presence of *Dorsetensia oregonensis* Imlay, n. sp. and *Stephanoceras* (*Skirroceras*) *kirschneri* Imlay, although *D. oregonensis* does not extend to the top and occurs also high in the Warm Springs Member. With these species in the lower part of the member occur five species that range up from the Warm Springs or Weberg Members but do not range higher (fig. 6). Two of these, *Asthenoceras delicatum* Imlay, n. sp. and *Stephanoceras juhlei* Imlay, barely extend into the base of the member. The other three species, *Dorsetensia* cf. *D. subtexta* Buckman, *D.* cf. *D. edouardiana* (d'Orbigny), and *Pelekodites silviesensis* Imlay, n. sp. range to the top of the lower part, which is roughly 400 to 500 feet above the base of the member. The basal part of the member is characterized also by an overlap of the top of the range of *Stephanoceras juhlei* Imlay with the lowest part of the range of *S. kirschneri* Imlay.

The middle part of the Basey Member has not yielded many ammonites. Besides the two long-ranging species characteristic of the member as a whole, these include only *Sphaeroceras* sp.

The upper part of the Basey Member is characterized by the presence of *Sphaeroceras* and by the first appearance of *Poecilomorphus* cf. *P. varius* Imlay, n. sp., *Chondroceras allani* (McLearn), *Normannites orbignyi* Buckman, *N.* (*Itinsaites*) *crickmayi* McLearn and *Stephanoceras* cf. *S. nodosum* (Quenstedt). The latter four species have been found in association with *Poecilomorphus* but not with *Dorsetensia*, and presumably they occur above the range of *Dorsetensia.*

The lower part, or lower few hundred feet, of the Basey Member probably correlates with the upper part of the *Otoites sauzei* zone. This is indicated by the fact that all the ammonite species present, except *Stephanoceras kirschneri* Imlay, range upward from the Warm Springs Member. Even the lowest occurrence of that species in southern Alaska is in beds that correlate with the upper part of the *Otoites sauzei zone* (Imlay, 1964a, p. B7, B11, B47). Furthermore, the presence of *Parabigotites* in the upper part of the Warm Springs Member is evidence, as discussed previously, that the top of the member does not correlate with the top of the *Otoites sauzei* zone.

The middle part of the Basey Member definitely correlates with the *Stephanoceras humphriesianum* zone as shown by the presence of *Sphaeroceras*, which is not known below that zone (Westermann, 1956a, p. 24–35; Arkell, 1952a, p. 77; Arkell, 1956, p. 32, 50, 100, 142, 262, 278) and *Dorsetensia* which is not known higher (Arkell, 1952b, p. 269, 295).

The upper part of the Basey Member has furnished even stronger evidence for correlation with the European zone of *Stephanoceras humphriesianum.* This is shown by an association (Mesozoic loc. 29816) of *Sphaeroceras*, not known below that zone, with *Dorsetensia*, not known above that zone, and *Poecilomorphus*, which occurs mainly in that zone (fig. 6). It is favored also by the association of *Poecilomorphus* with *Chondroceras* (Mesozoic loc. 28384) and *Normannites* (Mesozoic loc. 29815) at and near the top of the Basey Member. Furthermore, such species as *Chondroceras allani* (McLearn) and *Normannites crickmayi* (McLearn) furnish a correlation with the formations in the Cook Inlet area, Alaska, that clearly belong in the *Stephanoceras humphriesianum* zone (Imlay, 1964a, p. B7, B13–B15). In fact, the absence of *Dorsetensia* from the highest beds of the Basey Member favors a correlation with the European *Teloceras blagdeni* subzone at the top of the *Stephanoceras humphriesianum* zone, in which *Dorsetensia* is locally rare or absent (Dorn, 1935, p. 96, 105, 120; Pavia and Sturani, 1968, p. 311, 312).

SNOWSHOE FORMATION IN THE IZEE AREA

LOWER MEMBER

The lower member of the Snowshoe Formation has yielded ammonites of late Toarcian age in its lower 125 feet (Imlay, 1968, p. C14, C16, C44–C46), ammonites of early Bajocian (Aalenian age from 125 to 200 feet above its base, and ammonites of middle Bajocian age from 225 feet upward (fig. 7). The early Bajocian (Aalenian) is represented mainly by *Tmetoceras scissum* (Benecke) which in the upper 50 feet of its range is associated with some tuberculate ammonites referred questionably to *Planammatoceras*. Of these ammonites, *Tmetoceras* ranges throughout the substage (Arkell, 1956, p. 34; Westermann, 1964a, p. 435) and *Planammatoceras?*, if correctly identified, suggests correlation with the *Ludwigia murchisonae* zone (Arkell and others, 1957, p. L267; Elmi, 1963b, p. 82–90, 101–103; Westermann, 1969, p. 66), or with the upper instead of the lower part of the lower Bajocian.

The middle Bajocian part of the lower member contains the ammonites *Asthenoceras delicatum* Imlay, n. sp., *Sonninia* (*Papilliceras*) sp., *Witchellia connata* (Buckman), *Dorsetensia* cf. *D. subtexta* Buckman, *Pelekodites silviesensis* Imlay, n. sp., *Lissoceras hydei* Imlay, n. sp., and *Stephanoceras* (*Skirroceras*) *juhlei* Imlay (fig. 7). These same species occur in the Warm Springs Member of the Snowshoe Formation and have the same general age connotations discussed under that member. In fact, the presence only 250 feet above the base of the lower member of such ammonites as *Dorsetensia*, *Lissoceras hydei* Imlay, n. sp., and *Pelekodites silviesensis* Imlay, n. sp. suggests that all higher beds in the lower member may be equivalent to only the middle and upper parts of the Warm Springs Member and may not be older than the *Otoites sauzei* zone. This leaves only 25 feet, or slightly more, above the highest occurrence of *Tmetoceras* to account for the time represented by the middle and upper parts of the Weberg Member, as well as the lower part of the Warm Springs Member. These few feet, however, have not furnished any ammonites that are restricted to the Weberg Member of the Suplee area, but only *Asthenoceras delicatum* Imlay, n. sp., which ranges through the Warm Springs Member.

Collecting failure in poorly exposed beds probably explains in part the absence within the lower member of the Snowshoe Formation of any ammonite typical of the middle and upper parts of the Weberg Member. It may be that the environment in the sea during deposition of the lower member (Dickinson and Vigrass, 1965, p. 58) was unfavorable for the ammonites that are found in the Weberg Member. It is also possible that the downwarping of the Suplee area during deposition of the Weberg Member was sufficient to trap most of the sediment that was brought into the sea. Conceivably, therefore, the time represented by the Weberg Member could be represented in the Izee area by nondeposition (nonsequence or diastem) or by only a few feet of beds.

MIDDLE MEMBER

The middle member of the Snowshoe Formation in the Izee area is characterized (fig. 7) by the presence throughout of *Dorsetensia oregonensis* Imlay, n. sp. and by the presence at or near the base of the member of *Pelekodites silviescensis* Imlay, n. sp., *Poecilomorphus varius* Imlay, n. sp., *Normannites* (*Itinsaites*) cf. *N.* (*I.*) *gracilis* Westermann, *Stephanoceras* cf. *S. nodosum* (Quenstedt), *S.* (*S.*) *kirschneri* Imlay, and *S.* (*S.*) *juhlei* Imlay. This distribution is almost the same as in the Basey Member of the Snowshoe Formation in the Suplee area except for the lower stratigraphic occurrence of *Poecilomorphus*. Accordingly, as in the Basey Member, the lower 200–300 feet of the middle member is correlated with the upper part of the European zone of *Otoites sauzei*, and the remaining 700 to 800 feet is correlated with the *Stephanoceras humphriesianum* zone. The age evidence for the upper part of the middle member is weak, but the presence of *Dorsetensia* shows that the top of the middle member is not younger than the *Stephanoceras humphriesianum* zone, and probably not younger than the lower part of that zone when the genus was most abundant in Europe (Dorn, 1935, p. 96, 120; Westermann, 1954, p. 142).

UPPER MEMBER

The presence of *Leptosphinctes* near the base of the upper member of the Snowshoe Formation (fig. 7) is fairly good evidence that at least the basal part of the member is of late Bajocian age, although the genus has been reported from slightly older beds in Alaska (Imlay, 1964a, B18, B54) and Argentina (Westermann, 1956b, p. 268). Both of these occurrences, however, need confirmation by careful stratigraphic collecting.

SNOWSHOE FORMATION IN THE SENECA AREA

Three distinct ammonite assemblages are recognizable in the Seneca area in the southwestern part of the Seneca quadrangle and in nearby parts of the Logdell and Calamity Butte quadrangles (fig. 8). The oldest assemblage is identical specifically with that in the upper part of the Warm Springs Member and that in the lower part of the Basey Member of the Snowshoe Formation in the Suplee area. The next higher, or middle, assemblage is identical with that in the highest part of the Basey Member of the Snowshoe Formation. The highest ammonite assemblage, characterized by *Spiroceras*, is

Species	Snowshoe Formation		
	Lower member	Middle member	Upper member
Holcophylloceras sp	—	—	
Asthenoceras delicatum Imlay, n. sp	—		
Tmetoceras scissum (Benecke)	—		
Planammatoceras? sp	—		
Sonninia (Papilliceras) sp	—		
Witchellia connata (Buckman)	—		
Dorsetensia cf. *D. subtexta* Buckman	—		
oregonensis Imlay, n. sp		—	
sp	—	—	
Pelekodites silviesensis Imlay, n. sp	—	—	
sp	—		
Poecilomorphus varius Imlay, n. sp		—	
Lissoceros hydei Imlay, n. sp	—		
Normannites (Itinsaites) cf. *N. (I.) gracilis* Westermann		—	
Stephanoceras cf. *S. nodosum* (Quenstedt)	—	—	
(Skirroceras) kirschneri Imlay		—	
(S.) juhlei Imlay	—	—	
(S.) sp	—	—	
(Phaulostephanus?) cf. *S. (P.) oregonense* Imlay, n. sp	—		
Leptosphinctes sp			—
Parabigotites cf. *P. crassicostatus* Imlay	?		

FIGURE 7.—Stratigraphic distribution of Bajocian ammonite species in the Snowshoe Formation in the Izee area.

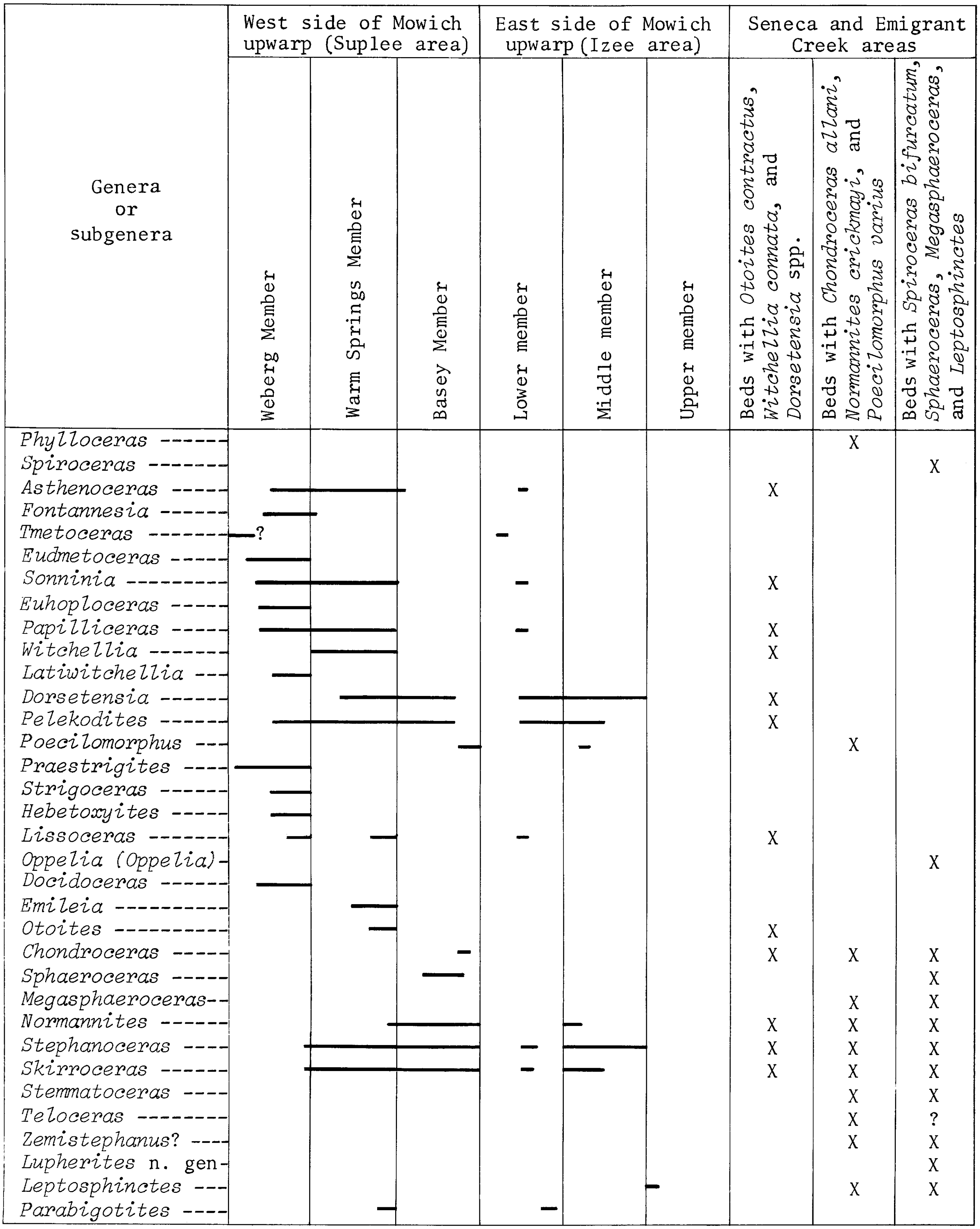

FIGURE 8.—Stratigraphic distribution of Bajocian ammonite genera in the Snowshoe Formation in the Suplee, Izee, Seneca, and Emigrant Creek areas.

not known from the Suplee or Izee areas but does occur in the Juniper Mountain area in Malheur County and probably also near the center of the Huntington quadrangle in Baker County, Oreg.

The lowest ammonite assemblage occurs only in the central part of the Seneca area in secs. 23–27, T. 17 S., R. 31 E., and is listed as follows:

Asthenoceras delicatum Imlay, n. sp. (Lupher's loc. 490)
Sonninia cf. *S. nodatipinguis* (Buckman) (Lupher's loe, 272)
(*Papilliceras*) *stantoni* (Crickmay) (Lupher's loc. 57, Mesozoic locs. 21617, 28026)
Witchellia connata (Buckman) (Lupher's loc. 57 and Mesozoic loc. 28026).
Dorsetensia diversistriata Imlay, n. sp. (Lupher's loc. 57)
oregonensis Imlay, n. sp. (Lupher's loc. 272).
Pelekodites silviesensis Imlay, n. sp. (Lupher's loc. 57 and 272)
Lissoceras hydei Imlay, n. sp. (Lupher's loc. 57 and Mesozoic locs, 21617 and 28027)
Otoites contractus (J. de C. Sowerby) (Lupher's loc. 57)
Chondroceras sp. (Lupher's loc. 57)
Normannites? *kialagvikensis* Imlay (Lupher's loc. 57)
cf. *N. braikenridgii* (J. de C. Sowerby) (Lupher's loc. 57)
formosus Buckman (Mesozoic loc, 21617)
aff. *N. itinsae* (McLearn) (Lupher's loc. 272)
Stephanoceras sp. B (Lupher's loc. 57)
cf. *S. nodosum* (Quenstedt) (Lupher's loc. 57)
(*Skirroceras*) *kirschneri* Imlay (Lupher's loc. 272)
(*S.*) *juhlei* Imlay (Lupher's loc. 272 and Mesozoic loc. 29233)

Inspection of this list shows that two faunules are present. One of these is represented by Lupher's locality 272. The other faunule is represented by Lupher's locality 57 and probably by all of the other localities listed. The faunule represented by Lupher's locality 57 is characterized by the presence of the same fairly long-ranging species of *Witchellia*, *Papilliceras*, and *Otoites* that are typical of the Warm Springs Member of the Snowshoe Formation (fig. 6) and that have the same age significance. Nonetheless, the association of these taxa with *Normannites* and *Chondroceras* shows that the faunule corresponds to only the upper part of the Warm Springs Member and to only the upper part of the European *Otoites sauzei* zone.

The faunule at Lupher's locality 272 differs from that at Lupher's locality 57, or in the Warm Springs Member, in lacking species of *Witchellia*, *Papilliceras*, and *Otoites*, and in containing *Sonninia* cf. *S. nodatipinguis* (Buckman) and *Stephanoceras* (*Skirroceras*) *kirschneri* Imlay. These differences, plus the presence of *Pelekodites silviesensis* Imlay, n. sp. and *Stephanoceras juhlei* Imlay, show that the faunule at Lupher's locality 272 is essentially the same as that in the lower few hundred feet of the Basey Member (fig 6) of the Snowshoe Formation which correlates with the highest part of the *Otoites sauzei* zone. A correlation with that zone rather than with the *Stephanoceras humphriesianum* zone is supported by the presence of a species of *Sonninia*.

The next higher ammonite assemblage in the Seneca area occurs both south and north of the assemblage just discussed. In the northern part of the area it has been identified in a large roadcut, exposing about 250 feet of shale, on the east side of U.S. Highway 395 about 0.6 mile south of Seneca (Lupher's loc. 28, Vigrass' loc. 242, Mesozoic locs. 29790 and 29792). In the southern part of the area the assemblage has been identified from Camp Creek southward about 2½ miles to the north side of Flat Creek near the southern margins of the Seneca and Logdell quadrangles (Mesozoic locs. 25818, 25692, 26771, 29413, 29415, Lupher's locs. 55 and 56). Directly south of Flat Creek occur beds of early Callovian age, but about 2 miles still farther south the middle Bajocian is represented on Hall Creek in the Calamity Butte quadrangle (Mesozoic loc. 26777) by tuffaceous beds that appear to be the same as on Camp Creek.

The ammonites found in this middle assemblage are listed as follows:

Phylloceras sp. (Mesozoic loc. 29790)
Poecilomorphus varius Imlay, n. sp. (Lupher's loc. 28, Mesozoic locs. 29790, 29792)
Megasphaeroceras rotundum Imlay (Lupher's loc. 28)
Chondroceras allani (McLearn) (Mesozoic loc. 29413)
cf. *C. allani* (McLearn) (Lupher's loc. 28)
Normannites orbignyi Buckman (Mesozoic locs. 26777, 29415, 29790)
(*Itinsaites*) *crickmayi* (McLearn) (Mesozoic locs. 29413, 29790)
cf. *N.* (*I.*) *crickmayi* (McLearn) (Mesozoic loc. 25692)
(I.) sp. (Mesozoic loc. 26777)
cf. *N.* (*Epalxites*) *anceps* (Quenstedt) (Mesozoic loc. 29413)
Stephanoceras cf. *S. nodosum* (Quenstedt) (Lupher's loc. 28)
sp. *A* (Mesozoic loc. 25818)
(*Skirroceras*) *kirschneri* Imlay (Lupher's loc. 55, Mesozoic loc. 29790)
cf. *S.* (*S.*) *kirschneri* Imlay (Lupher's loc. 28, Mesozoic loc. 29792)
aff. *S.* (*S.*) *juhlei* Imlay (Mesozoic loc. 29413
cf. *S.* (*S.*) *juhlei* Imlay (Vigrass' loc. 242)
S. (*S.*) sp. (Lupher's loc. 28, 56, Mesozoic locs. 26771, 26777, 29415)
Stemmatoceras? sp. (Lupher's loc. 28)
Leptosphinctes cf. *L. leptus* Buckman (Lupher's loc. 28)

The middle assemblage in the Seneca area differs from the lower assemblage in containing an association of *Chondroceras allani* (McLearn), *Normannites orbignyi* Buckman, *N. crickmayi* (McLearn), *Stephanoceras kirschneri* Imlay, and *Poecilomorphus varius* Imlay, n. sp. and in lacking *Dorsetensia*, *Witchellia*, *Sonninia*. *S.* (*Papilliceras*), *Asthenoceras*, and *Pelekodites*. In these respects it is identical with a faunule that occurs above the range of *Dorsetensia* in the upper part of the Basey Member of the Snowshoe Formation in the Suplee area and, for the same reasons, is correlated with the upper part part of the *Stephanoceras humphriesianum* zone. Additional evidence that the middle assemblage correlates with the upper part of that zone, or perhaps in part with the basal upper Bajocian, is indicated by the presence at Lupher's locality 28 of single specimens of *Megasphaeroceras* and *Leptosphinctes* both of which normally occur in beds of late Bajocian age (Imlay, 1962, p. A2, A9–A11; 1967, p. 26, 59). Their presence could mean that those genera have a longer range in Oregon than is known elsewhere, or that the middle assemblage is actually of early late Bajocian age, or that the highest part of the 250 feet of shale at Lupher's locality 28 is of late Bajocian age.

At present the last possibility is favored because the faunal evidence is strongly indicative of correlation with the *Stephanoceras humphriesianum* zone. Also, recent collections (Mesozoic locs. 29790 and 29792) made below the upper 25 feet of the shale sequence of Lupher's locality 28 contained nearly all the genera and species found by Lupher and his students except *Leptosphinctes* and *Megasphaeroceras*. These two genera could very well have been obtained from the highest 25 feet, which is now mostly covered by talus.

The highest ammonite assemblage found in the Seneca area has been identified only near and west of the town of Seneca along the south side of Bear Valley. The ammonites present are listed as follows:

Spiroceras bifurcatum (Quenstedt) (Mesozoic locs. 28017, 28022, 29232, 29234)
  annulatum (Deshayes) (Mesozoic locs. 28018, 29232)
  cf. *S. annulatum* (Deshayes) (Mesozoic loc. 29236)
  sp. (Mesozoic loc. 25824)
Sphaeroceras cf. *S. brongniarti* (J. de C. Sowerby) Mesozoic locs. 28017, 28018, 29236)
Normannites aff. *N. orbignyi* Buckman (Mesozoic locs. 25821, 28020, 29231, 29232)
  cf. *N.* (*Itinsaites*) *crickmayi* (McLearn) (Mesozoic loc. 25824)
Stephanoceras sp. D. (Mesozoic loc. 28020)
  sp. C (Mesozoic loc. 29231)
  sp. (Lupher's loc. 5; Mesozoic locs. 25817, 28019–28021, 29235)
  cf. *S.* (*Skirroceras*) *kirschneri* Imlay (Lupher's loc. 30)
  cf. *S.* (*S.*) *juhlei* Imlay (Lupher's loc. 30)
Teloceras? sp. (Lupher's loc. 30)
Zemistephanus? cf. *Z. richardsoni* (Whiteaves) (Lupher's loc. 30)
Lupherites senecaensis Imlay, n. sp. (Lupher's loc. 30)
Leptosphinctes cf. *L. evolutus* Imlay (Lupher's loc. 30)
  (*Prorsisphinctes*) spp. juv. (Lupher's loc. 30)

Inspection of this list shows that two ammonite faunules are present. One of these is represented by Lupher's locality 30 and the other by the remainder of the localities. The faunule at Lupher's locality 30 is characterized by the new genus *Lupherites* in association with *Stephanoceras*, *Teloceras*?, *Zemistephanus*?, *Leptosphinctes*, and its subgenus *Prorsisphinctes*. An early late Bajocian age is indicated by the presence of the last two taxa and by the geographic position of Lupher's locality 30 within an area that has furnished *Spiroceras*. The locality, however, is on the north side of a minor syncline, as shown on an unpublished map by C. I. Trantham, and may be slightly lower stratigraphically than the beds containing *Spiroceras*. Also, the presence of an ammonite resembling *Zemistephanus* suggests an age older than late Bajocian.

The other faunule, at the top of the Jurassic sequence near Seneca, is definitely of late Bajocian age as shown by the presence of *Spiroceras bifurcatum* (Quenstedt), which in Eurasia and Africa is characteristic of the lower and middle parts of the upper Bajocian sequence (Arkell, 1952b, p. 296). This age determination is not contradicted by the presence of *Sphaeroceras*, *Normannites*, and *Stephanoceras* which in those continents range upward from the lower Bajocian into the lower to middle parts of the upper Bajocian (Westermann, 1956a, p. 24–35; Arkell, 1952a, p. 77; Arkell, 1956, p. 32, 50, 63, 99, 100, 122, 142, 176, 232, 262–264, 278, 300, 483; Pavia, 1969, p. 445–451). Also, the species described herein as *Normannites* aff. *N. orbignyi* Buckman and *Stephanoceras sp.* C and D are normal associates of *Spiroceras* and *Leptosphinctes* farther east in Oregon in the Juniper Mountain area.

Bearing on the ages of both the middle and the upper ammonite assemblages in the Seneca area are some ammonites (Lupher's locs. 8, 135, 136) collected about half a mile south of Seneca from a conglomeratic sandstone sequence about 40 feet thick that caps a ridge on the east side of the road. The conglomeratic sandstone lies north of and rests sharply on about 250 feet of shale (Lupher's loc. 28) exposed in a roadcut. The fossils, obtained mostly from talus but partly in situ, are preserved as molds in hard, noncalcareous grayish-brown pebbly sandstone. Two specimens, however, representing *Lupherites* and *Poecilomorphus* are preserved in a matrix of grayish-yellow siltstone. Most fossils appear to be reworked as pebbles from the underlying Snowshoe Formation, according to Lupher (1941, p. 262), and such a source seems reasonable to the writer.

The fossils obtained from the conglomeratic sandstone are listed as follows:

Oppelia cf. *O. subradiata* (J. de C. Sowerby) (Lupher's loc. 8)

Chondroceras sp. (Lupher's locs. 8 and 135)
Poecilomorphus varius Imlay, n. sp. (Lupher's loc. 136)
Normannites cf. *N. quenstedti* Roche (Lupher's loc. 8)
Stephanoceras spp. (Lupher's loc. 8)
Stemmatoceras aff. *S. albertense* McLearn (Lupher's loc. 8)
Lupherites senecaensis Imlay, n. sp. (Lupher's loc. 8)
Sphaeroceras cf. *S. brongniarti* (J. de C. Sowerby) (Lupher's loc. 8).

Some of these fossils, such as *Chondroceras*, *Stephanoceras*, and *Poecilomorphus*, could be derived from concretions or nodules from the underlying shale. Most of the others could be derived from nearby beds. The presence of a single specimen of *Lupherites* suggests an origin from the beds represented by Lupher's locality 30 just southwest of Seneca. The absence of *Spiroceras*, *Sphaeroceras*, and *Leptosphinctes* suggests that none of the ammonites were derived from the highest Bajocian beds exposed near Seneca. The absence of such genera could also be explained by simple collection failure, considering that only about 30 specimens were found.

From the above discussion it is assumed that the fossils from Lupher's localities 8, 135, and 136 were derived by erosion of beds older than the conglomeratic sandstone. If the fossils were not derived, however, then their age would probably be early late Bajocian as indicated by the presence of *Lupherites*, which occurs with *Leptosphinctes* at Lupher's locality 30, and by the fact that the underlying shale, Lupher's locality 28, has furnished both *Leptosphinctes* and *Megasphaeroceras*.

SNOWSHOE FORMATION IN THE EMIGRANT CREEK AREA

A few ammonites obtained north of Emigrant Creek in secs. 33 and 34, T. 20 S., R. 28 E., in the Sawtooth Creek quadrangle, are listed as follows:

Poecilomorphus? sp. (Mesozoic loc. 26772)
Chondroceras allani (McLearn) (Mesozoic loc. 26770)
sp. (Mesozoic locs. 26772, 29410)
Normannites orbignyi Buckman (Mesozoic locs. 26772, 27579)
(*Itinsaites*) *crickmayi* (McLearn) (Mesozoic locs. 26770, 26772, 29410)
Stephanoceras (*Skirroceras*) *kirschneri* Imlay (Mesozoic locs. 26770, 26772, 29410)
(*S.*) sp. (Mesozoic loc. 27579)
Teloceras itinsae McLearn (Mesozoic locs. 26770, 29410)
Zemistephanus? cf. *Z. richardsoni* (Whiteaves) (Mesozoic loc. 29410).

This faunule contains the same ammonite species that occur in the middle ammonite assemblage in the Seneca area and at the top of the Basey Member in the Suplee area. It also contains *Teloceras itinsae* McLearn and fragments suggestive of *Zemistephanus richardsoni* Whiteaves. Most of the species present occur also in the Fitz Creek Siltstone on the northwest side of Cook Inlet, Alaska (Imlay, 1964a, p. B12–B14). Correlation of the beds containing these ammonites with the European zone of *Stephanoceras humphriesianum* is shown by the association of *Teloceras*, *Normannites*, and *Chondroceras* and by the absence of genera characteristic of higher or lower zones. Correlation with only the upper part of that zone is favored by the absence of *Dorsetensia*, as in the middle ammonite assemblage near Seneca and in the top beds of the Basey Member in the Suplee area.

BAJOCIAN BEDS IN CLOVER CREEK AREA

The Middle Jurassic fossils from Rail Canyon (Mesozoic loc. 27393) in the Clover Creek drainage of the Ironside Mountain quadrangle are poorly preserved and cannot be identified generically with much assurance. Nonetheless, two large external molds probably represent *Stephanoceras*, two moderate-sized specimens suggest *Parabigotites*, and several small keeled ammonites could represent *Witchellia*. Overall the faunule resmbles that of the Warm Springs Member of the Snowshoe Formation in the Suplee area and probably is of the same general age.

The other ammonite faunule, obtained 5 miles to the east on the Duncan Ranch (Mesozoic loc. 28387), may be correlated much more exactly because it contains the ammonites *Fontannesia* cf. *F. luculenta* Buckman and *Asthenoceras delicatum* Imlay, n. sp. Of these, *Fontannesia* in Europe has been found only in the lower part of the *Sonninia sowerbyi* zone and *Asthenoceras* has been found only in the *Ludwigia murchisonae* zone (Buckman, 1889, p. 214). In eastern Oregon, *Fontannesia* has been found elsewhere mainly near Suplee in beds that correlate with the lower part of the *S. sowerbyi* zone, whereas *Asthenoceras* ranges through beds that are correlated with the entire *Sonninia sowerbyi* zone and the *Otoites sauzei* zone.

BAJOCIAN BEDS IN JUNIPER MOUNTAIN AREA

In the Juniper Mountain area the lower Bajocian (Aalenian) is represented by *Tmetoceras scissum* (Benecke) (Mesozoic locs. 28374 and 28373) found in the SW. cor., sec. 5, T. 16 S., R. 41 E. To the southwest, nearly along the strike, in the NE¼ sec. 7, were found ammonites that furnish a correlation with the lower part of the *Sonninia sowerbyi* zone of Europe and with the middle and upper parts of the Weberg Member of the Snowshoe Formation in the Suplee area. These include *Fontannesia* cf. *F. luculenta* Buckman, *Asthenoceras delicatum* Imlay, n. sp., *Eudmetoceras* sp., and *Docidoceras*? sp. juv. (Mesozoic locs. 28380 and 28381). About 800 to 1,000 feet higher stratigraphically were found fragments of *Stephanoceras* (Mesozoic loc. 28232) which could represent the upper part of the

Sonninia sowerbyi zone or even higher Bajocian. Still another 800 to 1,000 feet higher and about 300 feet north of Pole Creek in the northwest quarter of sec. 5, were found ammonites of early late Bajocian age (Mesozoic locs. 28649, 28650). Such an age is indicated by the association of *Spiroceras*, *Leptosphinctes* (*Prorsisphinctes*), *Normannites*, and *Stephanoceras*. This faunule is the same as found at the top of the Jurassic sequence near Seneca, Oreg., as discussed previously.

BAJOCIAN BEDS IN HUNTINGTON AREA

Middle Jurassic ammonites have been found at three places in the Huntington quadrangle, two near its center and one in its southwestern part. One of these occurrences is of early Bajocian (Aalenian) age as shown by the presence of *Tmetoceras scissum* (Benecke) Mesozoic loc. 29784). One is probably of early late Bajocian age, as shown by the association of *Stephanoceras* and *Lupherites*, n. gen. (Mesozoic loc. 29111) and by the presence of *Spiroceras* (Mesozoic loc. 29782). These genera have been found in association elsewhere only near Seneca, Oreg. (Lupher's loc. 30) in a sequence that contains *Spiroceras*, *Leptosphinctes*, *Stephanoceras*, and *Normannites*, as discussed previously. In addition to these occurrences, the Middle Jurassic is probably represented by an ammonite (Mesozoic loc. 27583) identical with *Tmetoceras* in side view, found in the Bridgeport quadrangle.

COMPARISONS WITH OTHER FAUNAS

SOUTHERN ALASKA

During the Bajocian, the ammonite succession in southern Alaska greatly resembled that in eastern Oregon at certain times and differed appreciably at other times (fig. 5 and table 3). The only ammonites the two areas had in common during early Bajocian (Aalenian) time were *Tmetoceras scissum* (Benecke) and the subgenus *Eudmetoceras* (*Euaptetoceras*) (Westermann, 1964a, text-fig. 5 opposite p. 344). During the time corresponding to the lower part of the *Sonninia sowerbyi* zone (early middle Bajocian), the areas had no ammonite species in common, unless represented by specimens of *Hebetoxyites* and *Asthenoceras*, and each area had many ammonite genera and subgenera not found in the other area. In contrast, during most of the remainder of the middle Bajocian, both areas had essentially the same ammonite genera and subgenera and some identical species occurring in the same stratigraphic order. Finally, in both areas, the highest ammonite assemblages, corresponding to the early late Bajocian, had some genera and species in common but are a little less similar than are the assemblages in the underlying beds.

TABLE 3.—*Comparisons of Bajocian ammonites in eastern Oregon and southern Alaska*

European zones	Taxa represented by identical or similar species	Taxa differences with southern Alaska
Parkinsonia parkinsoni	Not identified	
Garantiana garantiana		
Strenoceras subfurcatum	*Megasphaeroceras*, *Leptosphinctes*, and *L.* (*Prorsisphinctes*)	Absence of *Lissoceras* and *Liroxyites*. Abundance of *Spiroceras* and *Sphaeroceras*
Stephanoceras humphriesianum	*Chondroceras*, *Normannites*, *Stephanoceras*, and *Teloceras*	Presence of *Sphaeroceras*, *Poecilomorphus*, and *Dorsetensia*
Otoites sauzei	*Stephanoceras*, *Witchellia*, *Papilliceras*, and *Otoites* *Normannites* *Parabigotites*	Absence of *Bradfordia*, *Labyrinthoceras*, and *Eudmetoceras*
Sonninia sowerbyi (upper and middle parts)		Absence of *Alaskoceras*, *Pseudolioceras*, and *Pseudotoites*
Sonninia sowerbyi (lower part)	*Asthenoceras*, *Euaptetoceras*, *Docidoceras*, and *Hebetoxyites*	Presence of *Papilliceras*, *Fontannesia*, *Latiwitchellia*, *Strigoceras*, *Praestrigites*, and *Stephanoceras*
Graphoceras concavum	*Tmetoceras*	Absence of *Erycitoides*, *Erycites*, and *Pseudolioceras*
Ludwigia murchisonae	-----do-------	
	?	?
Tmetoceras scissum		
Leioceras opalinum	Not identified	

Overall, the affinities of the Bajocian ammonites in southern Alaska are close with Bajocian ammonites in eastern Oregon except for ammonites for the time represented by the lower part of the *Sonninia sowerbyi* zone. Definite comparisons cannot be made, however, for the times represented by the upper part of the *Sonninia sowerbyi* zone and the lower part of the *Stephanoceras humphriesianum* zone because beds of those ages in Alaska have furnished few ammonites (Imlay, 1964a, p. B9, B12–B15; Westermann, 1969, p. 17–22). For example, at Wide Bay on the Alaska Peninsula, some of the *Sonninia sowerbyi* zone could be represented by 240–300 feet (80–100 m) of unfossiliferous shale and sandstone that overlie beds characterized by *Witchellia sutneroides* Westermann (1969, p. 21) and underlie the lowest beds characterized by ammonites of the *Otoites sauzei* zone (Imlay, 1964a, p. B18; Westermann, 1969, p. 22).

These faunal identities and close similarities between the Bajocian ammonite successions in southern Alaska and Oregon permit fairly accurate correlations of lithologic units between the two areas. Thus, for the Wide Bay area, Alaska (Westermann, 1969, p. 15–22), the lowest exposed beds characterized by *Erycitoides howelli* (White) are equivalent to the *Tmetoceras*-bearing beds in the lower part of the Weberg Member of the Snowshoe Formation. The overlying beds characterized by *Eudmetoceras amplectens* Buckman and *Sonninia* (*Euhoploceras*) *bifurcata* Westermann are correlated with the basal subzone of the European *Sonninia sowerbyi* zone (Westermann, 1969, p. 20, 22) and are equivalent to the middle and upper parts of the Weberg Member. The next higher beds characterized by *Witchellia sutneroides* Westermann are correlated by that author (1969, p. 21, 22, 26) with either or both of the European subzones of *Sonninia trigonalis* and *Witchellia laeviuscula*. They should be equivalent, therefore, to the lower part of the Warm Springs Member of the Snowshoe Formation in Oregon, and probably also to transitional beds between the Weberg and Warm Springs Members.

The highest Bajocian beds at Wide Bay characterized by *Parabigotites crassicostatus* Imlay (Imlay, 1964a, p. B18; Westermann, 1969, p. 22) in association with such genera as *Eudmetoceras*, *Bradfordia*, *Otoites*, *Stephanoceras*, *Stemmatoceras*, *Dorsetensia*, and *Arkelloceras* provide a correlation with the European *Otoites sauzei* zone and with the middle and upper parts of the Warm Springs Member of the Snowshoe Formation in eastern Oregon. Positive correlation with those parts of the member is furnished by the presence of *Parabigotites crassicostatus* Imlay. That taxon, however, both in Oregon and in the Cook Inlet region, Alaska, does not range to the top of the beds that are correlated with the *Otoites sauzei* zone.

Correlation of formations of Bajocian age on the northwest side of Cook Inlet with lithologic units of that age in eastern Oregon is shown in figure 1. Evidence for correlating the lower part of the Red Glacier Formation with the lower part of the Snowshoe Formation is furnished by the presence of *Tmetoceras*, of early Bajocian age. Younger Bajocian, probably correlative with the basal subzone of the European *Sonninia sowerbyi* zone, is represented by *Sonninia* (*Euhoploceras*) *bifurcata* Westermann (1969, p. 94, pls. 23–26; Imlay, 1964a, p. B33, pl. 4, figs. 10, 11) and *Docidoceras?* cf. *D.? paucinodosum* Westermann (1969, p. 153, pl. 43, figs. 2a, b, pl. 44, figs. 1, 2) (see pl. 38, figs. 10, 11 this report). These were obtained about 1,200 feet below the top of the Red Glacier Formation on the south shore of Chinitna Bay (Mesozoic loc. 21293).

The next higher ammonite faunule north of Cook Inlet is characterized by *Parabigotites crassicostatus* Imlay and occurs in the upper part but not at the very top of the Red Glacier Formation (Imlay, 1964a, p. B6, B10–B12). For example, on the south shore of Chinitna Bay, *P. crassicostatus* Imlay occurs from 300 to 850 feet below the top of the formation, and its lowest occurrence (Mesozoic loc. 19966) is only 350 feet above *Sonninia* (*Euhoploceras*) *bifurcata* Westermann (Mesozoic loc. 21293). Within this range below the top of the formation occur *Stemmatoceras* n. sp., *Witchellia?* and *Normannites?* cf. N. *kialagvikensis* Imlay at 350 to 360 feet (Mesozoic loc. 21296); *Sonninia* (*Papilliceras*) cf. *S.* (*P.*) *arenata* (Quenstedt) at 630 feet (Mesozoic loc. 19964); *Dorsetensia adnata* (Imlay) at 725 to 775 feet (Mesozoic loc. 19956); and *Stemmatoceras* and *Stephanoceras* at 850 feet (Mesozoic loc. 19966).

The *Parabigotites crassicostatus* faunule on the south shore of Tuxedni Bay has been identified by ammonites collected from 480 feet to at least 700 feet below the top of the Red Glacier Formation. These include *P. crassicostatus* Imlay, its possible dimorph *Normannites? kialagvikensis* Imlay, *Otoites* cf. *O. contractus* (J. de C. Sowerby), and species of *Emileia*, *Stemmatoceras* and *Dorsetensia*.

Correlation of the upper part of the Red Glacier Formation that contains the above listed faunule with the middle and upper parts of the Warm Springs Member is shown by the association of *Parabigotites crassicostatus* Imlay with *Dorsetensia*, *Sonninia*, *S.* (*Papilliceras*), *Emileia*, and *Otoites*. The presence of the last three taxa show that the beds are not younger than the European *Otoites sauzei* zone.

The highest few hundred feet of the Red Glacier Formation on the north side of Cook Inlet contains the ammonites *Sonninia tuxedniensis* Imlay, *Normannites* (*Itinsaites*) *crickmayi* (McLearn), *Stephanoceras* cf. *S. nodosum* (Quenstedt), and *S.* (*Skirroceras*) *kirschneri* Imlay. This faunule is correlated with the European *Otoites sauzei* zone because of the presence of *Sonninia* and because the basal 150 feet of the overlying Gaikema Sandstone contains *Sonninia* (*Papilliceras*) and *Emileia*, taxa not known above that zone. Correlation with the upper part of that zone is indicated by stratigraphic position and by the present of *Normannites*.

The lower fourth of the Fitz Creek Siltstone, overlying the Gaikema Sandstone, has furnished few ammonites, and those do not permit a precise age determination. The upper three fourths, however, has furnished many species of the genera *Chondroceras*, *Normannites*, *Stephanoceras*, *Stemmatoceras* and *Teloceras*, which in association are excellent evidence for correlation with the European zone of *Stephanoceras humphriesianum* (Imlay, 1964 a, p. B12–B14). Furthermore, this ammonite faunule contains some of the same species as occur in eastern Oregon in certain units of the Snowshoe Formation. Thus species in common occur in the upper part of the Basey Member in the Suplee area, the middle member in the Izee area, in the middle part of the Snowshoe Formation in the Seneca area, and in some beds just north of Emigrant Creek in the Sawtooth Creek quadrangle, as discussed in detail herein. These species include *Chondroceras allani* (McLearn), *Normannites* (*Itinsatites*) *crickmayi* (McLearn), *Stephanoceras* (*Skirroceras*) *kirschneri* Imlay, *Teloceras itinsae* (McLearn). They probably also include *Normannites* (*Itinsaites*) *itinsae* (McLearn), and *Zemistephanus richardsoni* (Whiteaves).

The overlying Cynthia Falls Sandstone north of Cook Inlet contains ammonite genera and species (Imlay, 1964a, p. B14) in common with those of the Fitz Creek Siltstone and similarly is correlated with the *Stephanoceras humphriesianum* zone. Its. stratigraphic position shows, however, that it belongs to the very top of that zone.

The highest beds of Bajocian age north of Cook Inlet are included in the Twist Creek Siltstone (Detterman and Hartsock, 1966, p. 34) and are characterized by the ammonites *Spiroceras?*, *Lissoceras*, *Oppelia* (*Liroxyites*), *Normannites*, *Megasphaeroceras*, *Sphaeroceras*, *Leptosphinctes*, and *L.* (*Prorsisphinctes*) (Imlay, 1962). An early late Bajocian age is shown by the association of *Normannites* with *Spiroceras?* and *Leptophinctes*. Most of these genera occur likewise in eastern Oregon in the highest part of the Snowshoe Formation near Seneca and at the top of a Bajocian sequence in the Juniper Mountains south of Brogan.

In the Talkeetna Mountains of southern Alaska, the Tuxedni Formation has yielded ammonites of early to late Bajocian age as previously discussed (Imlay, 1962, p. A2, A6; 1964a, p. B9, B10, B14, B18, B27). Restudy of several collections, however, has furnished information of age significance.

First, from the basal part of the Tuxedni Formation was obtained *Asthenoceras cf. A. delicatum Imlay*, n. sp. (pl. 4, figs. 1, 2, this report) (Mesozoic loc. 24137), which, considering the range of *A. delicatum* in Oregon, could represent any part of the *Sonninia sowerbyi* or *Otoites sauzei* zones.

Second, from somewhat higher in the formation was obtained an ammonite (Imlay, 1964a, p. B33, pl. 4, figs. 5, 6, 12) that was identified by Westermann (1969, p. 94) with *Sonninia* (*Euhoploceras*) *bifurcata* Westermann from the Alaska Penninsula and assigned by him (1969, p. 22) to the basal subzone of the *Sonninia sowerbyi* zone.

Third, from a unknown stratigraphic position in the Tuxedni Formation were obtained (Mesozoic loc. 24120) the ammonites *Planammatoceras* cf. P. *benneri* (Hoffman), (Westermann, 1969, p. 24, 90; Imlay, 1964a, p. B33, pl. 3, figs. 2–4), *Sonninia* (*Alaskoceras*) cf. *S.* (*A.*) *alaskensis* Westermann (1969, p. 24, 103; Imlay, 1964a, p. B33, pl. 2, figs. 1, 2), *Stephanoceras* (*Skirroceras*) *nelchinanum Imlay* (1964a, p. B46, pl. 15, figs. 1, 3, 4–6, pl. 16, fig. 2), and *Stephanoceras* (*Skirroceras*) *juhlei* Imlay (1964a, p. B47, pl. 16, figs. 1, 5, 6). This association puzzled Westermann (1969, p. 24) because the first two species occur on the Alaska Peninsula with other ammonites characteristic of the basal subzone of the *Sonninia sowerbyi* zone, whereas *Skirroceras* in Europe is typical of the appreciably younger *Otoites sauzei zone*. He suggested, therefore, that the specimens of *Stephanoceras* may have been collected from a higher bed than the other ammonites (Westermann, 1969, p. 92). Nonetheless the association may be normal because in eastern Oregon the lowest occurrence of *S.* (*S.*) *juhlei* Imlay in the topmost bed of the Weberg Member can be only slightly younger than the basal subzone of the *Sonninia sowerbyi* zone.

Most of the Bajocian ammonites from the Talkeetna Mountains represent an assemblage characterized by *Parabigotites crassicostatus* Imlay (1964a, p. B54, pl. 29) in association with such ammonites as *Eudmetoceras*, *Sonninia* (*Papilliceras*), *Witchellia*, *Pelekodites*, *Bradfordia*, *Otoites*, *Labyrinthoceras* and *Stephanoceras*. Of these *Parabigotites*, *S.* (*Papilliceras*), *Witchellia*, and *Stephanoceras* are represented by identical or probably identical species in the Warm Springs Member of the Snowshoe Formation in eastern Oregon.

BRITISH COLUMBIA AND ALBERTA

Ammonites of early Middle Jurassic (Bajocian) age from western British Columbia have been described and correlated in detail by Frebold (1964) and Frebold, Tipper, and Coates (1969) and their age significance has been discussed briefly by Imlay (1964a, p. B19) and Westermann (1969, p. 24–26). Overall they bear close resemblances specifically and stratigraphically to Bajocian ammonites in Alaska and Oregon.

The lower Bajocian (Aalenian) is represented by *Tmetoceras* and *Erycites* (equals *Erycitoides* of Westermann, 1964a, p. 358) in three areas in southwestern British Columbia (Frebold, 1951; in Frebold and others, 1969, p. 21, 24, 25, fig. 1 opposite p. 1). Correlation with the lower part of the Kialagvik Formation on Wide Bay, Alaskan Peninsula, is furnished by the species present.

Lower middle Bajocian ammonites, probably representing *Sonninia* and *Witchellia*, have been found on Hudson Bay Mountain in west-central British Columbia (McLearn, 1926; Westermann, 1969, p. 24, 25). Two of these, *Sonninites silveria* McLearn (1926, p. 96, pl. 24, fig. 3) and *S. skawaki* McLearn (1926, p. 97, pl. 24, figs. 1, 2) resemble and possibly belong to the new subgenus *Witchellia* (*Latiwitchellia*) described herein. One of the ammonites, *Guhsania belle* McLearn (1926, p. 98, pl. 25, fig. 1) could be related to the subgenus *Sonninia* (*Papilliceras*), as suggested by Westermann (1969, p. 24). Another ammonite, *Sonninites hansoni* McLearn (1926, p. 95, pl. 23, figs. 2, 3) could be interpreted as a much worn specimen of *S.* (*E.*) *modesta* Buckman, as suggested by its vertical umbilical wall, abrupt umbilical edge, and the fine ribbing on its inner whorls. Overall, this ammonite faunule from Hudson Bay Mountain resembles the faunule in the upper part of the Weberg Member and is probably of the same age.

Another ammonite faunule, represented by *Sonninia*, has been collected in the Rocky Mountains near Lake Minnewanka in southwestern Alberta. It consists of a few poorly preserved ammonites that have been identified as *Sonninia* spp. undet. (Frebold, 1957, p. 48, 49, pl. 19, figs. 2a, b, pl. 20) and *Sonninia gracilis* (Whiteaves) (Frebold, 1957, p. 48, pl. 19, figs. 1a, b) and have been correlated with the *Sonninia sowerbyi* zone by Frebold (1957, p. 13; 1964, table 1 opposite p. 24). The same ammonites have been assigned to *Witchellia*, *Sonninia* (*Euhoploceras*) and questionably to *S.* (*Alaskoceras*) by Westermann (1969, p. 26, 94, 99, 107).

No faunal evidence has been found in western Canada for the presence of beds equivalent to the European *Otoites sauzei* zone or the *Parabigotites crassicostatus* ammonite faunule of southern Alaska and eastern Oregon. Furthermore, the possibility that the *sauzei* zone is represented in the Manning Park area, British Columbia, by an association of *Zemistephanus richardsoni* (Whiteaves) and *Graphoceras crickmayi* Frebold, as suggested by Frebold (in Frebold and others, 1969, p. 18, 22, 25, 26, 32, 33, 35, pl. 2) seems most unlikely, considering the range of *Zemistephanus* in Alaska (Imlay, 1964a, p. B15, B16, B51 and B52), and the range of *Graphoceras* in Europe (Arkell, 1956, p. 33).

Ammonites representing the European *Stephanoceras humphriesianum* zone are widespread in British Columbia and Alberta. (See references to McLearn, Warren, and Frebold in Imlay, 1964a, p. B19.) This correlation is based on the association of *Teloceras*, *Stemmatoceras*, *Stephanoceras*, *Normannites* and *Chondroceras* which are common in that zone in Europe. It is based also on the absence of such taxa as *Witchellia*, *Papilliceras*, *Otoites*, *Emileia* and *Labryinthoceras* which are characteristic of the underlying *Otoites sauzei* zone in Europe and of the *Parabigotites crassicostatus* faunule in southern Alaska and eastern Oregon.

WESTERN INTERIOR OF THE UNITED STATES

Marine Jurassic beds equivalent to the European *Stephanoceras humphriesianum* zone have been identified in the western interior of the United States only in northwestern Montana. The evidence consists of an association of *Chondroceras* and *Stemmatoceras* near the base of the Jurassic (Imlay, 1967, p. 34, 59, 90–94, pl. 6, figs. 1–3, 7, 8, pl. 7, figs. 1–13, pl. 8, pl. 9, pl. 12, figs. 1–4). The resemblance of the single specimen of *Chondroceras* present to *C. allani* (McLearn) indicates correlation with the highest known Bajocian beds in Canada, with the topmost part of the Basey Member of the Snowshoe Formation in the Suplee area, Oreg., and with equivalent beds near Seneca, Oreg.

Basal upper Bajocian beds, apparently equivalent to the European *Strenoceras subfurcatum* zone, occur near the base of the Twin Creek Limestone in southeastern Idaho, western Wyoming, and northern Utah (Imlay, 1967, p. 28, 61). The age evidence consists of an association of *Stephanoceras*, *Stemmatoceras*, *Megasphaeroceras* and *Spiroceras* (Imlay, 1967, p. 88–91, 96, 97). Derivation of this faunule from a transgression of the Pacific Ocean is shown by the presence of identical to similar ammonites in eastern Oregon, in the highest Bajocian rocks exposed near Seneca and on Juniper Mountain south of Brogan.

NORTHERN CALIFORNIA

From the Mormon Sandstone near Taylorsville (fig. 1) in the Sierra Nevada have been obtained a few ammonites that constitute excellent evidence for correlation with the European zone of *Otoites sauzei* and with the Warm Springs Member of the Snowshoe Formation in eastern Oregon. These correlations are based mainly on the occurrence of the subgenus *Sonninia* (*Papilliceras*) at several levels and particularly the species *S.* (*P.*) *stantoni* Crickmay in the lower part of the formation. The ammonites and their faunal units as described by Crickmay (1933, p. 898, 899, 908–913) are listed from top to bottom as follows:

Papilliceras juramontanum Crickmay (unit 8)
Holcophylloceras falciferum Crickmay (unit 7)
Papilliceras blackwelderi Crickmay (unit 7)
Otoites reesidei Crickmay (unit 7)
Chondroceras russelli Crickmay (unit 7)
Papilliceras stantoni Crickmay (unit 5)
Stiphromorphites schucherti Crickmay (unit 4)

The above listed species of *Papilliceras* are identical, or probably identical, with species in the Warm Springs Member of the Snowshoe Formation in eastern Oregon. *Sonninia* (*Papilliceras*) *juramontanum* (Crickmay) (1933, p. 911, pl. 311) is probably represented at Lupher's locality 206. *S.* (*P.*) *blackwelderi* Crickmay (1933, p. 911, pl. 30, figs. 1–4) is probably identical with *S.* (*P.*) cf. *S.* (*P.*) *arenata* (Quenstedt) from the upper part of the member at USGS Mesozoic loc. 29241. *S.*

(*P.*) *stantoni* Crickmay (1933, p. 910, pl. 29, figs. 1, 2, pl. 32, fig. 1) occurs throughout the Warm Springs Member as well as in beds transitional with the underlying Weberg Member.

Of the ammonites listed from faunal unit 7 of Crickmay (1933, p. 898), *Holcophylloceras* is of no age value and *Chondroceras russelli* Crickmay (1933, p. 913, pl. 27, figs. 6–8) is not generically determinable. *Otoites reesidei* Crickmay (1933, p. 912, pl. 27, figs. 9–11), now assigned to *Normannites*, is of stratigraphic significance however, because it is closely similar to the holotype of *N. braikenridgii* (J. de C. Sowerby) Buckman, 1913, pl. 81; Westermann, 1954, pl. 9, figs. 1–3) which appears to be restricted to the upper part of the *Otoites sauzei* zone (Davies, in Buckman, 1930, p. 34; Westermann, 1954, p. 168). This agrees with the specific comparison and age determination made by Crickmay (1933, p. 898, 912).

The species described as *Stiphromorphites schucherti* Crickmay (1933, p. 909, pl. 28, figs. 1–3) was considered by Westermann (1969, p. 99) to be related to *Sonninia* (*Euhoploceras*) *bifurcata* Westermann (1969, p. 94–101, pls. 23–26) from the Wide Bay area on the Alaskan Peninsula. It appears to differ, however, by lacking tubercles on all exposed whorls, by having rib furcation near the umbilicus instead of above the middle of the flanks, and by the ribs on its outer whorls fading on the margins of the venter. In these respects it shows more resemblance to *Sonninia nodatipinguis* (Buckman) (1923, pl. 398), with which it was compared by Crickmay (1933, p. 910), and to *S. tuxedniensis* Imlay (1964a, p. B32, pl. 2, figs. 5–10) from southern Alaska. If these comparisons are valid, the presence of *S. schucherti* indicates correlation with the *Otoites sauzei zone*, whereas its identification with the subgenus *Euhoploceras* would indicate correlation with the lower part of the *Sonninia sowerbyi* zone.

In addition to these ammonites, one external mold of *Stephanoceras* was collected by Dr. G. E. G. Westermann from the lower part of the upper half of the Mormon Formation and was labeled by him as *Stephanoceras* (*Skirroceras*) *bayleanum* (Oppel). This specimen is nearly identical with *Stephanoceras rhytus* Buckman (1921, pl. 250a,b) from the *Otoites sauzei* zone in England (Davies, in Buckman, 1930, v. 7, p. 34) in its highly evolute coiling and in the fineness and density of its secondary ribs. It likewise closely resembles *S.* (*S.*) *juhlei* Imlay (1964a, B47, pl. 16, figs. 1,3–6, pl. 17) from Alaska and Oregon in ribbing but apparently is a little more evolute. It is slightly finer ribbed than the holotype of *S.* (*S.*) *bayleanum* (Oppel) (d'Orbigny, 1946, pl. 133) from the *Otoites sauzei* zone and is much finer and denser ribbed than the specimens assigned to that species by Fallot and Blanchet (1923, p. 155, pl. 5, figs. 1–3). The close resemblance of this California specimen to *S. juhlei* Imlay suggests that it is a variant of that species and has the same age significance.

EAST-CENTRAL CALIFORNIA

The lower Bajocian (Aalenian) is represented near the middle of the Sailor Canyon Formation by the ammonite *Tmetoceras* in association with the pelecypod *Bositra buchii* (Römer). These were obtained from about 8,500 to 11,000 feet above the base of the formation on the north side of the North Fork of the American River near the center of SE¼ sec. 26 (USGS Mesozoic loc. 28389) and the NW¼ SW¼ sec. 25 (USGS Mesozoic loc. 28388), T. 16 N., R. 13 E., Royal Gorge quadrangle, Placer County, Calif., (L. D. Clark, written commun. September 1970).

SOUTHERN CALIFORNIA

The middle Bajocian is represented in the Bedford Canyon Formation of the Santa Ana Mountains southeast of Los Angeles, by the ammonite *Dorsetensia* in association with some small strongly tuberculate ammonites suggestive of *Teloceras* or *Stemmatoceras* (Imlay, 1964c). The specimens of *Dorsetensia* resemble *D. liostraca* Buckman (1892, pl. 53, figs. 11–16, pl. 55, figs. 4,5; pl. 56, fig. 1) from Europe. They have weaker ribbing than any of the species of *Dorsetensia* from eastern Oregon of a comparable size but are most similar to *D.* cf. *D. subtexta* Buckman, as illustrated herein.

EUROPE

During Bajocian time, the ammonite succession in Europe both resembled and differed from that in eastern Oregon as shown in table 4. The resemblances show clearly that certain genera and species lived at about the same time and in the same order in both areas. The differences, except in the basal *Tmetoceras*-bearing beds, cannot be explained by collection failure because the same, or similar, differences exist between the Bajocian ammonites of Alaska and those of Europe (Imlay, 1962, p. A4; 1964a, p. B21; Westermann, 1969, p. 29–31). Apparently during Bajocian time some faunal differentiation occurred in the Pacific Ocean different from that in the seas of Europe (Imlay, 1965, p. 1024, 1030–1032). Nonetheless the affinities of most of the Bajocian ammonites of Oregon are remarkably close to ammonites of the same age in Europe.

TABLE 4.—*Comparisons of Bajocian ammonites in eastern Oregon and Europe*

European zones	Taxa represented by identical or similar species	Taxa differences with Europe
Parkinsonia parkinsoni	Not identified	
Garantiana garantiana		
Strenoceras subfurcatum	*Spiroceras, Leptosphinctes,* and *Sphaeroceras*	Absence of Parkinsoniidae. Presence of *Megasphaeroceras*
Stephanoceras humphriesianum	*Teloceras, Normannites, Sphaeroceras, Chondroceras, Stephanoceras,* and *Poecilomorphus*	Presence of *Zemistephanus*
Otoites sauzei	*Witchellia, Dorsetensia, Papilliceras, Emileia, Otoites, Stephanoceras, Normannites* and *Pelekodites*	Presence of *Parabigotites* and *Asthenoceras.* Rarity of *Sonninia*
Sonninia sowerbyi (Upper and middle parts)	*Witchellia, Papilliceras,* and *Stephanoceras*	Presence of *Asthenoceras.* Absence of *Shirbuirnia* and *Fissilobiceras*
Sonninia sowerbyi (Lower part)	*Euhoploceras, Fontannesia, Docidoceras, Strigoceras, Praestrigites, Hebetoxyites, Euaptetoceras,* and *Pelekodites*	Absence of *Hyperlioceras.* Presence of *Latiwitchellia, Asthenoceras,* and *Papilliceras*
Graphoceras concavum	*Tmetoceras* and *Praestrigites*	Absence of Graphoceratidae
Ludwigia murchisonae	*Tmetoceras* and tuberculate *Planammatoceras?*	
Tmetoceras scissum		
Leioceras opalinum	Not identified	

The comparisons of Bajocian ammonites between Oregon and Europe apply partly to comparisons of Bajocian ammonites between Alaska and Europe. Thus, most of the Oregon taxa differences with Europe are also taxa differences between Alaska and Europe. Many of the taxa resemblances with Europe apply also between Alaska and Europe. Nonetheless, the affinities of the early middle Bajocian beds in eastern Oregon characterized by *Euhoploceras*, *Fontannesia*, and *Docidoceras* are much stronger with those in Europe than in Alaska. Likewise the affinities of the Oregon late Bajocian beds characterized by *Spiroceras* appear to be stronger with those in Europe. It appears, therefore, that marine connections with Europe at certain times were from the south via Central America or around South America, rather than from the north via Alaska.

PALEOGEOGRAPHIC SETTING

The Bajocian rocks of east-central Oregon were deposited in the western part of a sea that transgressed eastward from the Pacific Coast region far into the western interior of the continent (Imlay, 1967, fig. 13 on p. 54). Deposition of lower Bajocian (Aalenian) beds, identified by *Tmetoceras*, occurred at least as far east as the Snake River in Oregon, as far east as Westgate in west-central Nevada (Corvalán, 1962), and as far east as southwestern British Columbia (Frebold, 1951, pp. 18–20; Frebold and others, 1969, p. 21). Deposition of lower middle Bajocian marine beds, corresponding to the European *Sonninia sowerbyi* zone, occurred as far east as the Snake River area in eastern Oregon and as far east in Canada as southwestern Alberta (Frebold, 1957, p. 48, 49; 1964, p. 2; McLearn, 1926; Frebold and others, 1969, p. 35). Deposition of slightly younger marine beds, corresponding to the European *Stephanoceras humphriesianum* zone, occurred as far east as western Montana and southern Alberta and apparently were replaced farther east and south by red beds and gypsum. Finally the transgression was climaxed by deposition of formal marine upper Bajocian sediments in eastern Oregon as well as throughout the western interior region as far east as the Dakotas and as far south as southwestern Utah (Imlay, 1967, p. 22–35, 59). Failure to find any upper Bajocian fossils in British Columbia (Frebold and others, 1969, p. 16) or in the Rocky Mountains of Alberta (Frebold, 1957, p. 13; 1964, p. 5) indicates that main transgression came from the west rather than through Canada.

The Bajocian rocks of eastern Oregon are part of the western volcanic facies of the Jurassic as described by Dickinson (1962, p. 1243–1247) and consist mostly of clastic volcanic material but locally include submarine lava flows and volcanic breccias. Even the mudstones and claystones, such as represented by the Warm Springs Member in the Suplee area and the lower member of the Snowshoe Formation in the Izee area contain fragments of andesitic rocks (Dickinson and Vigrass, 1965, p. 46, 54). Nonvolcanic sedimentary material includes organic matter, apparently much of the mudstone and siltstone, some thin beds of limestone, and all of the clastic material derived from older nearby sedimentary beds, such as occurs in the Weberg Member of the Snowshoe Formation.

Conditions of deposition, as described by Dickinson and Vigrass (1965, p. 58–60), varied considerably in time and space, depending on the positions of volcanic vents and islands of Triassic or Paleozoic rocks and depending on the rapidity and amount of subsidence of the basins. Unquestionably the Weberg Member of the Snowshoe Formation in the Suplee area was deposited in fairly shallow waters of a sea that was transgressing westward. This is shown by the presence of numerous thick-shelled pelecypods. including *Ostrea* and *Gryphaea*, and by the fact that the basal part of the formation contains younger and younger ammonites from east to west. The lower part of the overlying Warm Springs Member was also deposited in shallow water, as shown by the presence of *Ostrea*.

The remainder of the Warm Springs Member, as well as the lower member of the Snowshoe Formation in the Izee area, were probably deposited in deeper water than was the Weberg Member, as suggested by the absence of benthonic mollusks and by the fact that the sea transgressed westward but the water need not have been deeper than neritic zone depth. Deposition in quiet waters is clearly shown, however, by the homogeneous character of the mudstones and siltstones, the presence of fine laminations in these rocks, and an abundance of well-preserved specimens of the fragile pelecypod *Bositra buchii* (Römer) (equals *Posidonia ornati* (Quenstedt)). As this species probably swam freely (Jefferies and Minton, 1965, p. 156–179), its presence is not an indication of depth.

The clastic volcanic rocks in the Suplee and Izee areas, according to Dickinson and Vigrass (1965, p. 49–51, 54–56, 58–60), were derived from volcanic vents to the east and west. They state that the volcanic materials of the Silvies Member of the Snowshoe Formation were probably deposited by westward-moving turbidity currents, as indicated by the presence of well-sorted graded layers, marked increase in conglomeratic layers eastward, and marked thickening eastward. They state that the Basey Member of the Snowshoe Formation contains well-sorted volcanic sandstone indicative of deposition in shallow agitated waters. Nonetheless the member also contains layers of finely laminated siltstone full of *Bositra* whose presence is indicative of quiet, but not necessarily shallow, waters.

GEOGRAPHIC DISTRIBUTION

The geographic occurrences of the ammonities described herein are shown on plate 48 and tables 5 to 10. Detailed descriptions of the individual localities follow table 10.

TABLE 5.—*Geographic distribution of Bajocian ammonites in the Weberg Member of the Snowshoe Formation in the Suplee area*

[All one- and two-digit numbers refer to localities on pl. 48 *E, F, H*. Other numbers are USGS Mesozoic locality numbers or collector's field numbers]

Species	Grant County																																Crook County				Grant Counyt																										
	Dayville quadrangle																																							Delintment Lake quadrangle																							
	8			9	10									11	13	17		18	19		20				21	22							23	25	28		30	31	32	37		38		39									40	41	43								
	Vigrass 158	26764	27374	Lupher 366	29821	Lupher 207	Lupher 208	Lupher 368	Lupher 411	Lupher 465	Lupher 466	Lupher 467	Lupher 468	29820	29822	Vigrass 155	Lupher 583	Vigrass 130	Vigrass 128	29403	Vigrass 120	Vigrass 121	Vigrass 121a	29404	Lupher 360	Vigrass 123	29402	Lupher 355	Lupher 361	Lupher 363	Lupher 410	Lupher 460	Vigrass 154	Vigrass 216	Vigrass 235	Vigrass 241	26762	Lupher 210	Lupher 212	Vigrass 16	29827	Vigrass 162	Lupher 408	Lupher 350	Lupher 351	Lupher 352	Lupher 353	Lupher 573	Lupher 574	Lupher 575	Lupher 578	Lupher 609	27735	Vigrass 112	21611	21612	21613	26766	29823	29824	29826	Lupher 580	Lupher 581
Phylloceras sp.													X																																																		
Calliphylloceras sp.																																																															
Holcophylloceras sp.																X																						X															X		X								
Asthenoceras delicatum Imlay, n. sp.																																								X	X											X	X	X	X								
? sp.																																																							X								
Fontannesia costula Imlay, n. sp.																																				X																											
intermedia Imlay, n. sp.																							X								X									X																	X	X					
cf. *F. luculenta* Buckman																												X																											X								
cf. *F. carinata* Buckman																							X					X																																X			
cf. *F. evoluta* (Buckman)																							X																																								
Tmetoceras scissum (Benecke)	X	X	X	X	X	X	X		X		X	X		X	X	X	X						X																																								
Eudmetoceras (*Euaptetoceras*) cf. *E.* (*E.*) *hauthali* (Burckhardt)																																																															
cf. *E.* (*E.*) *klimakomphalum* (Vacek)																																																															
cf. *E.* (*E.*) *amaltheiforme* (Vacek)																																																															
sp.						X																																																									
Sonninia (*Euhoploceras*) *modesta* Buckman																					X		X					X								X					X				X															X		X	
dominans Buckman																																	X	X										X								X				X		X			X		
cf. *S.* (*E.*) *dominans* Buckman																						X					X	X		X																									X								
polyacantha (Waagen)																										X			X	X																		X															X
cf. *S.* (*E.*) *polyacantha* (Waagen)																																																										X					
adicra (Waagen)																				X																																											
cf. *S.* (*E.*) *adicra* (Waagen)																																																															
crassispinata Buckman																													X								X										X				X					X		X					
cf. *S.* (*E.*) *crassispinata* Buckman																																																															
(*Papilliceras*) *stantoni* (Crickmay)																																																							X								
cf. *S.* (*P.*) *espinazitensis* Tornquist																					X				X																																						
(*P.*) sp.																																						X		X																							
Witchellia (*Latiwitchellia*) *evoluta* Imlay, n. sp.																			X	X								X	X						X	X				X															X	X		X				X	
Pelekodites webergi Imlay, n. sp.																																																								X		X					
Praestrigites cf. *P. deltotus* (Buckman)				X		X						X																																																			
Strigoceras cf. *S. languidum* (Buckman)																																X																															
sp.																																																										X	X				
Hebetoxyites cf. *H. hebes* Buckman																																																															
Lissoceras sp.																																																															
Docidoceras lupheri Imlay, n. sp.																																											X																				
warmspringsense Imlay, n. sp.																																														X																	
sparsicostatum Imlay, n. sp.								X																															X																								
cf. *D. liebe* Maubeuge																													X																					X													
? sp.				X						X														X																									X														
Stephanoceras aff. *S. nodosum* (Quenstedt)																																										X																					
(*Skirroceras*) *juhlei* Imlay																		X																																													
cf. *S.* (*S.*) *dolichoecus* (Buckman)																																								X		X																					

TABLE 5.—*Geographic distribution of Bajocian ammonites in the Weberg Member of the Showshoe formation in the Suplee area*—Continued

Species	Grant County—Continued																																																													Harney Co.	
	Delintment Lake quadrangle—Continued																																																														
	44			45									47	48	49			50														51			52	53					54	55	58	60		61					62	64	65		67	68	70			71	76	88	
	Lupher 228N	Vigrass 20a	Vigrass 20b	26768	Lupher 228X	Lupher 305	Lupher 307	Lupher 315	Lupher 370	29825	29828	29829	Vigrass 19	Lupher 491	26763	Vigrass 8	Lupher 610	Lupher 224	Lupher 225	Lupher 226	Lupher 228	Lupher 229	Lupher 230	Lupher 248	Lupher 371	Lupher 372	Lupher 373	Lupher 407	Lupher 474	Lupher 475	Lupher 1701	Lupher 584	Lupher 605	Lupher 313	Vigrass 152	Lupher 563	Lupher 238	Lupher 239	Lupher 596	Lupher 228W	Vigrass 15	Lupher 116a	Vigrass 14	Lupher 102	21610	27733	26760	26761	26765	Lupher 306	Vigrass 11	29401	Vigrass 205	Vigrass 237	27581	Lupher 214	Vigrass 3	Vigrass 86	Lupher 103	Vigrass 87	Lupher 108	29400	29817
Phylloceras sp																																																															
Calliphylloceras sp					X																		X									X			X																												
Holcophylloceras sp	X			X																														X																													
Asthenoceras delicatum Imlay, n. sp	X			X		X					X										X								X					X							X									X													
? sp																																																															
Fontannesia costula Imlay, n. sp	X								X		X					X					X											X																															
intermedia Imlay, n. sp	X				X																																	X		X								X					X										
cf. *F. luculenta* Buckman					X																X									X										X						X	X																
cf. *F. carinata* Buckman				X	X															X	X																																										
cf. *F. evoluta* (Buckman)																																																															
Tmetoceras scissum (Benecke)																																																									X						
Eudmetoceras (Euaptetoceras) cf. *E. (E.) hauthali* (Burckhardt).																																																													X	
cf. *E. (E.) klimakomphalum* (Vacek)																																																													X	X
cf. *E. (E.) amaltheiforme* (Vacek)																															X																																
sp																																													X																		
Sonninia (Euhoploceras) modesta Buckman	X		X		X					X	X					X	X				X	X			X	X	X	X				X			X		X			X		X	X						X	X											X		
dominans Buckman	X		X				X						X							X	X	X						X									X			X				X	X					X											X		
cf. *S. (E.) dominans* Buckman					X											X								X					X																																		
polyacantha (Waagen)	X				X				X		X										X		X				X																																				
cf. *S. (E.) polyacantha* (Waagen)												X																																																			
adicra (Waagen)	X							X						X							X																			X									X														
cf. *S. (E.) adicra* (Waagen)																							X																																								
crassispinata Buckman	X		X						X																								X																														
cf. *S. (E.) crassispinata* Buckman					X											X																																															
(Papilliceras) stantoni (Crickmay)																																																															
cf. *S. (P.) espinazitensis* Tornquist															X																																																
(P.) sp																																																															
Witchellia (Latiwitchellia) evoluta Imlay, n. sp	X						X		X		X	X									X				X		X					X			X	X				X																							
Pelekodites webergi Imlay, n. sp									X		X											X							X										X									X					X										
Praestrigites cf. *P. deltotus* (Buckman)	X																																												X																		
Strigoceras cf. *S. languidum* (Buckman)																									X																												X										
sp																																																															
Hebetoxyites cf. *H. hebes* Buckman																			X	X										X		X													X																		
Lissoceras sp																																													X																		
Docidoceras lupheri Imlay, n. sp	X										X										X																																						X				
warmspringsense Imlay, n. sp	X																			X					X																									X													
sparsicostatum Imlay, n. sp										X								X		X																											X				X				X	X		X		X			
cf. *D. liebe* Maubeuge																																																															
? sp		X																																																		X		X									
Stephanoceras aff. *S. nodosum* (Quenstedt)																																																															
(Skirroceras) juhlei Imlay																																																																
cf. *S. (S.) dolichoecus* (Buckman)																																																															

TABLE 6.—*Geographic distribution of Bajocian ammonites in the Warm Springs Member of the Snowshoe Formation in the Suplee area*

[One- and two-digit numbers refer to numbers on pl. 48, *E*, *F*, *H*. Other numbers are USGS Mesozoic locality numbers or collector's field numbers]

	Grant County						Crook County			Grant County																										Harney County					
	Dayville quadrangle								Delintment Lake quadrangle																															
	1	2	12		16	26	29	33	34	42	46		56								57		59	63			66	69	72	73	74	77	78			80	81	82	84	85	89
Species	Vigrass 141	Vigrass 149	29396	29397	29398	Lupher 211	Lupher 206	29241	29810	Lupher 298	Lupher 232	Vigrass 18	Lupher 116	Lupher 237	Lupher 476	Lupher 482	Lupher 560	Lupher 561	Lupher 566	26767	Vigrass 166	27375	Lupher 311	Lupher 316	Vigrass 10	Vigrass 403	Vigrass 168	Dickinson 94	Lupher 235	29399	29239	Dickinson 95	Dickinson 96	Lupher 109	29395	Dickinson 97	29808	29807	Dickinson 98	29805	29240
Holcophylloceras sp.		X				X	X							X	X			X	X	X					X				X		X										
Asthenoceras delicatum Imlay, n. sp.							X			X	X	X	X			X	X	X			X			X	X	X					X										X
Sonninia (*Papilliceras*) *stantoni* (Crickmay)								X				X											X																		
cf. *S.* (*P.*) *arenata* (Quenstedt)								X																																	
cf. *S.* (*P.*) *juramontana* (Crickmay)							X																																		
sp.																						X									X				X						X
Witchellia connata (Buckman)													X															X							X		X	X			
sp.																												X													
Dorsetensia cf. *D. pulchra* Buckman								X																										X	X						
cf. *D. subtexta* Buckman							X																								X										
cf. *D. complanata* Buckman			X																																						
cf. *D. edouardiana* (d'Orbigny)																																				X					
oregonensis Imlay, n. sp.																																?				X					
Fontannesia intermedia Imlay, n. sp.											X	X																													
Pelekodites silviesensis Imlay, n. sp.								X																						X	X					X					
Lissoceras hydei Imlay, n. sp.								X																																	
Emileia buddenhageni Imlay, n. sp.								X																										?							
sp. indet.								X																				X													
Otoites contractus (J. de C. Sowerby)								X																										X	X		X				
Normannites (*Masckeites*?) cf. *N.* (*M.*) *densus* (Buckman)								X																																	
cf. *N.* (*Itinsaites*) *crickmayi* (McLearn)																																		X							
Stephanoceras mowichense Imlay, n. sp.																																		X	X						
(*Skirroceras*) *juhlei* Imlay																							X																		
cf. *S.* (*S.*) *juhlei* Imlay																																	X	X							
cf. *S.* (*S.*) *leptogyrale* (Buckman)								X																																	
sp.	X			X	X				X																		X	X				X									
(*Phaulostephanus*?) *oregonense* Imlay, n. sp.								X																											X						
Parabigotites crassicostatus Imlay						X																						X					X						X	X	
Lamellaptychus sp.			X					X	X																									X	X						

TABLE 7.—*Geographic distribution of Bajocian ammonites in the Basey Member of the Snowshoe Formation in the Suplee area*

[One- and two-digit numbers refer to numbers on pl. 48, *E*, *F*, *H*. Other numbers are U.S.G.S. Mesozoic locality numbers or collector's field numbers]

	Grant County								Crook County		Harney County		Grant County		Harney County				
	Dayville quadrangle										Delintment Lake quadrangle								
	3	4	5		6	7	14	15	24	27	35	36	75	79	83	86		87	
Species	27376	Vigrass 401	27737	27377	Vigrass 170	Vigrass 169	29815	Vigrass 146	29406	26769	28385	28384	Dickinson 100	29813	29816	Dickinson 101	29814	29812	29818
Holcophylloceras sp.										X									X
Asthenoceras delicatum Imlay, n. sp.													X						
Dorsetensia cf. *D. subtexta* Buckman										X								X	X
cf. *D. edouardiana* (d'Orbigny)																		X	
oregonensis Imlay, n. sp.										X					X	X			X
sp.				X					X										
Pelekodites silviesensis Imlay, n. sp.													X			X		X	X
dobsonensis Imlay, n. sp.															X				
Poecilomorphus cf. *P. varius* Imlay, n. sp.							X	X				X							
Chondroceras allani (McLearn)												X							
Sphaeroceras sp.														X	X		X		
Normannites (*Normannites*) *orbignyi* Buckman							X												
(*Itinsaites*) *crickmayi* (McLearn)							X												
Stephanoceras cf. *S. nodosum* (Quenstedt)												X							
(*Skirroceras*) *kirschneri* Imlay			X	X										X	X				
cf. *S.* (*S.*) *kirschneri* Imlay							X												
juhlei Imlay		X																	
sp.	X				X	X	X			X									
Lamelloptychus sp.															X			X	X

TABLE 8.—*Geographic distribution of Bajocian ammonites in the Snowshoe Formation in the Izee area*

[Nos. 90–109 refer to numbers on pl. 48, *C, D*. Other numbers are USGS Mesozoic locality numbers or collector's field numbers]

Species	Grant County																										
	Logdell quadrangle			Izee quadrangle																							
	90	91	92	93	94	95	96	97	98	99	100	101	102		103		104	105		106	107				108	109	
	27356	26773	27370	29832	27578	26775	26776	28028	28029	26759	27363	26774	29230	Lupher 75	29237	29238	26756	Lupher 74	Dickinson 114	26758	26752	26753	26754	26755	Dickinson 108	Dickinson 102	Lupher 128
Holcophylloceras sp		×												×	×												
Asthenoceras delicatum Imlay, n. sp																	×			×							
Tmetoceras scissum (Benecke)																					×	×		×			
Planammatoceras? sp																						×		×			
Sonninia (*Papilliceras*) sp													×														
Witchellia connata (Buckman)												×	×														
Dorsetensia cf. *D. subtexta* Buckman														×													
oregonensis Imlay, n. sp					×		×											×									
sp		×													×				×								×
Pelekodites silviesensis Imlay, n. sp		×			×								×							×							
Poecilomorphus varius Imlay, n. sp										×	×																
Lissoceras hydei Imlay, n. sp													×	×											×		
Normannites (*Itinsaites*) cf. *N.* (*I.*) *gracilis* Westermann									×																		
Stephanoceras cf. *S. nodosum* (Quenstedt)					×						×			×													
(*Skirroceras*) *kirschneri* Imlay							×																				
(*s.*) *juhlei* Imlay					×			×																			
(*S.*) sp			×								×					×										×	
(*Phaulostephanus*?) cf. *S.* (*P.*) *oregonense* Imlay, n. sp				×																							
Leptosphinctes sp						×																					
Parabigotites cf. *P. crassicostatus* Imlay	×																										
Lamellaptychus sp		×											×	×													

TABLE 9.—*Geographic distribution of Bajocian ammonites in the Snowshoe Formation in the Emigrant Creek area in Harney County and the Seneca area in Grant County*

[Nos. 110–132 refer to numbers on pl. 48, *B*, *G*. Other numbers are USGS Mesozoic locality numbers or collector's field numbers]

Species	Harney County				Grant County																																					
	Sawtooth Creek quadrangle				Logdell quadrangle		Seneca quadrangle																															Logdell quadrangle				Calamity Butte quadrangle
	110	111	112	113	114	115	116								117	118			119			120				121	122	123			124	125		126	127			128	129	130	131	132
	26770	26772	27579	29410	25817	25824	25821	28017	28018	28019	28020	28021	29232	29234	Lupher 30	29235	28022	Lupher 5	Lupher 8	Lupher 135	Lupher 136	Lupher 28	29790	29792	Vigrass 242	29236	29231	28026	28027	29233	Lupher 57	Lupher 490	21617	Lupher 272	Lupher 56	26771	29413	25818	25692	Lupher 55	29415	26777
Phylloceras sp																							X																			
Spiroceras bifurcatum (Quenstedt)								X					X	X			X																									
annulatum (Deshayes)									X				X																													
cf. *annulatum* (Deshayes)																										X																
sp						X																																				
Asthenoceras delicatum Imlay, n. sp																																X										
Sonninia cf. *S. nodatipinguis* (Buckman)																																		X								
(*Papilliceras*) *stantoni* (Crickmay)																												X			X		X									
Witchellia connata (Buckman)																												X			X											
Dorsetensia diversistriata Imlay, n. sp																															X											
oregonensis Imlay, n. sp																																		X								
Pelekodites silviesensis Imlay, n. sp																															X			X								
Poecilomorphus varius Imlay, n. sp																					X	X	X	X																		
Lissoceras hydei Imlay, n. sp																													X		X		X									
Oppelia cf. *O subradiata* (J. de C. Sowerby)																			X																							
Otoites contractus (J. de C. Sowerby)																															X											
cf. *O. contractus* (J. de C. Sowerby)																																					X					
Chondroceras allani (McLearn)	X																																				X					
cf. *C. allani* (McLearn)																						X																				
n. sp. undet																						X																				
sp		X		X															X	X											X											
Sphaeroceras cf. *S. brongniarti* (J. de C. Sowerby)								X	X										X							X																
Megasphaeroceras rotundum Imlay																						X																				
Normannites (*Normannites*) *orbignyi* Buckman		X	X																				X																		X	X
n. sp. aff. *N.* (*N.*) *orbignyi* Buckman							X				X		X														X															
cf. *N.* (*N.*) *braikenridgii* (J. de C. Sowerby)																															X											
cf. *N.* (*N.*) *quenstedti* Roche																			X																							
sp						X													X																							X
(*Itinsaites*) *crickmayi* (McLearn)	X	X		X																			X														X					
cf. *N.* (*I.*) *crickmayi* (McLearn)						X																																	X			
(*I.*) *formosus* Buckman																																	X									
aff. *N.* (*I.*) *itinsae* (McLearn)																																		X								
(*Epalxites*) cf. *N.* (*E.*) *anceps* (Quenstedt)																																					X					
? *kialagvikensis* Imlay																															X											
Stephanoceras sp. A																																						X				
sp. B																															X											
sp. C																											X															
sp. D											X																															
cf. *S. nodosum* (Quenstedt)																						X									X											
(*Skirroceras*) *kirschneri* Imlay	X	X		X																			X											X						X		
cf. (*S.*) *kirschneri* Imlay															X							X		X																		
(*S.*) *juhlei* Imlay																									X					X				X								
aff. *S.* (*S.*) *juhlei* Imlay																																					X					
cf. *S.* (*S.*) *juhlei* Imlay															X																											
sp			X		X		X			X	X	X				X		X	X			X						X							X	X					X	X[1]
Stemmatoceras aff. *S. albertense* McLearn																			X																							
Teloceras itinsae McLearn	X			X																																						
? sp															X																											
Zemistephanus? cf. *Z. richardsoni* (Whiteaves)				X											X																											
Lupherites senecaensis Imlay, n. sp															X				X																							
Leptosphinctes cf. *L. leptus* Buckman																						X																				
cf. *L. evolutus* Imlay															X																											
(*Prorsisphinctes*) spp. juv															X																											
Lamellaptychus sp																						X									X											

TABLE 10.—*Geographic distribution of Bajocian ammonites in unnamed Jurassic beds in Malheur and Baker Counties*

[Nos. 133–143 refer to numbers on pl. 48, I, J, K. Other numbers are USGS Mesozoic locality numbers]

Species	Malheur County										Baker County		
	Clover Creek area		Brogan quadrangle							Bridgeport quadrangle	Huntington quadrangle		
	133	134	135		136	137		138	139	140	141	142	143
	28387	27393	28649	28650	28382	28373	28374	28380	28381	27583	29111	29784	29782
Phylloceras? sp		×											
Holcophylloceras sp									×				
Spiroceras bifurcatum (Quenstedt)				×									
annulatum (Desphayes)				×									
sp			×										×
Asthenoceras delicatum Imlay, n. sp	×								×				
Fontannesia cf. *F. luculenta* Buckman	×								×				
Imetoceras scissum (Benecke)						×	×					×	
?sp										×			
Eudmetoceras sp								×					
Witchellia? sp		×											
Docidoceras? sp. juv								×					
Normannites sp			×	×									
Stephanoceras sp. D			×										
sp. C			×										
sp											×		
?sp		×			×								
Lupherites senecaensis Imlay, n. sp											×		
Leptosphinctes (*Prorsisphinctes*) sp. juv			×	×									
Parabigotities? sp		×											
Lamellaptychus sp	×								×				

Loc. No. (pl. 48)	Geological Survey Mesozoic localities	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
1		V141	L. W. Vigrass and others, 1956. South-facing slope of a minor tributary to Spring Creek, 1,800 ft north of an old barn on Spring Creek, SW¼NW¼ sec. 7, T. 17 S., R. 27 E., Dayville 30-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, near base.
2		V149	L. W. Vigrass and others, 1956. South-facing slope of small bare hill in SE corner sec. 7, T. 17 S., R. 27 E., Dayville 30-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, upper part.
3	27376	I58–9–4B	R. W. Imlay, 1958. On road from Suplee to the South Fork of John Day River, just west of Beaver Creek, west-central part of SE¼SW¼ sec. 20, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Basey Member of Snowshoe Formation, near base in area where member is about 1,400 ft thick.
4		V401	L. W. Vigrass, 1957. About 100 ft east of a small channel, 1,400 ft north of road from Izee to Suplee, and 900 ft west of road from Pine Creek to the Schnabele Ranch houses, west-central part of NW¼NW¼ sec. 23, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Basey Member, near base, below a sandstone unit.
5	27377	I58–9–4C	R. W. Imlay, 1958. Roadcut in SE¼NE¼ sec. 22, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Basey Member of Snowshoe Formation, near base.
5	27737	Bud 57	H. J. Buddenhagen, 1959. Roadcut in SE¼NE¼ sec. 22, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Probably same place as Mesozoic loc. 27377. Basey Member of Snowshoe Formation, near base.
6		V170	L. W. Vigrass, W. R. Dickinson, S. W. Muller, and J. H. Beeson, 1956. Roadcut about 0.25 mile west of junction of Shaw Creek with Pine Creek, opposite crossing of road from the Old Harris Place, NW¼ SW¼ sec. 24, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Basey Member of Snowshoe Formation, probably at least 600 ft above base at place where member is about 800 ft thick.
7		V169	L. W. Vigrass, W. R. Dickinson, S. W. Muller, and J. H. Beeson, 1956. Base of west slope of short valley that drains northward into Pine Creek, about 1100 ft. south of channel of Pine Creek, NW corner of SW¼SW¼ sec. 24, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Basey Member of Snowshoe Formation, about 100 ft below base of a volcanic sandstone unit, probably 600 ft above base of member at place where member is about 800 ft thick.
8		V158	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. Roadcut on Shaw Creek, 700 ft southeast of a sulphur spring, SW¼NE¼ sec. 25, T. 17S., R. 26E., Grant County, Oreg. Weberg Member of Snowshoe Formation.
8	26764	I57–7–7	R. W. Imlay, 1957. Same place as loc. V158 in lower part of Weberg Member of Snowshoe Formation.
8	27374	I58–9–3A	R. W. Imlay, 1958. Same place as Mesozoic loc. 26764 and Vigrass' loc. 158.
9		L366	R. L. Lupher, 1930. Second spur east of the Old Wm. Harris Ranch house, near center sec. 26, T. 17 S., R. 26 E., Dayville 30-min. quad., Grant County Oreg. Above coarse grit bed in Weberg Member of Snowshoe Formation.
10	29821	I69–7–2C	W. O. Ross, 1969. On south side of small anticlinal nose east of the Old Harris Place (abandoned) in northern part of SE¼SW¼ sec. 26, T. 17 S., R. 26 E., Dayville quad., Grant County, Oreg. Weberg Member of Snowshoe Formation.
10		L411	R. L. Lupher, 1930? On the Old Wm. Harris Ranch in sec. 26, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Weberg Member of the Snowshoe Formation.
10		L207	R. L. Lupher, 1928. Hill directly east of Wm. Harris Ranch house (abandoned) on upper part of Pine Creek, NE¼SW¼ sec. 26, T. 17 S., R. 26 E. Dayville 30-min quad., Grant County, Oreg. Upper part of sandy beds containing many pelecypods. Weberg Member of Snowshoe Formation.
10		L208	R. L. Lupher, 1928. In hills a little east of Lupher's loc. 207 and probably lower stratigraphically.
10		L368	R. L. Lupher, 1930. First anticlinal spur east of Old Wm. Harris Ranch house, southern part of NE¼SW¼ sec. 26, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Above coarse grit bed in Weberg Member of Snowshoe Formation.
10		L465	R. L. Lupher, 1931. From coarse grit and calcareous sandstone in lower part of gritty sequence on spur east of the Old Wm. Harris Ranch house. Same location as Lupher's loc. 368. Lower part of Weberg Member of Snowshoe Formation.
10		L466	R. L. Lupher, 1931. From brown sandstone and grit above L465 and at same stratigraphic position and location as L207.
10		L467	R. L. Lupher, 1931. From brown sandstone stratigraphically above L466 at same location.
10		L468	R. L. Lupher, 1931. From gully 100 ft east of Old Wm. Harris barn. Stratigraphically above L467 at same location.
11	29820	I69–7–2B	R. W. Imlay, 1969. On northwest-facing slope near center of SE¼SW¼ sec. 26, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. From 20–30 ft above base of Weberg Member of Snowshoe Formation.
12	29396	I66–8–1A	W. O. Ross, 1966, Roadcut near center of SW¼SW¼ sec. 26, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, near middle.
12	29397	I66–8–1B	R. W. Imlay, 1966. Same as loc. 29396 except 25 ft higher stratigraphically.

Loc. No. (pl. 48)	Geological Survey Mesozoic localities	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
13	29822	I69-7-2A	W. O. Ross and R. W. Imlay, 1969. On northwest-facing slope of low ridge southwest from Old Harris Place, SE¼SW¼SW¼ sec. 26, T. 17 S., R. 26E., Dayville 30-min quad., Grant County, Oreg. Lower 50 ft of Weberg Member of Snowshoe Formation.
14	29815	I69-7-7A	W. O. Ross and R. W. Imlay, 1969. Roadcut on low hill just north of area mapped as Shaw Member of the Snowshoe Formation by Dickinson and Vigrass (1965, west half of pl. 1), NE¼SE¼NE¼ sec. 32, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Basey Member of Snowshoe Formation, probably 1,400–1,500 ft. above base (*See* Dickinson and Vigrass, 1965, p. 56, 86.)
15		V146	L. W. Vigrass, W. R. Dickinson, S. W. Muller, and J. H. Beeson, 1956. Roadcut on north side of small gully running southwest from volcanic cap rock to Swamp Creek, near center of NE¼NE¼ sec. 33, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Basey Member of Snowshoe Formation, about 1,400 ft. above base and near top of member.
16	29398	I66-8-1C	W. O. Ross, 1966. About 0.6 mile southwest of loc. 29396 in south-central part of NW¼NE¼ sec. 34, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, near base.
17		V155	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. On top of ridge, 1,300 ft. east-northeast of hairpin junction of Swamp Creek road with road to Pine Creek, SW¼NE¼ sec. 34, T. 17 S., R. 26 E., Grant County, Oreg. Top of Weberg Member of Snowshoe Formation.
17		L583	R. L. Lupher, 1934. About 1 mile south west of the old Wm. Harris Ranch house in north half of sec. 34, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Weberg Member of Snowshoe Formation.
18		V130	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. Bulldozer cut directly east of road to Pine Creek at hairpin juncture of Swamp Creek road with road to Pine Creek, SE¼NW¼ sec. 34, T. 17 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation, upper part.
19		V128	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. Bulldozer cut on southeast side of a right angle bend in road along Swamp Creek, NW. cor. of NE¼SW¼ sec. 34, T. 17 S., R. 26 E., Grant County, Oreg. Above middle of Weberg Member of Snowshoe Formation.
19	29403	I66-8-1D	R. W. Imlay and W. O. Ross, 1966. East side of Swamp Creek in south-central part of NW¼ sec. 34, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Near Vigrass' loc. 128. Near top of Weberg Member of Snowshoe Formation.
20		V120	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. Crest of north-trending nose 200 ft west of Swamp Creek, SW¼SW¼ sec. 34, T. 17 S., R. 26 E., Grant County, Oreg. Near middle of Weberg Member of Snowshoe Formation.
20		V121	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. About 50 ft southwest of loc. V120 and possibly 10 ft higher stratigraphically in Weberg Member.
20		V121a	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. Same location as V120 but about 20 ft higher stratigraphically in Weberg Member.
20	29404	I66-8-1E	R. W. Imlay and W. O. Ross, 1966. At north end of low ridge 200 ft west of Swamp Creek, SW¼SW¼ sec. 34, T. 17 S., R. 26 E., Dayville 30-min. quad., Grant County Oreg. Probably same place as Vigrass' loc. 120. Near middle of Weberg Member of Snowshoe Formation.
21		L360	R. L. Lupher, 1930. On west side of Swamp Creek, probably North-central part of NW¼ sec. 3, T. 18 S., R. 26 E., Grant County, Oreg. Brown and gray calcareous sandstone about 50 ft stratigraphically above base of Weberg Member of Snowshoe Formation.
22		V123	L. V. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. On bare north-facing slope 150 ft northeast of a tributary to Swamp Creek, NW. cor. of SW¼ sec. 3, T. 18 S., R. 26 E., Grant County, Oreg. One-third of distance from base to top of Weberg Member. Presumably below middle of member.
22	29402	I66-8-2A	R. W. Imlay and W. O. Ross, 1966. On bare northerly slope, about half a mile west of Swamp Creek in NW. cor. SW¼ sec. 3, T. 18 S., R. 26 E., Dayville 30-min quad., Oreg. Near Vigrass' loc. 123. Near middle of Weberg Member of Snowshoe Formation.
22		L355	R. L. Lupher, 1930. On a western tributary of Swamp Creek near Old Huck Smith Ranch (abandoned), west-central part of sec. 3, T. 18 S., R. 26 E. (See description of sequence (Lupher, 1941, p. 252), Dayville 30-min quad., Grant County, Oreg.) Upper part of *Sonninia*-bearing limestone of Weberg Member of Snowshoe Formation.
22		L361	R. L. Lupher, 1930. Same locality data as L360. From a limestone bed 6–18 in. thick in brown calcareous sandstone about 15 ft. above base of *Sonninia*-bearing beds in upper part of Weberg Member of Snowshoe Formation.
22		L363	R. L. Lupher, 1930. At same place as Lupher's loc. 361 but about 8 ft lower stratigraphically. Upper part of Weberg Member of the Snowshoe Formation.
22		L410	R. L. Lupher, 1930. From measured section (Lupher, 1941, p. 252) east of the Old Huck Smith house on a western tributary of Swamp Creek in west-central part of sec. 3, T. 18 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Upper part of *Sonninia*-bearing beds in the upper part of Weberg Member of the Snowshoe Formation.
22		L460	R. L. Lupher, 1931. Gray limestone stratigraphically above Lupher's loc. 355, western part of sec. 3, T. 18 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Upper part of Weberg Member of Snowshoe Formation.
23		V154	L. V. Vigrass, S. W. Muller, W.R. Dickinson, and J. H. Beeson, 1956. South side of east-trending ridge 750 ft east of Camp Creek and 300 ft north of a gully, NE¼NW¼ sec. 1, T. 18 S., R. 25 E., Crook County, Oreg. Weberg Member of Snowshoe Formation, probably near middle.
24	29406	I66-7-26A	R. W. Imlay and W. O. Ross, 1966. From barrow pit below flow rock on east side of road, south central part of NE¼SW¼ sec. 1, T. 18 S., R. 26 E., Dayville 30-min quad., Crook County, Oreg. Basey Member of Snowshoe Formation, about 900 ft above base in area where member is about 2,500 ft thick.
25		V216	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. On crest of short northwest-trending ridge at head of creek that flows past the Basey Ranch house, SW¼SE¼ sec. 14, T. 18 S., R. 25 E., Crook County, Oreg. Between 2 and 4 ft above base of Weberg Member of Snowshoe Formation.
26		L211	R. L. Lupher, 1927. From black sandy shale on ditch bank on east side of Beaver Creek opposite lower cabin between the mouths of Warm Springs Creek and Clear Creek. Probably in SE¼SW¼ sec. 8, T. 18 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, probably upper part.
27	26796	V412	R. W. Imlay, 1957. Greenish shale in roadcut about 1 mile northwest of Weberg Ranch houses at point where road changes from west-northwest to north, near center of SE¼NW¼ sec. 13, T. 18 S., R. 25 E., Dayville 30-min quad., Crook County, Oreg. Basey Member of Snowshoe Formation, about 600 ft above base at place where member is about 2,500 ft thick.
28		V235(V241)	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. Near Wade Butte. A little west of center of sec. 24, T. 18 S., R. 24 E., Crook County, Oreg. Weberg Member of Snowshoe Formation.
		V241	Same as loc. V235.

Loc. No. (pl. 48)	Geological Survey Mesozoic localities	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
29		L206	R. L. Lupher, 1928. From shale exposed on westward-trending strike ridge capped with porphyry on west side of Warm Springs Creek opposite the Weberg Ranch house. Probably from northern part of NE¼ sec. 24, T. 18 S., R. 25 E., Dayville quad., Crook County, Oreg. Warm Springs Member of Snowshoe Formation.
30	26762	I57-7-10B	R. W. Imlay, 1957. Roadcut directly south of Weberg Ranch houses, NW¼ sec. 19, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation.
31		L210	R. L. Lupher, 1928, On west side of canyon of Beaver Creek above upper cabins. Probably in SW¼ SE¼ sec. 17, T. 18 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Probably from Weberg Member, rather than Warm Springs Member of Snowshoe Formation.
32		L212	R. L. Lupher, 1928. Sandstone along ditch bank north and above Lupher's loc. 211 which is in the Warm Springs Member. Presence of *Docidoceras* at Lupher's loc. 212 shows that it was derived from Weberg Member to the south or east and probably in the SE¼ sec. 8, T. 18 S., R. 26 E., Dayville quad., Grant County, Oreg.
33	29241	Bud. 135	H. J. Buddenhagen, W. O. Ross, and R. W. Imlay, 1965. Small gully 0.4 mile north of country road in NW¼SW¼SW¼ sec. 24, T., 18 S., R. 24 E., Crook County, Oreg. Warm Springs Member of Snowshoe Formation, about 100 ft above base of member.
34	29810	I69-7-10A	W. O. Ross and R. W. Imlay, 1969. West of and below rib of Jurassic lava supporting country road. North-central part, NW¼ SE¼ sec. 33, T. 18 S., R. 25 E., Delintment Lake 15-min quad., Crook County, Oreg. Warm Springs Member of Snowshoe Formation.
35	28385	Bud. 96	H. J. Buddenhagen and R. W. Imlay, 1961. About 1,400 ft south of Twelvemile Creek NE. cor. NE¼NW¼ sec. 15, T. 19 S., R. 25 E., Delintment Lake 15-min quad., Harney County, Oreg. Snowshoe Formation, Basey Member, about 300 ft below top.
36	28384	Bud 95	H. J. Buddenhagen and R. W. Imlay, 1961. Along county road in south-central part of sec. 29 (about 500 ft north of southern boundary), T. 19 S., R. 25 E., Delintment Lake 15-min quad., Harney County, Oreg. Snowshoe Formation Basey Member, upper part.
37		V16	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. From spur projecting into southeast end of a small valley one mile east-southeast of the Weberg Ranch house, SE. cor. of NE¼ NE¼ sec. 19, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation, near top.
37	29827	I69-7-10A	W. O. Ross and R. W. Imlay, 1969. Float from spur at southeast end of alluvial valley in SE¼NE¼NE¼ sec. 19, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Probably from upper part of Weberg Member of Snowshoe Formation.
38		V162	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. From rounded spur that projects west into head of valley which joins Warm Springs Creek at Suplee Hot Springs. SE¼NE¼ sec. 19, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation.
38		L408	R. L. Lupher, 1930. Top of hill northeast of second gully north of the Colpitts (Old Washburn) Ranch house, probably NE¼ SE¼ sec. 19, T. 18 S., R. 26 E. near Vigrass' loc. 162. Delintment Lake 15-min quad., Grant County, Oreg. Weberg Member of Snowshoe Formation.
39		L350	R. L. Lupher, 1930. About 600 ft north of gully which is about three-quarters of a mile north of Old Washburn place. Probably in NE¼SW¼ sec. 19, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Upper 10 ft of Weberg Member of Snowshoe Formation.
39		L351	R. L. Lupher, 1930. Same location as L350. From middle part of *Sonninia*-bearing limestone, below bed of Lupher's locality 350, in upper part of Weberg Member of Snowshoe Formation.
39		L352	R. L. Lupher, 1930. Same location for Lupher's loc. 350 but on south side of gully. From *Sonninia*-bearing limestone in upper part of Weberg Member of Snowshoe Formation.
39		L353	R. L. Lupher, 1930. Same location as L350 but high on south side of gully. From lower or middle beds of *Sonninia*-bearing limestone in upper part of Weberg Member of Snowshoe Formation.
39		L573	R. L. Lupher, 1934. In third gulch north of old Washburn place, about one-fourth of a mile from county road and 75–100 ft. below a lone pine tree in bottom of main gully, northern part of NE¼SW¼ sec. 19, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. From *Sonninia*-bearing beds in upper part of Weberg Member of Snowshoe Formation.
39		L574	R. L. Lupher, 1934. Same location as L573 but near base of *Sonninia*-bearing beds, a few feet above gritty sandstone, in the Weberg Member.
39		L575	R. L. Lupher, 1934. From north side of ridge south of gulch described under Lupher's loc. 573, about 100 ft east of a fault, and more than one-fourth of a mile east of county road. Probably near center of NE¼SW¼ sec. 19, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. A little higher stratigraphically than Lupher's loc. 574 in lower part of *Sonninia*-bearing beds of the Weberg Member.
39		L578	R. L. Lupher, 1934. Same data as L573.
39		L609	R. L. Lupher, 1934? In third gulch north of old Washburn place, NE¼SW¼ sec. 19, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Weberg Member of Snowshoe Formation.
40	27735	Bud 70	H. J. Buddenhagen, 1959. North side of gulch in NW¼ SW¼ SE¼ sec. 19, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. About 100 ft above base of Weberg Member of Snowshoe Formation.
41		V112	L. W. Vigrass, 1956. Near center SW¼ SE¼ sec. 19, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Near base of upper limestone part of Weberg Member of Snowshoe Formation.
42		L298	R. L. Lupher, 1930. East side of Warm Springs Valley half a mile below (north of) the Colpitts (Washburn) Ranch house. Probably in south-central part of sec. 19, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation.
43	21611	I49-8-18A	R. W. Imlay and John McIntyre, 1949. On northeast side of road directly north of the old Washburn (Colpitts) Ranch houses, probably NE cor. of NW¼NE¼ sec. 30, T. 18 S., R. 26 E., Grant County, Oreg. Top of Weberg Member of Snowshoe Formation.
43	21612	I49-8-18B	R. W. Imlay and John McIntyre, 1949. North of old Washburn Ranch house, SE¼SW¼SE¼ sec. 19, T. 18 S., R. 26 E., Grant County, Oreg. Upper part of Weberg Member of Snowshoe Formation.
43	21613	I49-8-18C	R. W. Imlay and John McIntyre, 1949. Same data as for loc. 21612.
43	26766	I57-8-9	R. W. Imlay, 1957. From gully in SE¼SW¼ SE¼ sec. 19, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Lower part of upper third of Weberg Member of Snowshoe Formation.
43	29823	I69-6-26A	W. O. Ross and R. W. Imlay, 1969. In first gully north of old Washburn place in SE¼SW¼SE¼ sec. 19, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. From upper 10 ft of 113 ft of sandstone and sandy beds in lower part of Weberg Member of Snowshoe Formation.
43	29824	I69-6-26B	W. O. Ross and R. W. Imlay, 1969. Same data as for Mesozoic loc. 29823, but in limestone bed about 25 ft above top of 113 ft of the sandstone division of the Weberg Member.
43	29826	I69-6-26E	R. W. Imlay and W. O. Ross, 1969. Same data as for Mesozoic loc. 29823 but from upper 10 ft of sandstone division.

Loc. No. (pl. 48)	Geological Survey Mesozoic localities	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
43		L580	R. L. Lupher, 1934. From second gulch north of Old Washburn Place, NE¼NW¼NE¼ sec. 30, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Mostly upper 20 ft of *Sonninia*-bearing beds at top of Weberg Member of Snowshoe Formation.
43		L581	R. L. Lupher, 1934. Same data as L580 except not restricted to upper 20 ft of upper part of *Sonninia*-bearing beds.
44		L228N	R. L. Lupher, 1928. In low hills east of Warm Spring Creek and north of Colpitts Spring. Probably mostly near center of north half of NE¼ sec. 30, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Weberg Member of Snowshoe Formation, probably upper part.
44		V20a	Same data as loc. V20b but only 75 ft above base of Weberg Member.
44		V20b	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. About 600 ft north of same gulch as V19 and 600 ft northeast of road, NE¼NE¼ sec. 30, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation, 125 ft above base and about 20 ft above middle.
45	26768	I57-7-9D	R. W. Imlay, 1957. In gully east of old Washburn place, east of road, south-central part NE¼NE¼ sec. 30, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Near top of Weberg Member of Snowshoe Formation.
45	29825	I69-6-26C	R. W. Imlay, 1969. In gulch east of old Washburn place in south-central part of NE¼NE¼ sec. 30, T. 18 S., R. 26 E., Grant County, Oreg. From 38 ft of yellowish-gray, calcareous sandstone which is from 40–78 ft above base of sandstone division and 56 ft below base of limestone division of the Weberg Member of the Snowshoe Formation.
45	29828	I69-6-26D	R. W. Imlay and W. O. Ross, 1969, Same data as Mesozoic loc. 29825 but from 45–50 ft above base of limestone division which is about 110 ft thick. Near middle of upper part of Weberg Member of Snowshoe Formation.
45	29829	I69-7-9A	R. W. Imlay and W. O. Ross, 1969. Same data as Mesozoic loc. 29825, but collected about 110 ft above the base of limestone division at top of Weberg Member of Snowshoe Formation.
45		L228X	R. L. Lupher, 1929? In low hills east of Warm Springs Creek in vicinity of Colpitts (old Washburn) Ranch, Probably from east half of NE¼ of sec. 30, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Upper part of *Sonninia*-bearing beds in upper part of Weberg Member of Snowshoe Formation.
45		L307	R. L. Lupher, 1927? East of Colpitts (old Washburn) Ranch near a bench mark. Probably east-central part of NE¼, sec. 30, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation.
45		L315	R. L. Lupher, 1927? North side of gully from 300-500 ft east of Colpitts (old Washburn) Ranch house. South-central part of NE¼ NE¼ sec. 30, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Weberg Member of Snowshoe Formation, probably upper part.
45		L370	R. L. Lupher, 1930? Probably from eastern side of valley of Warm Springs Creek. Upper part of *Sonninia*-bearing beds in Weberg Member of the Snowshoe Formation.
45		L305	R. L. Lupher, 1927? Near mouth of gully 200 ft east of county road and east of Colpitts (old Washburn) Ranch house, south-central part of NE¼ sec. 30, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Weberg Member of Snowshoe Formation, probably upper part.
46		V18	L. W. Vigrass and others, 1956. From calcareous sandstone on west slope of hill 1,000 ft east of old Washburn place. NW¼SE¼NE¼ sec. 30, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, basal bed. Labeled top of Weberg Member in original locality description.
46		L232	R. L. Lupher, 1928. On hillside east of Colpitts (old Washburn) Ranch house. Probably NW¼SE¼NE¼ sec. 30, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, near base.
47		V19	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. About 1,000 ft east and 400 ft north of old Washburn place on south side of gulch near center of east half of NE¼ sec. 30, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation, about 80 ft above base and a little below middle of member.
48		L491	R. L. Lupher, 1929. North of North Ammonite Hill. Probably NW¼ sec. 29, or SW¼ sec. 20, T. 18 S., R. 26 E., Grant County, Oreg. Upper part of Weberg Member of Snowshoe Formation.
49		V8	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. Directly east of stream channel and 600 ft below (south) of head of gully draining south-southwest from North Ammonite Hill, SW¼NE¼ sec. 29, T. 18 S., R. 26 E., Grant County, Oreg. Near top of lower third of Weberg Member of Snowshoe Formation.
49		L610	E. L. Packard, 1934? Probably from big gully on west side of North Ammonite Hill, NW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Weberg Member of Snowshoe Formation.
49	26763	I57-7-9A	R. W. Imlay, 1957. Northern part of North Ammonite Hill, NW¼ sec. 29, T. 18 S., R. 26 E., Grant County, Oreg. Lower fourth of Weberg Member of Snowshoe Formation.
50		L224	R. L. Lupher, 1928. East side of North Ammonite Hill, east half of NW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. From 1 to 2 ft limestone bed containing many rhynchonellid brachiopods at base of *Ichthyosaur*-bearing beds and from 60 to 80 ft above base of Weberg Member of Snowshoe Formation.
50		L225	R. L. Lupher, 1928. From shale and sandy limestone containing many pelecypods and directly overlying brachiopod-bearing beds at Lupher's loc. 224. Forms middle part of a 45–60 ft unit that consists mostly of highly fossiliferous light-gray sandy limestone.
50		L226	R. L. Lupher, 1928. From 45–60 ft of shale, limestone, and sandy limestone whose base is 60–80 ft above base of Weberg Member. Includes beds of Lupher's locs. 224 and 225 as well as overlying beds characterized by large terebratulid brachiopods. Same location as L224.
50		L228	R. L. Lupher, 1928. From a limestone unit in lower part of an 85 foot sequence consisting mostly of sandy calcareous shale, This limestone overlies a shaly unit which overlies beds of Lupher's loc. 226 on North Ammonite Hill.
50		L229	R. L. Lupher, 1928. East side of North Ammonite Hill at same place as Lupher's locs. 225–230. From sandy calcareous shale in middle of 85-ft sequence in upper part of Weberg Member of Snowshoe Formation. L 229 is higher stratigraphically than L228 and lower than L230.
50		L230	R. L. Lupher, 1928. Same location as Lupher's locs. L225–229 but near top of hill. From *Sonninia*-bearing limestone in uppermost part of Weberg Member of Snowshoe Formation. May include some specimens from base of overlying Warm Springs Member.
50		L248	R. L. Lupher, 1928. From 1 ft of brown calcareous sandstone overlying *Ichthyosaur*-bearing bed near divide on North Ammonite Hill. Probably near center of NW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min. quad., Grant County, Oreg. Base of *Sonninia*-bearing beds in upper part of Weberg Member.
50		L371	R. L. Lupher, 1930? Location unknown. Probably from area near the University of Oregon field camp in secs. 29 or 30, T. 18 S., R. 26 E., Grant County, Oreg. Probably from the *Ichthyosaur*-bearing beds near the middle of the Weberg Member of the Snowshoe Formation.

Loc. No. (pl. 48)	Geological Survey Mesozoic localities	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
50		L372	R. L. Lupher, 1930? Probably from the same place and beds as Lupher's loc. 226 near the middle of the Weberg Member of the Snowshoe Formation.
50		L373	R. L. Lupher, 1930? Location unknown. Fossils indicate derivation from upper part of the Weberg Member of the Snowshoe Formation.
50		L407	R. L. Lupher, 1930? Location unknown. Fossils indicate derivation from upper part of Weberg Member of the Snowshoe Formation.
50		L474	R. L. Lupher, 1931. North Ammonite Hill about 300 ft north of county road, NW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. From *Ichthyosaur*-bearing bed near middle of Weberg Member of Snowshoe Formation.
50		L475	R. L. Lupher, 1931. Same place as L474 but just above *Ichthyosaur*-bearing bed near middle of Weberg Member of Snowshoe Formation.
50		L1701	Collector and year unknown. Suplee area. Presumably near the former field camp of the University of Oregon in secs. 28–30, T. 18 S., R. 26 E., Grant County, Oreg. From *Ichthyosaur*-bearing beds of the Weberg Member of the Snowshoe Formation.
51		L313	R. L. Lupher, 1927? Southwest slope of North Ammonite Hill near a north-trending fence, NW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. From *Ichthyosaur*-bearing beds in middle part of Weberg Member of Snowshoe Formation.
51		L584	R. L. Lupher, 1934. Southwest side of North Ammonite Hill. About 200 ft north of county road and on east side of big gulch. From *Sonninia*-bearing beds in upper part of Weberg Member of Snowshoe Formation.
51		L605	R. L. Lupher, 1934. South slope of North Ammonite Hill in NW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Weberg Member of Snowshoe Formation, probably from upper part of *Sonninia*-bearing beds.
52		V152	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. Between two small draws on southwest slope of hill, 250 ft east of road, SE¼NE¼ sec. 30, T. 18 S., R. 26 E., Grant County, Oreg. About 20 ft below top of Weberg Member of Snowshoe Formation.
53		L228W	R. L. Lupher, 1928. On hill west of North Ammonite Hill and west of a big gully, SW¼NW¼ sec. 29, and east-central part of sec. 30, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. From about 25 ft of beds consisting of limestone, sandy limestone, and sandy shale equivalent to beds at Lupher's loc. 228 and probably also 230 in upper part of Weberg Member of Snowshoe Formation.
53		L238	R. L. Lupher, 1928. Same location as L228W. From *Sonninia*-bearing beds in upper part of Weberg Member of Snowshoe Formation.
53		L239	R. L. Lupher, 1928. Same data as L238 but about 10 ft lower stratigraphically.
53		L563	R. L. Lupher, 1934. From easternmost small gully on south slope of hill west of North Ammonite Hill, about 150 ft north of county road, probably in SW. cor. NW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Weberg Member of Snowshoe Formation, probably near top.
53		L596	R. L. Lupher, 1934. On south slope of hill directly west of North Ammonite Hill, 200 ft west of a big gully, and 25 ft north of county road. Probably west-central part of sec. 29 (near line with sec. 30), T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. *Sonninia*-bearing beds in upper part of Weberg Member of Snowshoe Formation.
54		V15	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. From cut where road bends sharply eastward from valley of Warm Springs Creek, NE¼ SE¼ sec. 30, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation, near top.
55		L116A	R. L. Lupher, 1928. No data available Presumably from top of Weberg Member near L116 which is in the basal part of the Warm Springs Member on divide between Beaver Creek and Warm Springs Creek on south slope of North Ammonite Hill, sec. 29, T. 18 S., R. 26 E., Grant County, Oreg.
56		L116	R. L. Lupher, 1927. South slope of North Ammonite Hill on divide between Warm Springs Creek and Beaver Creek. Probably south-central part of NW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, near base.
56		L237	R. L. Lupher, 1928. South slope of North Ammonite Hill about 100 ft above the road and between the divide and a big south-trending gully. Probably south-central part of NW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, near base.
56		L476	R. L. Lupher, 1931. South side of North Ammonite Hill, 250 ft above road, near divide. Probably near locs. L116 and L237 in southern part of NW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, probably near base.
56		L482	R. L. Lupher, 1934. From North or South Ammonite Hill, or both. Warm Springs Member of Snowshoe Formation.
56		L560	R. L. Lupher, 1934. South side of North Ammonite Hill, north of road and 100 ft west of divide. Probably near locs. L116 and L237. Warm Springs Member of Snowshoe Formation, probably upper part.
56		L561	R. L. Lupher, 1934. Same location as L560. Warm Springs Member of Snowshoe Formation, probably upper part.
56		L566	R. L. Lupher, 1934. Same location as L560. Lower than L561. Warm Springs Member of Snowshoe Formation, probably upper part.
56	26767	I57-7-10A	R. M. Imlay, 1957, South side of North Ammonite Hill, north of road in south-central part of NW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, near base.
57		V166	L. W. Vigrass and others, 1956. Bulldozer cut on divide southwest of junction of road to Boundary Spring with Suplee-Izee road. SE¼NW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, near base.
57	27375	I58-9-4A	R. W. Imlay, 1958. South side of North. Ammonite Hill, on road just west of road to Boundary Spring. Same place as loc. V166. Near base of Warm Springs Member of Snowshoe Formation.
58		V14	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. On short spur 200 ft south of road and 500 ft east of entrance to the old Ontko place (abandoned), NE¼SE¼ sec. 30, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation, near top.
59		L311	R. L. Lupher, 1926? Black shale about one-quarter mile west of South Ammonite Hill near road to Twelvemile Creek. Probably in SE¼SE¼ sec. 30, T. 18 S., R. 26 E., Delintment Lake 15-min. quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation.
60		L102	R. L. Lupher, 1927. From northeast base of South Ammonite Hill, probably NE¼ SW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min. quad., Grant County, Oreg. Weberg Member of Snowshoe Formation, probably upper part.
60	21610	I49-8-17B	R. L. Lupher, R. W. Imlay, John McIntyre, and H. J. Buddenhagen, 1949. South half of sec. 29, T. 18 S., R. 26 E., Grant County, Oreg. Upper part of Weberg Member of Snowshoe Formation.
61	27733	Bud 39	H. J. Buddenhagen, 1959. Top of South Ammonite Hill in SW¼NE¼SW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min. quad., Grant County, Oreg. Weberg Member of Snowshoe Formation.

Loc. No. (pl. 48)	Geological Survey Mesozoic localities	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
61	26760	I57-7-9C	R. W. Imlay, 1957. South side of South Ammonite Hill, SW¼ sec. 29, T. 18 S., R. 26 E., Grant County, Oreg. Upper part of Weberg Member of Snowshoe Formation.
61	26761	I57-7-9B	R. W. Imlay, 1957. Same description as locality 26760 except from upper third of Weberg Member.
61	26765	I57-7-8C	R. W. Imlay, 1957. South Ammonite Hill in SW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Upper part of Weberg Member of Snowshoe Formation.
61		L306	R. L. Lupher, 1927? Western slope of South Ammonite Hill about 600 ft south of county road and 50 ft west of a north-trending fence. Probably SW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. From *Ichthyosaur*-bearing beds in middle part of Weberg Member of Snowshoe Formation.
62		V11	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. Southeast slope of South Ammonite Hill, SE¼SW¼ sec. 29, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation, about 100 ft above base.
63		L316	R. L. Lupher, 1926? From 600 ft south of Suplee-Izee road and 100 ft west of Boundary Spring road between North and South Ammonite Hill. Probably in NE¼SW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation.
63		V10	L. W. Vigrass, W. R. Dickinson, S. W. Muller, and J. H. Beeson, 1956. Saddle between South Ammonite Hill and pyramidal hill to south. NE¼SW¼SW¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation.
63		V403	Same as loc. V10.
64	29401	I66-7-27C	R. W. Imlay and W. O. Ross, 1966. Roadcut on eastern end of anticlinal hill south of South Ammonite Hill in SW¼SE¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Weberg Member of Showshoe Formation.
65		V205	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. South slope of pyramidal hill directly south of South Ammonite Hill, SE¼SW¼ sec. 29, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation, 100 ft below top and probably near middle.
65		V237	Same data as for loc. V205, but only 50 ft below top of Weberg Member of Showshow Formation.
66		V168	L. W. Vigrass and others, 1956. Saddle south of pyramidal hill directly south of South Ammonite hill. NE¼NE¼NW¼ sec. 32, T. 18 S., R. 26 E., near line of sec. 29, Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, near base.
67	27581		R. W. Imlay, 1959. At site of former field camp of the University of Oregon, west of spring. SE. cor. sec. 29, T. 16 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Near base of Weberg Member of Snowshoe Formation.
68		L214	R. L. Lupher, 1928. On hillside 100 ft east of site of University of Oregon field camp, SW¼SW¼ sec. 28, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Weberg Member of Snowshoe Formation, probably lower part.
69		D94	W. R. Dickinson, S. W. Muller, L. W. Vigrass, and J. H. Beeson, 1956. West side of ridge southeast of Jim Robertson Ranch house. NE¼SW¼SE¼ sec. 28, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, near middle.
70		V3(=D88)	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. On west slope of ridge east of Dobson Creek, near center of SE¼ sec. 28, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation, 50 ft above base.
70		L103	R. L. Lupher, 1927? Southeast of Robertson Ranch house in SE¼ sec. 28, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Locality claimed by Lupher as in the Nicely Shale but the presence of *Docidoceras* shows that the locality must be in the Weberg Member of the Snowshoe Formation.
70		V86(=D88)	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. About 600 ft south of north end of ridge east of Dobson Creek, near center of SE¼ sec. 28, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation, 80 ft. above base.
71		V87(D89)	L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. Float along irrigation ditch 400 ft west of Freeman Creek and 1300 ft south of Beaver Creek, SW¼SW¼ sec. 27, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation.
72		L235	R. L. Lupher, 1928. On road to Allison guard station about 0.3 mile south of junction of Freeman Creek with Beaver Creek. SW¼ sec. 27, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation.
73	29399	I66-7-28A	R. W. Imlay and W. O. Ross, 1966. Just above ditch on south side of field west of Freeman Creek. SE¼SW¼SW¼ sec. 27, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, near top.
74	29239	I65-7-14A	R. W. Imlay and W. O. Ross, 1965. On east side of road up Freeman Creek about 0.4 mile south of junction with road along Beaver Creek. South central part of SE¼ SW¼ sec. 27, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, near top of lower third.
75		D100(56-77)	W. R. Dickinson, S. W. Muller, L. W. Vigrass, and J. H. Beeson, 1956. Roadcut at sharp bend in road west of Freeman Creek, SE¼NW¼ sec. 34, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Basey Member of Snowshoe Formation, near base.
76		L108	R. L. Lupher, 1927. From long strike ridge adjoining southwest side of upper part of Freeman Creek, probably southern half of NE¼ sec. 34, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Near eastern pinchout of Weberg Member of Snowshoe Formation.
77		D95	W. R. Dickinson, S. W. Muller, L. W Vigrass, and J. H. Beeson, 1956. Float at cellar entrance just west of road near Harris Ranch house on west fork of Freeman Creek. A couple hundred feet north of loc. D96 in same quarter section. Warm Springs Member of Snowshoe Formation, at top.
78		D96	W. R. Dickinson and L. W. Vigrass, 1957. Roadcut on bend in road at J. H. Harris Ranch house on west fork of Freeman Creek in NE¼SW¼ sec. 34, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Probably same spot as L109 and USGS Mesozoic loc. 29395. Warm Springs Member of Snowshoe Formation, near top.
78		L109	R. L. Lupher, 1927. Roadcut 1.3 miles south of junction of Freeman Creek with Beaver Creek near forest boundary. Probably near USGS Mesozoic loc. 29395 and Dickinson's loc. 96. NE¼SW¼ sec. 34, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, near top.
78	29395	I66-7-28B	R. W. Imlay and W. O. Ross, 1966. Roadcut on west side of road up west fork of Freeman Creek about 100 ft southeast of J. H. Harris Ranch house. Near center NE¼SW¼ sec. 34, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, near top.

Loc. No. (pl. 48)	Geological Survey Mesozoic localities	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
79	29813	I69-7-9C	W. O. Ross and R. W. Imlay, 1969. Roadcut in SE¼SW¼NW¼ sec. 32, T. 18 S., R. 26 E., Delintment Lake 15-min quad., Grant County, Oreg. Basey Member of Snowshoe Formation, probably at least 800 ft above base in area where member is about 1,400 ft thick.
80		D97	W. R. Dickinson and S. W. Muller, 1957. Low roadcut in valley of Freeman Creek. South central part of NE¼NW¼ sec. 3, T. 19 S., R. 26 E., Delintment Lake 15-min quad., Harney County, Oreg. Warm Springs Member of Snowshoe Formation, near top.
81	29808	I69-7-10F	R. W. Imlay, 1969. Cut on broad eastward curve in road to Allison guard station. SE¼NE¼NW¼ sec. ', T. 19 S., R. 26 E., Delintment Lake 15-min quad., Harney County, Oreg. Warm Springs Member of Snowshoe Formation, upper part.
82	29807	I69-7-10E	R. W. Imlay and W. O. Ross, 1969. Cut on road to Allison guard station. East-central part of SE¼NW¼ sec. 3, T. 19 S., R. 26 E., Delintment Lake 15-min quad., Harney County, Oreg. Warm Springs Member of Snowshoe Formation, near base.
83	29816	I69-7-8A	R. W. Imlay and W. O. Ross, 1969. Roadcut just east of small stream that flows into Dobson Creek, SE corner of NE¼NE¼ sec. 4, T. 19 S., R. 26 E., Delintment Lake 15-min quad., Harney County, Oreg. Basey Member of Snowshoe Formation. Probably 700-800 ft above base in area where member is about 1,000 ft thick.
84		D98	W. R. Dickinson and L. W. Vigrass, 1957. Roadcut at bend in road along west fork of Freeman Creek. South-central part of SE¼NW¼ sec. 3, T. 19 S., R. 26 E., Delintment Lake 15-min quad., Harney County, Oreg. Warm Springs Member of Snowshoe Formation, upper part.
85	29805	I69-7-10C	W. O. Ross and R. W. Imlay, 1969. Cut on road to Allison guard station. SE¼SE¼ NW¼ sec. 3, T. 19 S., R. 26 E., Delintment Lake 15-min quad., Harney County, Oreg. Warm Springs Member of Showshoe Formation, near top.
86		D101(56-74)	W. R. Dickinson, S. W. Muller, L. W. Vigrass, and J. H. Beeson, 1956. On road to Allison guard station, a little south of pass between Freeman Creek and Howard Valley, near center of NE¼SW¼ sec. 3, T. 19 S., R. 26 E., Delintment Lake 15-min quad., Harney County, Oreg. Basey Member of Snowshoe Formation, about 400 ft above base at place where member is about 1,000 ft thick.
86	29814	I69-7-10H	W. O. Ross and R. W. Imlay, 1969. Near top of hill on road to Allison guard station. Probably same place as Dickinson's locality 101, NE¼SW¼ sec. ·, T. 19 S., R. 26 E., Delintment Lake 15-min quad., Harney County, Oreg. Near Dickinson's loc. 101. Basey Member of Snowshoe Formation, about 400-450 ft above base in area where member is about 1,000 ft thick.
87	29812	I69-7-6A	R. W. Imlay, 1969. From ?00-400 ft west of Mowich Spring in cut on south side of road, NW¼SE¼ sec. ?, T. 19 S., R. 26 E., Delintment Lake 15-min quad., Harney County, Oreg. Basey Member of Snowshoe Formation, about 300 ft above base in area where member is about 1,000 ft thick.
87	29818	I69-7-3B	W. O. Ross and R. W. Imlay, 1969. Roadcut 100-200 ft west of Mowich Spring. NW¼ NE¼SE¼ sec. 3, T. 19 S., R. 26 E., Delintment Lake 15-min quad., Harney County, Oreg. Basey Member of Snowshoe Formation, probably 20 ft lower than USGS Mesozoic loc. 29812.
88	29400	I66-7-28C	R. W. Imlay and W. O. Ross, 1966. Cut on south side of road around north side of Big Mowich Mountain, near center of NE¼ sec. 3, T. 19 S., R. 26 E., Delintment Lake 15-min quad., Harney County, Oreg. From 8-12 ft below top of Weberg Member of Snowshoe Formation.
88	29817	I69-7-3A	W. O. Ross and R. W. Imlay, 1969. Same spot as USGS Mesozoic loc. 29400 but slightly higher in Weberg Member in beds transitional into Warm Springs Member of Snowshoe Formation.
89	29240	Bud 141	R. W. Imlay, W. O. Ross, and H. J. Buddenhagen, 1965. Roadcut about one mile NNE of Allison guard station, NE¼ SW¼SE¼ sec. 10, T. 19 S., R. 26 E., Delintment Lake 15-min quad., Harney County, Oreg. Warm Springs Member of Snowshoe Formation, about 150 ft above base.
90	27356	I58-8-22A	R. W. Imlay, 1958. Barrow pit about 1 mile northeast of Bear Valley guard station and 200 ft north of road to John Day, NE¼NW¼ sec. 7, T. 16 S., R. 30 E., Logdell 15-min quad., Grant County, Oreg. Snowshoe Formation, probably upper part of lower member.
91	26773	I57-7-31C	R. W. Imlay, 1957. North of Snowshoe Creek on northwest side of road from John Day to Izee at elevation of about 5,200 ft, SE¼ sec. 21, T. 16 S., R. 29 E., Logdell 15-min quad., Grant County, Oreg. Snowshoe Formation, lower part of middle member.
92	27570	I58-8-28C	R. W. Imlay and Reed Christner, 1958. North side of road from John Day to Izee, SE¼NW¼NE¼ sec. 22, T. 16 S., R. 29 E., Logdell 15-min quad., Grant County, Oreg. Snowshoe Formation, middle member.
93	29832	I69-6-28A	W. O. Ross and R. W. Imlay, 1969. Shaley beds in roadcut on east side of hill about 1½ miles by road south of Flagtail lookout tower, NW. cor. sec. 20, T. 16 S., R. 29 E., Izee 15-min quad., Grant County, Oreg. Snowshoe Formation, probably upper part of lower member.
94	27578	I59-6-27	R. W. Imlay, 1959. Roadcut at head of Snowshoe Creek near center of sec. 29, T. 16 S., R. 29 E., Izee 15-min quad., Grant County, Oreg. Snowshoe Formation, lower part of middle member.
95	26775	I57-7-31B	R. W. Imlay, 1957. On old road up Lewis Creek, 0.6 mile south of divide and 1.8 miles by road south of main road from John Day to Izee, slightly northeast of center of sec. 32, T. 16 S., R. 29 E., Izee 15-min quad., Grant County, Oreg. Snowshoe Formation, base of upper member just above Silvies Member.
96	26776	I57-7-31A and D119.	R. W. Imlay and W. R. Dickinson, 1957. Roadcut on main road from John Day to Izee about 100 yards up road from outcrop of conglomerate, SW¼ sec. 31, T. 16 S., R. 29 E., Izee 15-min quad., Grant County, Oreg. Snowshoe Formation, near base of middle member.
97	28028	D129	W. R. Dickinson, 1960. Cut on logging road about 90 ft east of bend at crest of divide between Bunton Creek and Duncan Hollow, north central part of SW¼NE¼ sec. 1, T. 17 S., R. 28 E., Izee 15-min quad., Grant County, Oreg. Snowshoe Formation, lower member, about 375 ft. above base of formation.
98	28029	D130	W. R. Dickinson, 1960. Roadcut on east side of logging road in west fork of Bunton Hollow, SE¼NE¼ sec. 1, T. 17 S., R. 28 E., Izee 15-min quad., Grant County, Oreg. Snowshoe Formation, lower part of middle member, about 700 ft above base of formation.
99	26759	D117(3-49-25).	R. W. Imlay and W. R. Dickinson, 1957. Roadcut on northwest side of Rosebud Creek about 125 yards east of largest draw between the mouths of Caps and Stonewall Creeks. Near center NW¼-NW¼ sec. 15, T. 17 S., R. 28 E., Izee 15-min quad., Grant County, Oreg. Snowshoe Formation near base of middle member and about 750 ft above base of formation.
100	27363	I58-8-26D	R. W. Imlay and Reed Christener, 1958. Roadcut on west side of Rosebud Creek just south of bend in road and about 100 yd north of creek crossing, NW¼SW¼-NW¼ sec. 15, T. 17 S., R. 28 E., Izee 15-min quad., Grant County, Oreg. Snowshoe Formation, lower part of middle member, about 750 ft above base of formation.

Loc. No. (pl. 48)	Geological Survey Mesozoic localities	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
101	26774	D116(3-49-26).	R. W. Imlay and W. R. Dickinson, 1957. Roadcut on west side of Rosebud Creek near junction with Caps Creek. SE¼NE¼ sec. 16, T. 17 S., R. 28 E., Izee 15-min quad., Grant County, Oreg. Snowshoe Formation, middle member, about 750 ft above base of formation.
102		L75	R. L. Lupher, 1927. On north side of knoll about 100 ft south of sharp bend in road and 300 ft south of South Fork Bridge, SW¼ sec. 30, T. 17 S., R. 28 E., Izee 15-min quad., Grant County, Oreg. Lower member of Snowshoe Formation, about 250 ft above base.
102	29230	I65-7-8C and D112.	W. O. Ross and R. W. Imlay, 1965. About 250 yd southeast of South Fork Bridge, on spur east of mouth of Sheep Creek, SE¼SW¼ sec. 30, T. 17 S., R. 28 E., Izee 15-min quad., Grant County, Oreg. Probably same as Lupher's loc. 75. Lower member of Snowshoe Formation, about 250 ft above base.
103	29237	I65-7-17A	W. O. Ross and R. W. Imlay, 1965. On north facing slope about 400 ft south of South Fork of John Day River, NE¼SE¼SW¼ sec. 30, T. 17 S., R. 28 E., Izee 15-min quad., Grant County, Oreg. Lower member of Snowshoe Formation, probably a little higher stratigraphically than USGS Mesozoic loc. 26756.
103	29238		R. W. Imlay, 1965. Collected about 10 ft higher stratigraphically than USGS Mesozoic loc. 29237.
104	26756	I57-7-16C and D113.	R. W. Imlay, 1957. On low, narrow spur projecting north into meadows along south side of South Fork of John Day River, North-central part of SW¼SE¼ sec. 30, T. 17 S., R. 28 E., Izee 15-min quad., Grant County, Oreg. Lower member of Snowshoe Formation, about 200-225 ft above base.
105		L74	R. L. Lupher, 1927. Half a mile east of South Fork Bridge and one-fourth of a mile south of the South Fork of John Day River at head of a small alluvial fan in a large draw, probably NE¼NE¼ sec. 31, T. 17 S., R. 28 E., Izee 15-min quad., Grant County, Oreg. Snowshoe Formation, middle member at least 1,500 ft above base of formation.
105		D114	W. R. Dickinson, 1957. On south side of South Fork of John Day River and on east slope of the largest gully between Sheep Creek and Buck Creek, NE¼NE¼ sec. 31, T. 17 S., R. 28 E., Izee 15-min quad., Grant County, Oreg. Snowshoe Formation, near top of middle member.
106	26758	D109	S. W. Muller, R. W. Imlay, W. R. Dickinson, L. W. Vigrass, and John Beeson, 1957. Bulldozer cut on open hillside east of head of Pole Canyon, about 500 ft east of county road, SE¼SW¼ sec. 3, T. 18 S., R. 27 E., Izee 15-min quad., Grant County, Oreg. Lower member of Snowshoe Formation about 500 ft above base.
107	26752	I57-7-19A and D105.	R. W. Imlay, 1957. Bed of Flat Creek, NW¼NW¼ sec. 15 (near north line), T. 18 S., R. 27 E., Izee 15-min quad., Grant County, Oreg. Lower member of Snowshoe Formation about 125 ft above base.
107	26753	I57-7-12B and D106.	R. W. Imlay, R. L. Lupher, and J. H. Beeson, 1957. Bed of Flat Creek, SW¼SW¼ sec. 10 (near south line), T. 18 S., R. 27 E., Izee 15-min quad., Grant County, Oreg. Lower member of Snowshoe Formation, 150-175 ft above base.
107	26754	I57-7-17C	R. W. Imlay, 1957. Bed of Flat Creek, about half way between localities 26753 and 26755. Lower member of Snowshoe Formation, about 185-190 ft above base.
107	26755	I57-7-17A and D107.	R. W. Imlay, 1957. Bed of Flat Creek' SW¼SW¼ sec. 10, T. 18 S., R. 27 E., Izee 15-min quad., Grant County, Oreg. Lower member of Snowshoe Formation, about 200 ft. above base.
108		D108(56-67)	S. W. Muller, 1956. On east slope of canyon of Flat Creek about 100 ft above bed of creek, NW¼NW¼ sec. 15, T. 18 S., R. 27 E. Izee 15-min quad., Grant County, Oreg. Lower member of Snowshoe Formation, about 250 ft above base.
109		L128	R. L. Lupher, 1937. On east side of Flat Creek, 100 ft above stream bed, and 250 yards N. 25° W. from mouth of first main tributary that comes into Flat Creek from the west below Big Flat, probably south-central part of NW¼ sec. 15, T. 18 S., R. 27 E., Izee 15-min quad., Grant County, Oreg. Probably same place as Dickinson's loc. 102. Snowshoe Formation, middle member.
109		D102	R. W. Imlay, W. R. Dickinson, and L. W. Vigrass 1956. Black mudstone and siltstone on open slope north of Flat Creek, SE¼NW½ sec. 15, T. 18 S., R. 27 E., Izee 15-min quad., Grant County, Oreg. Probably near Lupher's loc. 128. Snowshoe Formation, 60 ft below top in middle member.
110	26770		J. H. Beeson and R. W. Imlay, 1957. North side of road along Emigrant Creek, near center of NE¼ sec. 33, T. 20 S., R. 28 E., Sawtooth Creek 15-min quad., Harney County, Oreg. Snowshoe Formation.
111	26772		J. H. Beeson and R. W. Imlay, 1957. West side of road along Blue Creek, one-quarter mile north of junction with road along Emigrant Creek, near center of NE¼NW¼ sec. 34, T. 20 S., R. 28 E., Sawtooth Creek 15-min quad., Harney County, Oreg. Snowshoe Formation.
112	27579		R. W. Imlay, 1959. North side of road along Emigrant Creek about 800 ft west of junction with road up Blue Creek, near center of SE¼NW¼ sec. 34, T. 20 S., R. 28 E., Sawtooth Creek 15-min quad., Harney County, Oreg. Snowshoe Formation.
113	29410	166-7-30B	R. W. Imlay and W. O. Ross, 1966. North side of road along Emigrant Creek, near point where road bends from west to northwest, east central part of SE¼NE¼ sec. 33, T.20 S., R. 28 E., Sawtooth Creek 15-min quad., Harney County, Oreg. Snowshoe Formation.
114	25817	REW55-F18	R.E. Wallace and J. A. Calkins, 1955. Roadcut in south central part of SW¼ sec. 35 (near south line) T. 16 S., R. 30 E., Logdell 15-min quad., Grant County, Oreg. Snowshoe Formation.
115	25824	REW55-F35	R. E. Wallace and J. A. Calkins, 1955. On road southeast of Damon Creek, SE¼SE¼ sec. 2, T. 17 S., R. 30 E., Logdell 15-min quad., Grant County, Oreg. Snowshoe Formation.
116	25821	REW55-F26	R. E. Wallace and J. A. Calkins, 1955. In road-metal quarry west of railroad siding and west of road along Shirttail Creek. Along west boundary of NE¼ sec. 3, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg.
116	28017	14	C. I. Trantham, 1960. Near main chute in quarry west of railroad track, west of road along Shirttail Creek, and along west boundary of NE¼ sec. 3, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation, near top.
116	28018	14-1	C. I. Trantham, 1960. Same location as loc. 28017 except about 100 ft farther south.
116	28019	14-2	C. I. Trantham, 1960. Same as loc. 28018 except 5 ft farther south.
116	28020	14-3	C. I. Trantham, 1960. About 300 yd south of loc. 28017 and 50 ft north of a spring.
116	28021	14-4	C. I. Trantham, 1960. About 100 ft south of loc. 28020.
116	29232	I65-7-13B	W. O. Ross and R. W. Imlay, 1965. In quarry about 225 ft south of main chute on west side of old railroad track west of Seneca. Along west line of NE¼ sec. 3, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation.
116	29234	I65-7-13A	W. O. Ross and R. W. Imlay, 1965. About 170 ft south of main chute in quarry on west side of road along Shirttail Creek. Along west line of NE¼ sec. 3, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation.
117		L20	R. L. Lupher, 1927. Sandstone in new channel of Silvies River excavated by railroad company about a quarter mile below southern margin of Bear Valley, near west line of NW¼NW¼ sec. 2, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Described by Lupher as near east line of NE¼ sec. 3. Snowshoe Formation, probably slightly lower stratigraphically than Lupher's loc. 5.

Loc. No. (pl. 48)	Geological Survey Mesozoic localities	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
118		L5	R. L. Lupher, 1927. Shales in first roadcut south of Seneca at north end of Silvies Canyon, SW¼NW¼ sec. 2, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation.
118	28022	41	C. I. Trantham, 1960. East side of U.S. Highway 395 at first outcrop south of Seneca, NW¼ sec. 2, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation, near top.
118	29235	I65-7-16A	W. O. Ross, 1965. Same place as Mesozoic loc. 28022 and probably same as Lupher's loc. 5, NW¼ sec. 2, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation, near top.
119		L8	A. K. Guard, 1927. Conglomeratic sandstone about 40 ft thick on ridge northeast of road above shales of Lupher's loc. 28 at north edge of Soda Valley. Most fossils collected from talus between outcrop of conglomerate and road. All fossils are in pebbles. NE¼SW¼ sec. 2, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation.
119		L135	R. L. Lupher, 1937. Float from middle (?) part of conglomerate exposed at Lupher's loc. 8.
119		L136	R. L. Lupher, 1937. Float from lower part of conglomerate exposed at Lupher's loc. 8.
120		L28	A. K. Guard, 1927. From 200-250 ft of dark-gray shale containing some concretions exposed on northeast side of road at north edge of Soda Valley below conglomerate of Lupher's loc. 8 and above a basalt porphyry sill, NE¼SW¼ sec. 2, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation.
120		V242	L. W. Vigrass, 1957. Roadcut on northeast side of highway 0.6 mile south of Seneca. Probably from same place as Lupher's loc. 28. Snowshoe Formation.
120	29790	I69-6-24A	R. W. Imlay and W. O. Ross, 1969. From 25-30 ft below top of about 250 ft of dark shale which underlies conglomeratic sandstone on northeast side of U.S. Highway 395, NE¼SW¼ sec. 2, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. From upper part of same shale sequence as at Lupher's loc. 28. Snowshoe Formation.
120	29792	I69-6-24C	R. W. Imlay and W. O. Ross, 1969. From lower 30 ft of about 250 ft of dark shale exposed at USGS Mesozoic loc. 29790.
121	29236	I65-7-13D	W. O. Ross, 1965. East side of road along Shirttail Creek, south central part of SE¼SW¼ sec. 3 (near south line), T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation.
122	29231	I65-7-13C	W. O. Ross and R. W. Imlay, 1965. South side of road along Shirttail Creek, near center of NW¼ sec. 10, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation.
123	28026	60-1	C. I. Trantham, 1960. About 120 ft south of massive porphyry exposed in highway cut, SW¼NE¼ sec. 23, T. 17 S., R 31 E., Grant County, Oreg. Snowshoe Formation.
123	28027	60-2	C. I. Trantham, 1960. Sixty feet south of USGS Mesozoic loc. 28026.
123	29233	I65-7-16	W. O. Ross, 1965. On east side of U.S. Highway 395 near center of NE¼ sec. 23, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Probably same place as USGS Mesozoic loc. 28023. Snowshoe Formation.
124		L57	R. L. Lupher, 1927. Baked shale near prophyry in railroad cut between railroad and highway, near east line of section in SW. cor. sec. 23, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation.
125		L490	R. L. Lupher, 1931. Shale in roadcut at south end of Silvies Canyon between two points of porphyry. Near USGS Mesozoic loc. 21617 in NW¼ sec. 26, T. 17 S., R. 31 E., Seneca 15-min quad., Oreg. Snowshoe Formation.
125	21617	I49-8-20B	R. W. Imlay, 1949. Roadcut on east side of U.S. Highway 395 in Silvies Canyon, NW¼NW¼ sec. 26, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation.
126		L272	R. L. Lupher, 1929. From baked shale near porphyry intrusion exposed on west side of old road from Silvies to Seneca, 0.7 mile north of the Craddock Ranch house, SW¼SW¼ sec. 24, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation.
127		L56	R. L. Lupher, 1927. Shale on south side of road along Camp Creek about a quarter of a mile above gate of Pacific Livestock Company, south central part of SW¼ SE¼ sec. 34, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation.
127	26771	I57-4-8	J. H. Beeson and R. W. Imlay, 1957. South side of Camp Creek near center of SE¼ SE¼ sec. 34, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Snowshoe Formation.
127	29413	I66-7-21A	R. W. Imlay and W. O. Ross, 1966. From tuffaceous beds exposed along strike for about 600 ft from hilltop to hilltop in southern part of SE¼ sec. 34, T. 17 S., R. 31 E., Seneca 15-min quad., Grant County, Oreg. Includes same places as Lupher's loc. 56 and USGS Mesozoic loc. 26771. Snowshoe Formation.
128	25818	REW55-F19	R. E. Wallace and J. A. Calkins, 1955. About one-sixth of a mile north of road along Camp Creek, south central part NE¼SE¼ sec. 30, T. 17 S., R. 31 E., Logdell 15-min quad., Grant County, Oreg. Snowshoe Formation.
129	25692	REW55-F12	R. E. Wallace and J. A. Calkins, 1955. Borrow pit on east side of road along Crooked Creek, SE¼SW¼NW¼ sec. 2, T. 18 S., R. 30 E., Logdell 15-min quad., Grant County, Oreg. Snowshoe Formation.
130		L55	R. L. Lupher, 1927. Near forest margin on west side of Silvies Valley about half a mile southwest of Jump Creek, sec. 8, T. 18 S., R. 31 E., Logdell 15-min quad., Grant County, Oreg. Snowshoe Formation.
131	29415	I66-7-22A	W. O. Ross and R. W. Imlay, 1966. On hillside north of Flat Creek and 0.4 mile west of forest boundary NW¼SE¼SE¼ sec. 7, T. 18 S., R. 31 E., Logdell 15-min quad., Grant County, Oreg. Snowshoe Formation.
132	26777		J. H. Beeson, 1957. Water-laid tuff near road north of Hall Creek, NE¼NW¼ sec. 34, T. 18 S., R. 31 E., Calamity Butte quad., Grant County, Oreg. Snowshoe Formation.
133	28387		R. W. Imlay, N. S. Wagner, H. C. Brooks, and R. A. Duncan, 1961. About 9 miles south of town of Ironside in NE. cor. sec. 9, T. 16 S., R. 39 E., Clover Creek Ranch 15-min quad., Malheur County, Oreg. Unnamed beds.
134	27393		W. D. Lowry, 1957. Near Rail Canyon, at elevation of 5000 ft, in roadcut 300 ft east of west side and 1,000 ft north of south side of sec. 11, T. 16 S., R. 38 E., Ironside Mountain 30-min quad., Malheur County, Oreg. Unnamed beds.
135	28649	Wag 6a	N. S. Wagner, H. C. Brooks, and R. W. Imlay, 1962. Juniper Mountain, about 300 ft north of Pole Creek on west side of a gulch in SW¼SE¼NW¼ sec. 5, T. 16 S., R. 41 E., Brogan 15-min quad., Malheur County, Oreg. Unnamed beds.
135	28650	Wag 6b	N. S. Wagner and R. W. Imlay, 1962. Juniper Mountain. On hill about 150 ft northwest of USGS Mesozoic loc. 28649.
136	28382	Wagner 6	N. S. Wagner, Howard Brooks, and R. W. Imlay, 1962. Center of south line of SE¼NW¼ sec. 5, T. 16 S., R. 41 E., Brogan 15-min quad., Malheur County, Oreg. Unnamed beds.
137	28373	I61-7-18A	R. W. Imlay, George Kasch, and Jacob Nir, 1961. On Juniper Mountain near top of ridge 100 ft north of fence, SW. cor. of SW¼ sec. 5, T. 16 S., R. 41 E., Brogan 15-min quad., Malheur County, Oreg. Unnamed beds.
137	28374	I61-7-18B	R. W. Imlay, George Kasch, and Jacob Nir, 1961. About 100 ft north of USGS Mesozoic loc. 28373.
138	28380	Wag 60-3	N. S. Wagner, 1960. On Juniper Mountain near center of NE¼ sec. 7, T. 16 S., R. 41 E., Brogan 15-min quad., Malheur County, Oreg. Unnamed beds.

Loc. No. (pl. 48)	Geological Survey Mesozoic localities	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
139	28381	Wag 60-4	N. S. Wagner, George Kasch, and R. W. Imlay, 1961. Juniper Mountain in SE. cor. NW¼ sec. 7, T. 16 S., R. 41 E., Brogan 15-min quad., Malheur County, Oreg. Unnamed beds.
140	27583		Ernest Wolff, 1958. Nearly 1 mile east of Becker Creek in north-central part of NE¼SE¼ sec. 26, T. 14 S., R. 42 E., Bridgeport 15-min quad., Malheur County Oreg. Unnamed beds.
141	29111		N. S. Wagner, H. C. Brooks, and R. W. Imlay, 1964. North side of Durbin Creek on the Alvin Abrams Ranch, north central part of NE¼NW¼ sec. 7, T. 14 S., R. 44 E., Huntington 15-min quad., Baker County, Oreg. Unnamed beds.
142	29784	Brooks-3	H. C. Brooks, 1969. North side of road along Durbin Creek, near middle of NW¼ sec. 16, T. 14 S., R. 44 E., Huntington 15-min quad., Baker County, Oreg. Unnamed beds.
143	29782	I69-6-19A	H. C. Brooks, N. S. Wagner, W. O. Ross, and R. W. Imlay, 1969. Near elevation of 4,193 ft on south side of road in SW¼ SW¼ sec. 28, T. 14 S., R. 43 E., Huntington quad., Baker County, Oreg. Unnamed beds.

SUMMARY OF RESULTS

Middle Jurassic ammonites of early to late Bajocian age occur in east-central Oregon in several inliers spaced over a distance of about 120 miles, from 10 miles east of Paulina on the west to the Snake River on the east. In the Suplee area, which is farthest west, Bajocian ammonites occur throughout 1,100–2,650 feet of beds included in the Weberg, Warm Springs, and Basey Members of the Snowshoe Formation. Next to the east in the Izee area Bajocian ammonites occur in 1,600–2,400 feet of the Snowshoe Formation but not in the lowest 125 feet, which is of Toarcian age, or in the upper 1,000 feet, which is of Bathonian? to early Callovian age. A little farther east near Seneca the Snowshoe Formation appears to be much thicker, but its total thickness is unknown, and its oldest exposed Bajocian beds contain ammonites of the *Otoites sauzei* zone. About 60 miles east of Seneca in the Juniper Mountains southwest of Brogan, the Bajocian sequence is about 2,000 feet thick, and still farther east in the Huntington area is apparently several thousand feet thick. All these Bajocian beds contain considerable volcanic material derived from nearby volcanoes and, except in the Suplee area, apparently represent continuous deposition from Early Jurassic to early late Bajocian times. They were deposited in a sea that transgressed eastward far into the western interior of the continent and was most extensive in late Bajocian time.

Early Bajocian (Aalenian) beds characterized by the ammonite *Tmetoceras* have been identified (1) in the Suplee area in the basal part of the Weberg Member of the Snowshoe Formation, (2) in the Izee area from 125 to 200 feet above the base of the Snowshoe Formation, (3) in the Juniper Mountain area, and (4) in the Huntington area. *Tmetoceras* is associated with *Praestrigities* and *Eudmetoceras* in the Suplee area and and with fragments suggestive of *Planammatoceras* in the Izee area.

The middle Bajocian is well represented in many areas. Beds equivalent to the *Hyperlioceras discites* subzone at the base of the *Sonninia sowerbyi* zone include such ammonites as *Sonninia* (*Euhoploceras*), *Sonninia* (*Papilliceras*), *Asthenoceras*, *Eudmetoceras*, *Fontannesia*, *Hebetoxyites*, *Praestrigites*, *Strigoceras*, *Pelekodites*, and *Docidoceras*. Most of this assemblage has been found only in the Weberg Member of the Snowshoe Formation in the Suplee area. It comprises two faunules of which the upper may be distinguished from the lower by the presence of *S.* (*Euhoploceras*) *adicra* (Waagen), *S.* (*E.*) *crassispinata* Buckman, *Docidoceras lupheri* Imlay, n. sp., and *Witchellia* (*Latiwitchellia*) new subgenus. Beds of the same general age, identified by the presence of *Fontannesia*, occur also farther east in Oregon in the Clover Creek and the Juniper Mountain areas.

This ammonite assemblage, corresponding to the basal part of the *Sonninia sowerbyi* zone, has much more in common with ammonites of the same age in Europe than those in Alaska. Thus eastern Oregon and Europe contain the same highly variable species, or subspecies of *Sonninia* (*Euhoploceras*). Other species in common probably include most of those ammonites that are herein compared with European species of *Fontannesia*, *Eudmetoceras*, *Praestrigites*, *Strigoceras*, *Hebetoxyites* and *Docidoceras*. Differences with Europe consist mainly of the absence in Oregon of *Hyperlioceras* and the presence of *Latiwitchellia*, n. subgen., *Asthenoceras*, and *Papilliceras*. Resemblances with Alaska include the presence of similar, or possibly identical, species of *Eudmetoceras*, *Hebetoxyites*, *Asthenoceras*, and *Pelekodites*. Differences with Alaska include the absence in Alaska of *Fontannesia*, *Latiwitchellia*, *Papilliceras*, *Strigoceras*, and *Praestrigites* and the absence in Oregon of *Pseudolioceras*, *Alaskoceras*, and *Pseudocidoceras*. Part of these differences may reflect collecting failure, but part probably reflects facies or environmental differences related to the much greater amount of calcium carbonate deposited in Oregon at that time than in Alaska.

Beds equivalent to the *Shirbuirnia trigonalis* and *Witchellia laeviuscula* subzones of the *Sonninia sowerbyi* zone have been identified only in the Suplee area in the topmost beds of the Weberg Member and in the lower part of the Warm Springs Member of the Snowshoe Formation. These beds are characterized throughout by the presence of *Witchellia connata* (Buckman), *Sonninia* (*Papilliceras*) *stantoni* (Crickmay), *Asthenoceras delicatum* Imlay, n. sp., and *Stephanoceras* spp. In addition the basal beds of the Warm Springs Member contain *Fontannesia intermedia* Imlay, n. sp. The highest beds in the Weberg Member contain that species as well as *Stephanoceras juhlei* Imlay, *S.* cf. *S. dolichoecus* (Buckman), *S.* aff. *S. nodosum* (Quenstedt), *Sonninia* (*Papilliceras*) *stantoni* (Crickmay), and apparently also *Sonninia* (*Euhoploceras*) sp., and *Witchellia* (*Latiwitchellia*) *evoluta* Imlay, n. sp. at the top of their range.

These beds in the Weberg and Warm Springs members are not older than the *Shirbuirnia trigonalis* subzone, as shown by the presence of *Witchellia* proper and *Stephanoceras* throughout. They are not much younger basally, as shown by the presence of *Fontannesia*. They are older than the *Otoites sauzei* zone, as shown by their stratigraphic position below beds containing *Dorsetensia*, *Emileia*, and *Otoites*.

Beds equivalent to the European *Otoites sauzei* zone contain most of the ammonite genera just mentioned, except *Fontannesia*, but also include species of *Dorsetensia*, *Pelekodites*, *Lissoceras*, *Emileia*, *Parabigotites*, *Otoites*, and *Normannites*. The last two occur only near the top of the ranges of *Witchellia*, *S.* (*Papilliceras*), and *Emileia*. Otherwise all these ammonites are present in the middle to upper parts of the Warm Springs Member in the Suplee area, in the upper part of the lower member of the Snowshoe Formation in the Izee area, in the lower exposed part of that formation in Silvies Canyon about 4 miles south of Seneca, and in unnamed beds in the Clover Creek drainage of the Ironside Mountain quadrangle.

The highest part of the *Otoites sauzei* zone is probably represented also in the lower part of the Basey Member of the Snowshoe Formation even though those beds lack *Witchellia*, *Papilliceras*, *Otoites* and *Parabigotites*. The evidence consists of five ammonite species that range upward from the Warm Springs Member but do not range higher, the absence of any genera characteristic of the *Stephanoceras humpriesianum* zone, and, by comparison with Alaska (Imlay, 1964a, p. B7, B15), the association of *Stephanoceras kirschneri* Imlay at the bottom of its range with *S. juhlei* Imlay at the top of its range. A similar association of ammonites, occurring about four miles south of Seneca (Lupher's loc. 272), also contains *Sonninia* and is unlikely, therefore, to be younger than the *Otoites sauzei* zone.

These ammonites representing the *Otoites sauzei* zone bear close affinities both with Alaska and with Europe. Species in common with Alaska include *Parabigotites crassicostatus* Imlay, *Normannites? kialagvikensis* Imlay, *Stephanoceras kirschneri* Imlay, *S. juhlei* Imlay, and probably *Otoites contractus* (J. de C. Sowerby). Species in common with Europe include *Witchellia connata* (Buckman), *Otoites contractus* (J. de C. Sowerby) and *Normannites formosus* Buckman. In addition, species in common with Europe probably include many of those that are compared with European species of *Sonninia* (*Papilliceras*), *Dorsetensia*, *Normannites*, and *Stephanoceras*.

Beds equivalent to the European *Stephanoceras humphriesianum* zone contain such ammonites as *Dorsetensia*, *Pelekodites*, *Poecilomorphus*, *Chondroceras*, *Sphaeroceras*, *Normannites*, *Stephanoceras*, *Teloceras*, *Stemmatoceras?* and probably *Zemistephanus*. Of these, *Chondroceras*, *Teloceras*, *Stemmatoceras?* and *Zemistephanus?* occur above the local range of *Dorsetensia*, are equivalent to the upper part of the *Stephanoceras humphriesianum* zone, and characterize the top of the Basey Member of the Snowshoe Formation in the Suplee area, the Snowshoe Formation undifferentiated near Emigrant Creek, and the middle ammonite assemblage of the Snowshoe Formation south of Seneca. The lower part of the *S. humphriesianum* zone has been identified only in the middle part of the Basey Member by an association of *Sphaeroceras* with *Dorsetensia* and *Stephanoceras*.

These ammonities representing the *Stephanoceras humphriesianum* zone have stronger affinities with Alaska than with Europe. Species in common with Alaska include *Chondroceras allani* (McLearn), *Normannites crickmayi* (McLearn), *Stephanoceras kirschneri* Imlay, *Teloceras itinsae* (McLearn), and probably include species that are compared herein with *Normannites itinsae* (McLearn) and *Zemistephanus richardsoni* (Whiteaves). Species from Oregon that are similar to species from Europe are described herein under *Poecilomorphus*, *Chondroceras*, *Sphaeroceras*, *Normannites*, *Stephanoceras*, *Stemmatoceras*, and *Teloceras*, but the only identical species appears to be *Normannites orbignyi* Buckman.

Beds equivalent to the lower part of the upper Bajocian of Europe contain the ammonites *Leptosphinctes*, *L.* (*Prorsisphinctes?*), *Spiroceras*, *Sphaeroceras*, *Normannites*, *Stephanoceras*, *Teloceras? Zemistephanus?*, the new genus *Lupherites*, and probably *Megasphaeroceras*. This faunule occurs (1) at and near the top of the Snowshoe Formation west and immediately south of Seneca and (2) much farther east in unnamed beds in the Juniper Mountains south of Brogan, and (3) in the Huntington area. It bears stronger affinities with upper Bajocian ammonites of Europe than of Alaska. Species in common with Europe include *Spiroceras bifurcatum* (Quenstedt) and *S. annulatum* (Deshayes).

Species closely similar to species in Europe include *Sphaeroceras* cf. *S. brongniarti* (J. de C. Sowerby), *Normannites* aff. *N. orbignyi* Buckman, and *Leptosphinctes* cf. *L. leptus* Buckman. Species identical with Alaskan species includes only *Megasphaeroceras rotundum* Imlay but probably includes *Leptosphinctes* cf. *L. evolutus* Imlay. The upper Bajocian ammonites from eastern Oregon differ from those in Europe in lacking any species of the Parkinsoniidae and in having *Megasphaeroceras*. They differ from those in Alaska in having different species of *Normannitics* and *Sphaeroceras*, in lacking representatives of *Lissoceras* and *Oppelia* (*Liroxyites*) and in having a fair abundance of *Spiroceras* which genus is questionably represented in Alaska.

Close faunal resemblances of the Bajocian ammonites of eastern Oregon with those of Alaska and Europe show that marine connections existed with both regions. One connection with Europe via the Arctic region seems reasonable, when one considers the known distribution of Bajocian rocks in Alaska, Canada, and Greenland. Another marine connection with Europe either through Central America or around South America also seems reasonable during times when the ammonite faunules of eastern Oregon had greater affinities to those of Europe than of Alaska. Such times are represented in Oregon by early middle Bajocian beds characterized by *Euhoploceras* and by late Bajocian beds characterized by *Spiroceras*.

Bajocian ammonities from eastern Oregon are assigned to 12 families and 42 genera and subgenera. The Sonninidae, Hildoceratidae, and Stephanoceratidae are the dominant families, constituting 83 percent of the specimens and 52 percent of the genera and subgenera present. The six most common genera in decreasing order of abundance are *Asthenoceras*, *Sonninia*, *Dorsetensia*, *Stephanoceras*, *Pelekodites*, and *Tmetoceras*. One new genus *Lupherites* resembles *Polyplectites*. One new subgenus *Witchellia* (*Latiwitchellia*) resembles "*Zugophorites*" Buckman. Eighteen new species are described.

SYSTEMATIC DESCRIPTIONS

Family PHYLLOCERATIDAE Zittel, 1884
Genus PHYLLOCERAS Suess, 1865

Phylloceras spp.

Plate 1, figure 17, plate 2, figure 9

This genus is represented by two laterally crushed septate specimens. One specimen (pl. 1, fig. 17) has very fine, dense radial lirae similar to those on *Phylloceras kunthi* Neumayr (1871, p. 312, pl. 13, figs. la, b). The other specimen (pl. 2, fig. 9) has slightly flexuous ribs that are fine and closely spaced near the umbilicus but become a little coarser and fairly widely spaced ventrally. Its suture line is worn but shows a bifid external saddle and a trifid first lateral saddle. Both specimens have vague broad radial folds, and neither have constrictions.

Figured specimens.—USNM 168490 and CAS 13327.

Occurrences.—Snowshoe Formation, lower part of Weberg Member, at Lupher's loc. 468; Snowshoe Formation undifferentiated near Seneca at USGS Mesozoic loc. 29790.

Genus CALLIPHYLLOCERAS Spath, 1927

Calliphylloceras sp.

Plate 1, figures 1, 2

Four specimens are assigned to *Calliphylloceras*, rather than *Holcophylloceras*, because of the presence of fine dense raised lines, or lirae on their shells, and because the constrictions present are only gently sigmoidal, are confined mostly to the internal molds, and are represented by weak flares on the surface of the venter.

Figured specimen.—Stanford University Museum Paleontology 10006.

Occurrences.—Snowshoe Formation, upper part of Weberg Member, at Lupher's loc. 228X, 230, 584, and Vigrass' loc. 152.

Genus HOLCOPHYLLOCERAS Spath, 1927

Holcophylloceras sp.

Plate 1, figures 18–21, plate 2, figures 7 and 8.

Holcophylloceras is represented in the Bajocian beds of eastern Oregon by 50 small internal molds, of which a few retain some shell material. These molds have a moderately compressed shell, from six to seven acutely sigmoidal contrictions per whorl, and very weak riblets on the venter and on the upper parts of the flanks at diameters greater than about 35 mm. The suture line has diphyllic saddles.

The specimens closely resemble immature forms of *H. costisparsum* (Imlay (1964a, p. B32, pl. 1, figs. 11, 12) from beds of Bajocian age in the Cook Inlet region, Alaska, and possibly belong to that species.

Figured specimens.—CAS 13328–13330.

Occurrences.—Snowshoe Formation, Weberg Member at USGS Mesozoic locs. 21611, 26768, 27735, Lupher's locs. 210, 228N, and 313, and Vigrass' loc. 155; Warm Springs Member at Mesozoic locs. 26767, 29239, Lupher's locs. 206, 211, 235, 237, 476, 561, 566, and Vigrass' locs. 10 and 149; Basey Member at Mesozoic locs. 26769 and 29818; lower member at Mesozoic loc. 29237 and Lupher's loc. 75; middle member at Mesozoic loc. 26773. Also present in unnamed beds in the Juniper Mountain area of Malheur County at Mesozoic loc.

28381. The species is represented by 6 specimens from the Weberg Member, 35 from the Warm Springs Member, 3 from the lower member, and 1 from each of the other members or units listed.

Family SPIROCERATIDAE Hyatt, 1900
Genus SPIROCERAS Quenstedt, 1858

Spiroceras bifurcatum (Quenstedt)

Plate 1, figures 3–8.

Hamites bifurcati Quenstedt, 1858, pl. 55, figs. 1–12.
Hamites bifurcati Quenstedt, 1886, pl. 70, figs. 27–44.
Ancyloceras tenue Douville (not d'Orbigny), 1916, pl. 3, figs. 12a, b.
Spiroceras bispinatum (Baugier and Sauzé). Roman and Petouraud, 1927, pl. 3, figs. 13–20, pl. 4, figs. 1–13, pl. 5, figs. 7–11.
Spiroceras bifurcatum (Quenstedt). Potonie, 1929, pl. 17, figs. 4–8, pl. 18, figs. 26–28.

This species is represented near Seneca, Oreg. by 22 molds that exhibit considerable variation in coarseness of ribbing. Some (pl. 1, figs. 3, 4, 8) are as coarsely ribbed as the lectotype (Potonie, 1929, pl. 17, fig. 4; Arkell and others, 1957, p. L205, fig. 235–1a), and others are considerably finer ribbed. The ribs are narrow, high, fairly widely spaced, incline slightly forward on the flanks, become a little stronger ventrally, and terminate in prominent tubercles that bound a smooth mid-ventral area. In addition, a row of weak radially elongate tubercles, or swellings, occur on the ribs high on the flanks.

Types.—Hypotypes, USNM 168491–168495.

Occurrences.—Near top of Snowshoe Formation undifferentiated near Seneca at USGS Mesozoic locs. 28017, 28022, 29232, and 29234; unnamed beds in Juniper Mountain area at Mesozoic loc. 28650.

Spiroceras annulatum (Deshayes)

Plate 1, figures 9–16

Ancyloceras annulatum Deshayes. d'Orbigny, 1850, p. 576, pl. 225, figs. 1–7.
Ancyloceras tenue Douville (not d'Orbigny), 1916, pl. 3, figs. 11a, b, 13a, b.
cf. *Spiroceras toxoconicum* Buckman, 1924, *Type Ammonites*, v. 5, pl. 492.
Spiroceras annulatum (Deshayes). Roman and Petouraud, 1927, p. 33, pl. 3, fig. 21, pl. 5, fig. 15–19.
Spiroceras bifurcatum annulatum (Deshayes). Potonie, 1929, v. 50, p. 240, pl. 17, figs. 19–25a.

Twenty specimens from Oregon differ from *Spiroceras bifurcatum* in having finer and more closely spaced ribs, less reduced ribbing along the midventral line, and weaker ventral tubercles.

Types.—Hypotypes, USNM 168496, 168497, 168499–168502.

Occurrences.—Near top of Snowshoe Formation undifferentiated near Seneca at USGS Mesozoic locs. 28018 and 29232 and questionably at loc. 29236; unnamed beds in Juniper Mountain area at Mesozoic loc. 28650.

Family HILDOCERATIDAE Hyatt, 1867
Genus ASTHENOCERAS Buckman, 1899

Asthenoceras delicatum Imlay, n. sp.

Plate 3, figures 1–32, plate 4, figures 3–6

This species is represented by about 380 specimens. Of these 85 are from the middle and upper parts of the Weberg Member of the Snowshoe Formation, 215 from various parts of the Warm Springs Member, 3 from the base of the Basey Member, 14 from the lower 200 to 600 feet of the lower member of the Snowshoe Formation near Izee, 3 from the Snowshoe Formation undifferentiated in Silvies Canyon south of Seneca, and 60 from unnamed beds on Juniper Mountain in the Brogan quadrangle.

The shell is compressed and evolute. The whorls are subovate in section, higher than wide, vary considerably in thickness relative to the height, embrace the preceding whorl from one-fourth to one-third, and are most evolute on the body whorl. The flanks are gently to moderately rounded. The umbilical wall is low, nearly vertical at its base, and rounds evenly into the flanks. The venter is narrowly to moderately rounded and bears a fairly high hollow floored keel that is bordered by furrows. The body chamber occupies a little more than half a whorl and on three specimens terminates in elongate lateral lappets. Other specimens that are appreciably larger are either broken at the adoral end of their body chambers or appear to terminate in a simple aperture.

The inner whorls are smooth or bear faint swellings to a diameter of about 8 mm. The succeeding septate whorls bear ribs that vary considerably in coarseness, density and flexuosity from one specimen to another and even during the growth of a single specimen. Nonetheless about 90 percent of the specimens are finely ribbed, and only 10 percent are moderately to coarsely ribbed.

The finely ribbed septate whorls are characterized by fine, dense, gently falcoid unforked ribs and striae that extend from the umbilical seam to the keel, become slightly stronger ventrally, and project forward on the margins of the venter. In addition, these septate whorls generally bear low broad radial swellings or undulations on the lower parts of their flanks. Adorally on the penultimate whorl and on the body chamber of the finely ribbed specimens, the ribs gradually become a little stronger, more widely spaced, more falcoid; some bifurcate near the middle of the flanks, and some arise on the flanks as continuations of striae.

The moderately to coarsely ribbed variant differs from the finely ribbed variant in having coarser and more widely spaced ribs and more distinct rib furcation, and in lacking radial swellings on their septate whorls. Ten of these specimens (pl. 3, figs. 1–11) in particular have so much coarser ribbing than the finely ribbed specimens that they would normally be assigned to a different species except for the presence of a number of transitional forms (pl. 3, figs. 12–14).

The suture line is simple. The first lateral saddle is very broad. The ventral lobe is a little stouter than the first lateral lobe which is irregularly trifid. The suspensive lobe trends nearly straight to the umbilical seam.

The dimensions in millimeters and ratios of the diameter (in parentheses) are as follows:

Specimens	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype (pl. 3, figs. 19, 20)	27	9.5(0.35)	7.5(0.28)	11(0.41)
Paratype (pl. 3, fig. 26)	20	8 (.40)	6.5(.32)	7(.35)
Paratype (pl. 3, fig. 27)	21	8 (.38)	6 (.29)	8(.38)
Paratype (pl. 4, figs. 5, 6)	28.5	11 (.40)	10.5(.37)	10(.35)
Paratype (pl. 3, fig. 3)	28	9 (.32)	7.5(.27)	12(.43)
Paratype (pl. 3, figs. 5, 6)	32	11.5(.36)	9 (.28)	13(.41)

The septate whorls of *Asthenoceras delicatum* Imlay, n. sp. closely resemble the type specimens of *Asthenoceras nannodes* (Buckman) (1899, p. XLIX; 1889, p. 213, pl. 33, figs. 13–16) from the zone of *Ludwigia murchinsonae* in England. They differ by having stouter whorls and somewhat stronger ribs that project forward much more strongly on the margins of the venter. The most finely ribbed variants of the Oregon species have appreciably coarser ribbing than the specimens of *Asthenoceras* from Wide Bay on the Alaska Peninsula described by Westermann (1969, p. 61, pl. 14, figs. 1–7). *Asthenoceras* is represented elsewhere in Alaska by one specimen that probably belongs to the coarsely ribbed variant of *A. delicatum*. This specimen (pl. 4, figs. 1, 2) was obtained in the basal part of the Tuxedni Formation of the Talkeetna Mountains at USGS Mesozoic loc. 24137.

Types:—Holotype, CAS 13331; paratypes, CAS 13332–13347; Stanford University Museum Paleontology 10007–10014; USNM 168503.

Occurrences.—Snowshoe Formation, Weberg Member at Lupher's locs. 228, 228N, 305, 306, 313, 474, and 609, Vigrass' locs. 15, 16, and 112, USGS Mesozoic locs. 21611, 26768, 27735, 29827, 29828; Warm Springs Member at Lupher's locs. 116, 206, 232, 298, 316, 482, 560, and 561, Vigrass' locs. 10, 18, 166, and 403, USGS Mesozoic locs. 29239 and 29240; lower member near Izee at Mesozoic locs. 26756 and 26758; Snowshoe Formation undifferentiated at Lupher's loc. 490 in Silvies Canyon; basal beds of Basey Member at Dickinson's loc. 100; unnamed beds at USGS Mesozoic locs. 28381 and 28387 on Juniper Mountain in the Brogan quadrangle, Malheur County.

This species in the Suplee area ranges from the middle part of the Weberg Member into the basal part of the Basey Member. This range, on the basis of associated ammonites, corresponds with the European *Sonninia sowerbyi* zone and the *Otoites sauzei* zone. It occurs higher, therefore, than *A. nannodes* (Buckman) from the *Ludwigia murchisonae* zone of England (Buckman, 1889, p. 214).

Asthenoceras? sp.

Plate 35, figure 10

This species is represented by one laterally compressed internal mold which shows two outer septate whorls and most of the adult body chamber. The shell has highly evolute coiling, a wide umbilicus, and somewhat flattened flanks that round evenly into a low steeply inclined umbilical wall. The venter bears a low keel that is bordered by narrow smooth areas. The body chamber occupies about three-fifths of a whorl and terminates in an elongate lateral lappet.

The ribs on the innermost exposed whorl are variably fine, gently flexuous, and become slightly stronger ventrally. They trend forward on the lower third of the flanks, trend backward on most of the remainder of the flanks, and then curve gently forward on the venter. The ribs near the adapical end of the outermost septate whorl become abruptly much stronger, more widely spaced, and rursiradiate. On the adoral half of the same whorl the ribs do not recurve forward on the venter. Adorally on the body chamber the ribs become stronger and more widely spaced, remain strongly rursiradiate and persist to the aperture.

The suture line is poorly preserved but appears to have essentially the same plan as on *Asthenoceras delicatum* Imlay, n. sp.

This species has much finer ribbing on its innermost exposed whorl than occurs on any of the species that were referred to *Pelekodites* by Arkell (1954, p. 563). This feature suggests a generic relationship with the species herein described as *Asthenoceras delicatum* Imlay, n. sp. It differs, however, by being more evolute, by its ribs not projecting strongly forward on its septate whorls, and by its ribs becoming rursiradiate on its outermost whorl.

Figure specimen.—USNM 168505.

Occurrence.—Snowshoe Formation, upper part of Weberg Member at USGS Mesozoic loc. 21611.

Genus FONTANNESIA Buckman, 1902

Fontannesia costula Imlay, n. sp.

Plate 4, figures 16–26

This species, represented by 20 internal molds, is characterized by evolute coiling, a prominent keel, and faint ribbing. Its whorls are subovate in section, much higher than wide, and flattened on their sides. The umbilical wall is gently inclined and merges evenly into the flanks. The venter is narrow and bears a prominent narrow keel that is bordered by narrow flattened areas. A complete body chamber, present on the holotype, occupies a little more than half a whorl. The aperture is sinuous on the flanks and is prolonged ventrally as a lappet which is broken.

On the septate whorls the lower parts of the flanks are nearly smooth but under oblique lighting show radial trending striae and faint undulations. These pass a little below the middle of the flanks into very weak closely spaced ribs that incline backward on the flanks and then sharply forward on the margins of the venter. The ribs are strongest along the zone of greatest rib curvature, terminate abruptly before reaching the keel, and become slightly stronger toward the aperture. On the body chamber the lower parts of the flanks are likewise nearly smooth, but the highest parts of the flanks bear fairly distinct ribs that curve forward and then end abruptly along narrow flattened areas bordering the keel.

The suture line has a fairly broad first lateral saddle and a fairly narrow, trifid first lateral lobe that is considerably longer than the ventral and second lateral lobes. The suspensive lobe descends gradually to the umbilical seam.

The holotype, which has been somewhat crushed, at a maximum diameter of 85 mm, has a whorl height of 25 mm, a whorl thickness of 15? mm, and an umbilical width of 38 mm.

In its smooth appearance, this species resembles some specimens of *Fontannesia whitehousei* Arkell (1954, p. 566, pl. 29, figs. 3, 6, 8) from western Australia. That species, however, has strongly ribbed inner septate whorls and completely smooth outer whorls, whereas on the Oregon species the ribs are faint to weak on all whorls and are strongest on the body chamber.

Fontannesia costula Imlay, n. sp. closely resembles *F. intermedia* Imlay, n. sp. in shape and coiling. It differs by having much weaker ribbing and apparently also a more prominent keel. It is not considered a variant or subspecies of *F. intermedia* because the collections do not contain any specimens that have ribbing of intermediate strength.

Types.—Holotype, CAS 13348; paratypes CAS 13349–13351; Stanford University Museum of Paleontology 10015, 10016.

Occurrences.—Snowshoe Formation, Weberg Member at Luphur's locs. 228, 228N, 370 and 584, Vigrass' locs. 8 and 241, and USGS Mesozoic loc. 29828.

The species ranges through the upper two-thirds of the Weberg Member in those areas where the upper limestone division of the member is fully developed.

Fontannesia intermedia Imlay, n. sp.

Plate 4, figures 7–15

This species is represented by 27 internal and external molds. The shell is compressed and evolute. The whorls are subovate in section, are much higher than wide, embrace from one-fourth to one-fifth of the preceding whorl and become more evolute during growth. The flanks are flattened. The umbilical wall is gently inclined and merges evenly into the flanks. The venter is narrow, fastigate, and bears a fairly prominent hollow unfloored keel that is bordered by narrow flattened areas. An incomplete body chamber is represented by half a whorl on the largest specimen.

The ribs on the small septate whorls are mostly simple, gently falcoid, fairly closely spaced, faint on the lower part of the flanks and weak on the upper part. Adorally on the larger septate whorls the ribs gradually become a little stronger, more widely spaced, and more distinct. Some ribs bifurcate low on the flanks, and many ribs arise freely on the upper part of the flanks. On the outermost nonseptate half whorl the ribs are distinct on the entire flank but become stronger ventrally.

Fontannesia intermedia Imlay, n. sp. differs from *F. luculenta* Buckman (1905, p. CLXXXIX; 1902, pl. 46, figs. 4, 5, 8, pl. 47, figs. 10–12) from England and from the Oregon specimens herein compared with that species in having finer, denser ribbing, a distinctly higher keel, more evolute coiling, and a more compressed shell. Compared with species from western Australia, it shows some resemblance to the densely ribbed variety of *F. clarkei* (Crick) figured by Arkell (1954, pl. 29, figs. 1, 2, pl. 30, fig. 2) but differs by having finer ribbing on its inner whorls, and much coarser ribbing on its outer whorls. It is more evolute and has much finer ribbing on its inner whorls than some specimens of *Fontannesia* from New Guinea described by Westermann and Getty (1970, p. 238–244, pls. 48, 49).

The suture line is poorly preserved but has a very broad first lateral saddle and a slender, trifid first lateral lobe that is a little longer than the ventral lobe.

The small specimen shown on plate 4, figures 10, 11 at a diameter of 43 mm has a whorl height of 16 mm, a whorl thickness of 10.5 mm, and an umbilical width of 16 mm. These dimensions do not include the keel which is about 2.5 mm high.

Types.—Holotype, CAS 13352; paratypes CAS 13353, 13354; Stanford University Museum of Paleontology 10017.

Occurrences.—Snowshoe Formation, Weberg Member at USGS Mesozoic locs. 21613, 26761, 26766; Lupher's locs. 228N, 228W, 228X, 239, 410; Vigrass' locs. 16, 121a, and 205; Warm Springs Member, near base, at Lupher's loc. 232 and Vigrass' loc. 18. The species ranges through the upper limestone division of the Weberg Member into the basal beds of the Warm Springs Member.

Fontannesia cf. F. luculenta Buckman

Plate 5, figures 14–19

cf. *Fontannesia carinata* Buckman, 1905. Palaeontographical Soc. of London, supplement p. CLXXXIX; 1892, pl. 46, figs. 4, 5, 8, pl. 47, figs. 10–12.

This species is represented by 16 internal molds. It is characterized by moderately strong, gently falcoid ribs that persist onto the body chamber. The shell is moderately compressed and fairly evolute. The whorls are ovate in section, much higher than wide, and embrace about one-third of the preceding whorl. The flanks are somewhat flattened. The umbilical wall is steep at its base, gently inclined above, and rounds evenly into the flanks. The venter is fastigate and bears a low keel that becomes very weak adorally on the body chamber. The keel is hollow and unfloored. The body chamber occupies about half a whorl. The aperture is sinuous on the flanks and is prolonged ventrally as a lappet which is broken.

The ribs on the flanks are moderately strong, moderately spaced, gently falcoid, and persist onto the adult body chamber. They begin on the umbilical wall, become stronger ventrally on the flanks, are strongest on the margins of the venter, and then fade out rather abruptly. Most ribs remain simple, but a few bifurcate low on the flanks. Adorally on the body chamber the ribs gradually become stronger except near the aperture where they become slightly weaker, especially on the lower part of the flanks.

The suture line has a broad, bifid first lateral saddle. Its first lateral lobe is moderately long, trifid, and appreciably longer than the ventral lobe or the second lateral lobe. Its suspensive lobe descends slightly to the umbilical seam.

The specimen shown on plate 5, figure 15 appears to be only slightly compressed laterally. At a diameter of 73 mm its whorl height is 27 mm, its whorl thickness is 20.5 mm, and its umbilical width is 30 mm.

This Oregon species resembles *Fontannesia luculenta* Buckman (1905, p. CLXXXIX; 1892, pl. 46, figs. 4, 5, 8, pl. 47, figs. 10–12; Arkell, 1954, fig. 5 on p. 564) from England in whorl shape, coiling, and ribbing and may belong to that species. It appears to differ, however, by having slightly stronger ribbing on its umbilical slope and by developing an adult body chamber at a much smaller size. Its inner septate whorls likewise resemble those of *F. clarkei* (Crick) (Arkell, 1954, p. 565, pl. 28, pl. 29, figs. 1, 2, pl. 30, figs. 1–4) from Australia, but its outer septate whorls differ by retaining ribbing instead of becoming smooth. *F.* aff. *F. clarkei* (Crick) from New Guinea (Westermann and Getty, 1970, p. 238, pls. 48, 49) differs from the Oregon species in having a much more prominent keel and in its ribs projecting more strongly on the margins of the venter.

Figured specimens.—CAS 13355 and 13356.

Occurrences.—Snowshoe Formation, middle and upper parts of the Weberg Member at USGS Mesozoic locs. 21611, 26760, 27733 and Lupher's locs. 228, 228X, 228W, 355 and 475. Unnamed beds in the Clover Creek area at Mesozoic loc. 28387, and in the Brogan quadrangle at Mesozoic loc. 28381.

Fontannesia cf. F. carinata Buckman

Plate 5, figures 4–13

cf. *Fontannesia carinata* Buckman, 1905. Palaeontographical Soc. of London, p. CLXXXIX; 1892, pl. 47, figs. 13, 14.

Nineteen internal molds belong to a species that is characterized by fairly coarse, strongly falcoid ribs. The shell is moderately compressed and fairly evolute. The whorls are ovate to subquadrate in section, a little higher than wide, and embrace about one-third of the preceding whorl. The flanks are somewhat flattened on small specimens and gently rounded on larger septate specimens. The umbilical wall is moderately to steeply inclined and rounds evenly into the flanks. The venter on small specimens is fastigate and bears a low keel. During growth the venter becomes evenly rounded and the keel weakens and disappears. The body chamber on the largest specimen occupies about three-fifths of a whorl and is incomplete.

The ribs are strongly falcoid, fairly coarse and moderately spaced. On septate specimens the ribs begin weakly on the umbilical wall, become strong on the flanks, are strongest on the margins of the venter, and then fade out rather abruptly before reaching the keel. Most ribs remain simple, but a few bifurcate a little below the middle of the flanks. Adorally on the body chamber the ribs fade out on the umbilical wall, become less falcoid but stronger on the flanks, and are projected across the venter as broad low swellings.

The suture line has a moderately broad, bifid first lateral saddle, an equally broad trifid first lateral lobe that is a little longer than the ventral and second lateral lobes.

The specimen shown on plate 5, figures 7, 8 at a diameter of 61 mm, has a whorl height of 22 mm, a whorl thickness of 18 mm, and an umbilical width of 21 mm.

These Oregon specimens fit very well into the species concept of *Fontannesia grammoceroides* (Haug) as defined by Buckman (1892, p. 262) before he subdivided that species. Among those subdivisions, the Oregon specimens most closely resemble *F. carinata* Buckman (1905, p. CLXXXIX; 1892, pl. 47, figs. 13, 14) from England, but differ by having a slightly lower and weaker keel that disappears on the body chamber. Except for their strongly falcoid ribs, the Oregon specimens likewise resemble *F. explanata* Buckman (1905, p. CLXXXVIII; 1892, pl. 46, figs. 6, 7) and *F. grammoceroides* (Haug) as restricted by Buckman (1905, p. CLXXXVII; 1892, pl. 46, figs. 1–3; pl. 47, figs. 15–17). *F. fairbridgei* Arkell (1954, p. 563, pl. 27, figs. 1–4) from Australia differs by having wider and sparser ribs and a higher and more persistent keel.

Figured specimens.—CAS 13357–13361.

Occurrences.—Snowshoe Formation, middle and upper parts of Weberg Member at USGS Mesozoic locs. 26768 and 29824; Lupher's loc. 226, 228, 228X, 355; and Vigrass' loc. V121a.

Fontannesia cf. F. evoluta (Buckman)

Plate 5, figures 1–3

Cf. *Nannina evoluta* Buckman, 1927, v. 7, pl. 752.

One internal mold from eastern Oregon has highly evolute coiling, a low hollow unfloored keel, and moderately strong, fairly widely spaced ribs that trend radially or slightly forward on the flanks and then curve forward on the margins of the venter. Its overall appearance is similar to that of *F. evoluta* (Buckman), but at a comparable size its ribbing is slightly denser and its umbilicus is slightly wider.

Figured specimen.—Stanford University Museum of Paleontology 10018.

Occurrence.—Snowshoe Formation, near middle of Weberg Member at Vigrass' loc. V121a.

Genus TMETOCERAS Buckman, 1892

Tmetoceras scissum (Benecke)

Plate 2, figures 1–6

[For synonymy see Westermann, 1964a, p. 428, 429]

Tmetoceras scissum (Benecke) in eastern Oregon is represented by 105 molds from the lower part of the Snowshoe Formation in the Izee-Suplee areas, 40 molds from unnamed beds in the Juniper Mountain area southwest of Brogan, and 13 molds from the Huntington area.

The species is characterized by highly evolute coiling, by a subcircular to subovate whorl section, by sharp, high rectiradiate ribs that terminate ventrally in blunt spines, by a deep fairly smooth mid-ventral groove, and generally by deep constrictions. A more detailed description has been published by Westermann (1964a, p. 429, 435).

The worldwide range of *Tmetoceras scissum* (Benecke) probably corresponds to the entire early Bajocian (Aalenian) according to Westermann (1964a, p. 429–435). He notes that in Europe the species is most common in the upper part of the *Leioceras opalinum* zone and is not know definitely as high as the *Ludwigia murchisonae* zone, although the genus itself ranges that high. In Alaska and Argentina by contrast, *Tmetoceras scissum* (Benecke) occurs directly below the *Sonninia sowerbyi* zone in beds that are correlated with the *Ludwigia muchisonae* and *Graphoceras concavum* zones of northwest Europe (Westermann, 1964a, p. 434, 435; 1967, p. 67, 68).

In eastern Oregon, *Tmetoceras* is associated with *Praestrigites* in the lower 80 feet of the Weberg Member (Lupher's localities 207, 366 and 467), with *Planammatoceras*? in the lower member of the Snowshoe Formation (USGS Mesozoic locs. 26753 and 26755), and questionably with *Docidoceras* in the basal Weberg Member (Lupher's loc. 366). This last occurrence, however, is in a general collection made from a considerable thickness of beds. As yet, *Tmetoceras* in eastern Oregon has not been collected from the same bed as *Docidoceras*, and most occurrences are definitely below the range of *Docidoceras*.

Types.—Hypotypes CAS 13362, 13363; Stanford University Museum Paleontology 10019.

Occurrences.—Snowshoe Formation, (1) from 125 to 200 feet above base of lower member at USGS Mesozoic locs. 26752, 26753, and 26755; (2) from Weberg Member at Vigrass' locs. 3, 121a, 155 and 158, Lupher's locs. 207, 208, 366, 411, 466, 467 and 583, and USGS Mesozoic locs. 26764, 27374, 29820, 29821 and 29822; (3) questionably from basal bed of Warm Spring Member at Vigrass' loc. 18; (4) unnamed beds in Juniper Mountain area of the Brogan quadrangle, Malheur County, at USGS Mesozoic locs. 28373 and 28374; (5) unnamed beds in the Huntington quadrangle, Baker County, at USGS Mesozoic loc. 29784; and (6) probably represented in the Bridgeport quadrangle, Malheur County, at Mesozoic loc. 27583.

Family HAMMATOCERATIDAE Buckman, 1887
Genus EUDMETOCERAS Buckman, 1920
Subgenus EUAPTETOCERAS Buckman, 1922

Eudmetoceras (Euaptetoceras) cf. E. (E.) hauthali (Burckhardt)

Plate 6, figures 6–9

Seven small molds represent a species characterized by fairly involute coiling, a low vertical umbilical wall that rounds evenly into the flanks, a low keel, and fairly strong, gently flexuous ribs. The primary ribs are weak, low on the flanks but become stronger ventrally and are swollen at, or a little below, the middle of the flanks. From the primary ribs pass pairs of somewhat weaker secondary ribs that persist to the keel and become broader and lower ventrally. Some pairs of forked ribs are separated by single ribs that arise freely on the flanks or are faintly connected with one of the forked ribs.

This Oregon species has fairly involute coiling and swollen primary ribs as on *E. obtectum* Buckman (1925, pl. 555) from Europe. Close comparisons from Europe cannot be made, however, until the inner whorl of the European species has been illustrated. The Oregon species in lateral view agrees in the same features with *E. hauthali* (Burckhardt) (1903 p. 16, pl. 1, figs. 18–20) from Argentina and is nearly the same in size. It differs by having a stouter whorl section and slightly stronger primary ribs.

Figured specimens.—USNM 168506.

Occurrence.—Snowshoe Formation, highest part of Weberg Member at USGS Mesozoic loc. 29400 near the eastern pinchout of the member.

Eudmetoceras (Euaptetoceras) cf. E. (E.) klimakomphalum (Vacek)

Plate 6, figures 10–18

cf. *Harpoceras klimakomphalum* Vacek, 1886, p. 81, pl. 8, figs. 16a, b, 17a, b.
cf. *Harpoceras klimakomphalum* Vacek. Burckhardt, 1903, p. 15, pl. 2, figs. 1–3.
cf. *Eudmetoceras klimakomphalum* (Vacek). Arkell, 1956, p. 176.
cf. *Eudmetoceras klimakomphalum* (Vacek). Sapunov, 1964, p. 262, pl. 2, figs. 2a–c.
cf. *Eudmetoceras (Euaptetoceras) klimakomphalum* (Vacek). Seyed-Emami, 1967, p. 94, pl. 3, figs. 9 and 10; pl. 11, fig 5.
cf. *Hammatoceras (Pseudaptetoceras) klimakomphalum* (Vacek). Géczy, 1966, p. 78, pl. 19, fig. 2, pl. 40, fig. 11.
Eudmetoceras (Euaptetoceras) klimakomphalum (Vacek). See Westermann, 1969, p. 74, 75 for additional references to species.

This species is represented in eastern Oregon by about 30 septate specimens of which most are crushed laterally. It has a compressed ovate whorl section that is much higher than wide. Flanks are flattened and subparallel below but converge above to a narrowly rounded venter that bears a low keel. Umbilicus is narrow but widens slightly during growth. Umbilical wall is low, vertical and rounds abruptly into the flanks. The adult body whorl is not preserved.

The ribs on the smallest septate whorls are fine, closely spaced and gently flexuous. The primary ribs incline forward, become stronger ventrally, and generally pass into pairs of weaker secondary ribs on the middle third of the flanks. Some secondary ribs arise freely on the upper third of the flanks. The secondary ribs trend radially on the flanks but become slightly prorsiradiate near the keel.

During subsequent growth, the ribs weaken gradually on the lower parts of the flanks, and the primary ribs disappear. Therefore, the largest preserved septate whorl at its adoral end is nearly smooth on the lower part of the flanks and bears faint broad ribs on the upper part of the flanks.

The suture line cannot be traced. The largest specimen at an estimated diameter of 105 mm, has a whorl height of 55 mm, a whorl thickness of 35 mm, and an umbilical width of 22 mm.

These Oregon specimens, as far as preservation permits comparisons, are identical with *Eudmetoceras klimakomphalum* (Vacek). They differ from *E. amplectens* Buckman (1920, Type Ammonites, v. 3, pl. 180 A, B) in having a wider umbilicus and a fairly sharp umbilical edge. They differ from the subspecies *E. klimakomphalum discoidale* Westermann (1969, p. 75, pl. 14, figs. 8, 9, pl. 16, figs. 1, 2, pl. 17, fig. 1, pl. 18, fig. 1, text-figs. 23–25 on p. 77, 78) in having a stouter whorl section a wider umbilicus on their large septate whorls, somewhat finer and denser ribbing and a fairly sharp, instead of an evenly rounded, umbilical edge.

Figured specimens.—USNM 168507, 168508.

Occurrences.—Snowshoe Formation, highest part of Weberg Member as USGS Mesozoic locs. 29817 and 29400 near the eastern pinchout of the Weberg Member.

Eudmetoceras (Euaptetoceras) cf. E. (E.) amaltheiforme (Vacek)

Plate 6, figures 1–5

cf. *Harpoceras amaltheiforme* Vacek, 1886, p. 81, pl. 9, figs. 1–4.
cf. *Eudmetoceras amaltheiforme* (Vacek). Arkell, 1956, p. 176.
cf. *Hammatoceras (Pseudaptetoceras) amaltheiforme* (Vacek). Geczy, 1966, p. 82, pl. 21, pl. 41, fig. 5.
cf. *Eudmetoceras (Euaptetoceras) amaltheiforme* (Vacek). Bremer, 1966, p. 158, pl. 15, figs. 2a,b.
cf. *Eudmetoceras (Euaptetoceras) amaltheiforme* (Vacek). Seyed-Emami, 1967, p. 91–94, pl. 3, fig. 8, pl. 11, figs. 1a,b, 2a,b.

One small septate mold has a compressed ovate whorl section that is much higher than wide. The flanks are flattened and subparallel. The venter is narrowly rounded and bears a low keel. Its umbilicus is moderately narrow. The umbilical wall is low, vertical and rounds fairly abruptly into the flanks. The inner whorls exposed in the umbilicus bear transverse swellings at the base of the flanks but are not spinose. The outermost preserved septate whorl bears fairly weak, gently flexuous ribs that become broader and more distinct ventrally. The primary ribs are faint near the umbilicus, become fainter adorally, and pass into pairs of somewhat stronger secondary ribs at or below the middle of the flanks. Some secondary ribs arise freely on the middle third of the flanks.

The specimen at a diameter of 64 mm has a whorl height of 29 mm, a whorl thickness of 16 mm, and an umbilical width of 15 mm.

The suture line has a broad, deep and trifid first lateral lobe that is nearly twice as long as the second lateral lobe and slightly longer than the ventral lobe. The suspensive lobe trends nearly straight to the umbilical seam.

This Oregon specimen is similar in appearance to intermediate-size septate whorls of *E. amaltheiforme* (Vacek) as illustrated by Bremer (1966, pl. 15, figs. 2a, b) and Seyed-Emami (1967, pl. 11, figs. 2a, b). It differs from *E. klimakomphalum* (Vacek) (1886, pl. 8, figs. 16, 17) in having a wider umbilicus at a comparable size and a less abruptly rounded umbilical edge. *E. amplectens* Buckman (1920, pl. 180) has a much narrower umiblicus, and a more evenly rounded umbilical edge.

The straightness of the suspensive lobe on the Oregon specimen resembles that on *E. amplectens* Buckman and contrasts with the slightly contracted suspensive lobe on *E. amaltheiforme* (Vacek) (1886, pl. 9, fig. 1; Geczy, 1966, pl. 21, fig. 5), or on a larger specimen of *E. klimakomphalum* (Vacek) (1886, pl. 8, fig. 16). However, a small specimen of *E. klimakomphalum* (Vacek) (1886, pl. 8, fig. 17), comparable in size with the Oregon specimen, also has a straight suspensive lobe.

The Oregon specimen differs from *Eudmetoceras* (*Euaptetoceras*) sp. aff. *E.* (*E.*) *nucleospinosum* Westermann (1969, p. 80, pl. 17, figs. 2a, b, text fig. 23) in lacking nodes on its small inner whorls and in having a stouter whorl section, a more abruptly rounded umbilical edge, and slightly more evolute coiling.

Figured specimen.—CAS 13364.

Occurrence.—Snowshoe Formation, middle part of Weberg Member, at Lupher's loc. 1701.

Genus PLANAMMATOCERAS Buckman, 1922

Planammatoceras? spp.

Plate 24, figures 2, 3; plate 27, figures 2, 3

This genus is possibly represented by 14 crushed fragments. The smallest specimen (pl. 24, fig. 2) has evolute coiling, a low keel on its venter, sharp ribs that generally arise freely low on the flanks and incline slightly forward, and a few widely spaced umbilical tubercles from which pass two or three ribs. This specimen resembles the tuberculate whorls of *Hammatoceras tuberculatum* Sato (1954, p. 86, pl. 7, fig. 1, pl. 8, fig. 2, pl. 9, figs. 1, 2) which Westermann (1964a, p. 351) refers to *Planammatoceras.*

Somewhat larger specimens (pl. 27, figs. 2, 3) bear short, thick primary ribs that terminate low on the flanks in radially elongate swellings or tubercles from which arise pairs of fairly thick, gently flexuous secondary ribs. These specimens bear some resemblance to the outer whorls of *Parammatoceras rugatum* Buckman (1925, pl. 578) and *P. obtectum* Buckman (1925, pl. 555) from the *Ludwigia murchisonae* zone of England. They appear to be less strongly tuberculate than *Ammonites subinsignis* Oppel (Renz, 1925, pl. 1, figs. 5a, b) which is referred to a new genus *Pseudammatoceras* byElmi (1963a, p. 60; 1963b, p. 15, pl. 1, figs. 1, 2).

The largest specimen (pl. 24, fig. 3) from Oregon bears short, broad, low primary ribs that end in radially elongate swellings. From these pass from one to three fairly sharp flexuous secondary ribs that curve forward on the venter and appear to be slightly swollen on the margins of the venter. Other secondary ribs arise freely on the flanks. A low ventral keel is present. This specimen resembles "*Hammatoceras*" *hosourense* Sato (1954, pl. 7, figs. 5, 6, pl. 9, figs. 5, 6) from Japan, except for the presence of radially elongate swelling. Their presence suggests comparison with the large specimens of *P. tuberculatum* (Sato) (1954, pl. 9, fig. 1).

The presence of such swellings or tubercles does not bar an assignment to *Planammátoceras* as indicated by Sato (1962, p. 66), because swellings and tubercles do occur on *Parammatoceras rugatum* Buckman (1925, pl. 578) and *Hammatoceras planinsigne* Vacek (See Geczy, 1966, pl. 11, figs. 1–3) which Arkell (1956, p. 177) assigns to *Planammatoceras.* The subject has been discussed fully by Geczy (1966, p. 31) who, however, considers *Planammatoceras* to be a synonym of *Hammatoceras.*

Figured specimens.—USNM 168509–168511.

Occurrences.—Snowshoe Formation, lower member at USGS Mesozoic locs. 26753 and 26755. At these localities *Planammatoceras*? is associated with *Tmetoceras scissum* (Benecke) in dark siltstone from 125–200 feet above the base of the Snowshoe Formation. Their lowest occurrence is about 50 feet above beds containing *Haugia* of late Toarcian age (Imlay, 1968, p. C14, C46, pl. 9, figs. 14, 15, 17, 18).

Family SONNINIIDAE Buckman, 1892
Genus SONNINIA Bayle, 1879

Sonninia cf. S. nodatipinguis (Buckman)

Plate 13, figures 1–4

This species is represented by three laterally crushed internal molds and one external mold. The coiling is highly evolute on the inner whorls and fairly evolute on the outer whorls. The venter bears a high keel. The adult body chamber is unknown, but the adoral half of the outer whorl on the largest specimen is nonseptate.

The innermost (see pl. 13, fig. 4) whorls up to a diameter of about 7 mm bear small lateral tubercles. The succeeding whorl at diameters between 7 and 15 mm bears alternating long and short, rectiradiate, strong nontuberculate ribs of which the short ribs are slightly the weaker. The long ribs are fairly strong at the umbilical seam and are strongest low on the flanks. The short ribs appear first near the middle of the flanks, but during growth appear lower and lower on the flanks. All ribs curve slightly forward high on the flanks.

Adorally on the outermost preserved whorls all ribs become equally high, strong, widely spaced, are highest low on the flanks and fade out rather abruptly on the ventral margin before reaching the keel.

The suture line cannot be traced, and the specimens are too crushed to measure accurately.

The Oregon specimens possibly belong to *Sonninia tuxedniensis* Imlay (1964a, p. B32, pl. 2, figs. 5–10) from Alaska but appear to have stronger ribs on the lower parts of their flanks. In that respect they show more resemblance to the inner whorls of *Stiphromorphites nodatipinguis* Buckman (1923, pl. 398) from the *Shirbuirnia trigonalis* subzone of the *Sonninia sowerbyi* zone of England.

Figured specimens.—CAS 13365–13368.

Occurrence.—Snowshoe Formation undifferentiated near Seneca at Lupher's loc. 272.

Subgenus EUHOPLOCERAS Buckman, 1913

Sonninia (Euhoploceras) modesta Buckman

Plates 7–10

Sonninia modesta Buckman, 1892, p. 325, pl. 68, pl. 70, fig. 5; 1894, pl. 95, figs. 3–5 (holotype).
Sonninia simplex Buckman, 1892, p. 326, pl. 70, figs. 2–4.
Sonninia substriata Buckman, 1892, p. 330, pl. 70, figs. 6, 7, pl. 71, figs. 6–8.
Sonninia parvicostata Buckman, 1892, p. 339, pl. 75, figs. 3–5.
Sonninia nuda Buckman, 1893, p. 352, pl. 82, figs. 3, 4.
Sonninia inaequa Buckman, 1894, p. 400, pl. 101, figs. 4–6.
Sonninia modesta Buckman, 1894, p. 422, pl. 95, figs. 3–5; ?pl. 96, figs. 1, 2.
Sonninia subsimplex Buckman, 1894, p. 427, pl. 95, figs. 6–8.
?*Sonninia modesta* Buckman. Hiltermann, 1939, p. 153, pl. 10, figs. 5, 6, pl. 11, fig. 1.
Sonninia modesta modesta Buckman. Oechsle, 1958, p. 111, pl. 13, fig. 7, pl. 14, fig. 8, pl. 16, fig. 5.
Sonninia modesta substriata Buckman. Oechsle, 1958, p. 111, pl. 13, fig. 6, pl. 14, fig. 7, pl. 19, fig. 3.
Sonninia modesta nenningensis Oechsle, 1958, p. 111, pl. 13, fig. 5, pl. 14, fig. 6, pl. 18, fig. 1

The Oregon specimens, herein identified with *Sonninia modesta* Buckman, are represented by 70 internal molds. Many of the molds are much weathered, some are crushed laterally, and most are completely septate.

These specimens are characterized by striae and weak to fairly weak ribs on all or most of their septate whorls; weak tubercles or swellings only on their innermost whorls at diameters of less than 15 mm; a low rounded keel; flattened flanks; a compressed whorl section that is 30 to 50 percent higher than wide; a steplike umbilicus; a vertical or very steep umbilical wall; an abruptly rounded umbilical edge; and by their coiling changing during growth from moderately involute to moderately evolute. Thus the small septate whorls embrace about three-fifths, intermediate-sized whorls embrace about one-half, and the penultimate whorl embraces about one-third of the preceding whorls.

The body chamber is incompletely preserved but is possibly represented on the largest specimen by one-fifth of a nonseptate whorl whose former continuation is imprinted for nearly half a whorl. This imprint indicates that the body chamber embraced only about two-fifths of the preceding whorl.

On the septate whorls the ribs begin near the umbilical edge, trend radially to near the middle of the flanks, curve forward on the upper parts of the flanks and on the venter, and then fade near the keel. Many ribs arise singly near the umbilical edge, but many other ribs arise by furcation or intercalation on the lower parts of the flanks. The ribs are generally weak, become slightly stronger ventrally and adorally, and vary somewhat in strength in different specimens. On the finer ribbed specimens (pl. 10) the outermost septate whorl bears broad, faint radial undulations. On the more coarsely ribbed specimens the adoral end of the largest septate whorl bears several moderately strong, widely spaced ribs (pl. 7, fig. 5). In general the more coarsely ribbed specimens are stouter than the finer ribbed specimens.

The adult body chamber develops much stronger ribbing than the septate whorls. On the more coarsely ribbed variant (pl. 9, figs. 5, 6) the body chamber bears ribs that are single, flexuous, forwardly inclined, widely spaced, moderately strong, becoming slightly stronger adorally. On the finer ribbed variant the ribs are broad and faint on the adapical part of the body chamber but become moderately prominent adorally on the upper half of the flanks and on the ventral margin (pl. 8, figs. 6, 7).

The dimensions (in millimeters) and ratios of the diameters (in parentheses) are as follows:

Specimens	Diameter	Whorl height	Whorl thickness	Umbilical width
Hypotype (pl. 7, fig. 5)	153	63(0.41)	48(0.31)	53(0.34)
Hypotype (pl. 7, figs. 1, 4)	94	45(.48)	32(.34)	25(.25)
Hypotype (pl. 8, figs. 3, 5)	75	37(.50)	24(.32)	16(.21)

The largest available specimen at the adapical end of the incomplete body chamber has a diameter of about 250 mm. If the body chamber occupied three-fifths of a whorl, the adult shell had a diameter of at least 380 mm.

The suture line has a trifid first lateral lobe that is much longer than the ventral and second lateral lobes.

The Oregon specimens under discussion agree very well in most characteristics with the holotype of *Sonninia modesta* Buckman (1894, pl. 95, figs. 3–5), with the specimens assigned to that species by Oechsle (1958, pl. 13, figs. 5–7; pl. 16, fig. 5, pl. 18, fig. 1, pl. 19, fig. 3), and with most of the other described species herein considered to be synonyms of *S. modesta*. The finer ribbed specimens from Oregon (pl. 7, figs. 2, 3, pl. 8, figs. 3, 5, pl. 9, fig. 1, pl. 10) are closely comparable in strength of ribbing with *S. substriata* Buckman and *S. simplex* Buckman, and have slightly stronger ribbing than *S. parvicostata* Buckman, *S. nuda* Buckman, and *S. modesta nenningensis* Oechsle. The more coarsely ribbed specimens from Oregon (pl. 7, figs. 1, 4, 5) are comparable in strength of ribbing with *S. modesta* Buckman, *S. inaequa* Buckman, and *S. subsimplex* Buckman. Some specimens from Oregon bear fairly prominent ribs (pl. 7, fig. 5, pl. 9, figs. 5, 6) near the adoral end of their largest preserved septate whorl, as on one large paratype of *S. modesta* Buckman (1892, pl. 68, figs. 1, 2).

None of the Oregon specimens assigned to *Sonninia modesta* Buckman bear prominent tubercles on their inner whorls like those on one small ammonite described by Buckman (1894, p. 423, pl. 96, figs. 1, 2) as an immature example of that species. His assignment may be questioned, however, because the small ammonite does not have an abruptly rounded umbilical edge and because similar prominent tubercles have not been shown in any other illustration of the species at a comparable size.

Types.—Hypotypes CAS 13369–13375, 13467; Stanford University Museum Paleontology 10020; USNM 168512–168513.

Occurrences.—Snowshoe Formation, Weberg Member at Lupher's locs. 108, 116A, 228, 228W, 228N, 228X, 229, 238, 306, 351, 355, 371, 372, 373, 407, 580, 584, and 610; Vigrass' locs. 8, 14, 20b, 120, 121a, 152, and 241; USGS Mesozoic locs. 26765, 29824, 29825, 29827, and 29828.

Sonninia modesta Buckman in Oregon ranges through the upper two-thirds of the Weberg Member. The specimen from Lupher's loc. 116A is probably from the very top.

Sonninia modesta Buckman in England is recorded from the *Hyperlioceras discites* subzone at the base of the *Sonninia sowerbyi* zone. In Württemberg, Germany, the species is associated with other ammonites (Oechsle, 1958, p. 124) that Westerman (1966, p. 308) correlates with the lower and middle parts of the *S. sowerbyi* zone. Presumably he means those parts of the *S. sowerbyi* zone older than the *Witchellia laeviuscula* subzone.

Sonninia (Euhoploceras) dominans Buckman

Plates 11 and 12

Sonninia dominans Buckman, 1892, p. 322, pl. 66 (holotype), pl. 67, figs. 1, 2, pl. 69.
Sonninia subcostata Buckman, 1892, p. 330, pl. 71, figs. 4, 5.
Sonninia obtusiformis Buckman, 1892, p. 333, pl. 72, figs. 3–5.
Sonninia costata Buckman, 1892, p. 338, pl. 74, fig. 1, pl. 75, figs. 1, 2.
Sonninia papilionacea Buckman, 1893, p. 367, pl. 90, figs. 1–3.
Sonninia euromphalica Buckman, 1893, p. 362, pl. 85, figs. 1–3.
Sonninia omphalica Buckman, 1893, p. 363, pl. 83, figs. 5–9.
Sonninia palmata Buckman, 1893, p. 372, pl. 90, figs. 7–9.
Sonninia scalpta Buckman, 1893, p. 376, pl. 87, figs. 1–3.
Sonninia dominatrix Buckman, 1894, p. 392, pl. 94, figs. 3, 4, pl. 95, fig. 2.
Sonninia umbilicata Buckman, 1894, p. 397, pl. 84, figs. 1–3.
?*Sonninia camura* Buckman, 1894, p. 403, pl. 99, figs. 4–6.
Sonninia dominata Buckman, 1894, p. 408, pl. 97, figs. 1–3.
Sonninia multicostata Buckman, 1894, p. 410, pl. 86, figs. 1–3.
Sonninia costigera Buckman, 1894, p. 428, pl. 102, figs. 1–3.

Sonninia dominans Buckman is represented in eastern Oregon by 43 internal molds of which many are crushed, fragmentary, or much weathered. The outer three-fourths of the specimen shown on plate 11, figures 1 and 4, is nonseptate and probably represents the entire adult body chamber.

The Oregon specimens of this species are characterized by moderately to fairly evolute coiling, a slightly compressed to moderately stout subovate whorl section, a low steeply inclined umbilical wall, an evenly rounded umbilical margin, strongly costate intermediate and outer whorls, and weak tubercles that generally occur only in the smallest whorls (pl. 11, fig. 2, pl. 12, fig. 3).

Both tubercles and ribs show some variation in coarseness and density. The tubercles are rather inconspicuous, occur on most specimens at diameters of less than 16 mm, occur on a few specimens at diameters of about 25 mm, and occur rarely on intermediate-size whorls. The ribs, in contrast to the tubercles, are fairly conspicuous at nearly all growth stages. They begin near the edge of the umbilicus, trend radially or slightly backward on the lower part of the flanks, curve slightly forward high on the flanks and on the venter, are strongest near the middle of the flanks, and become markedly stronger and sparser adorally on the intermediate and outer whorls. On the smallest whorls most ribs arise singly, but a few arise in pairs low on the flanks. On larger whorls all ribs arise singly at the umbilical edge.

Most specimens are so deformed that measurements are meaningless. The large specimen shown on plate 11, figures 1 and 4 at a diameter of 190 mm, has a whorl height of 67 mm, a whorl thickness of 47 mm between ribs or 62 mm on the ribs, and an umbilical width of 65 mm.

The suture line is essentially the same as on *Sonninia modesta* Buckman as described and illustrated herein.

The Oregon specimens just described show considerable resemblance to the holotype of *Sonninia dominans* Buckman (1892, pl. 66, figs. 1, 2) and to most of the other described species that are herein considered synonyms of *S. dominans* but are less tuberculate than some immature specimens assigned to that species by Buckman (1892, pl. 67, figs. 1, 2; 1894, pl. 94, fig. 1). Some coarsely ribbed Oregon specimens (pl. 11, figs. 1, 4; pl. 12, figs. 1–4) of *S. dominans* Buckman closely resemble *S. dominatrix* Buckman (1894, p. 392, pl. 94, fig. 3), *S. costata* Buckman (1892, p. 338, pl. 74, fig. 1), and *S. costigera* Buckman (1894, pl. 102). Some finely ribbed Oregon specimens of *S. dominans* (pl. 11, fig. 1; pl. 12, fig. 5) are similar to *S. multicostata* Buckman (1894, p. 410; 1893, pl. 86, figs. 1–3) and *S. subcostata* Buckman (1892, p. 330, pl. 71, figs. 4, 5).

The Oregon specimens of *S. dominans* Buckman differ from the holotype of *Sonninia adicra* (Waagen) in lacking tubercles on their intermediate-sized whorls, in bearing much weaker and sparser tubercles on their small whorls, and in developing strongly costate ribbing at an earlier growth stage. Obviously fragments of strongly costate outer whorls that are not attached to intermediate-sized whorls cannot be definitely assigned to either species.

The Oregon specimens of *S. dominans* Buckman differ considerably from the associated specimens of *S. modesta* Buckman, described herein. They have a less compressed shell, an evenly rounded instead of an abruptly rounded umbilical edge, more evolute inner whorls, stronger ribbing at all growth stages, and in particular bear much more prominent ribs on their intermediate-sized septate whorls.

Types.—Hypotypes, CAS 13376–13381; Stanford University Museum Paleontology 10021.

Occurrences.—Snowshoe Formation, upper part of Weberg Member at Lupher's locs. 102, 108, 226, 228, 228N, 228W, 229, 238, 306, 307, 350, 407, 609; Vigrass' locs. 19, 20b, 154, 216; USGS Mesozoic locs. 21610, 21612, 26766, 29826. The species is possibly represented also at Lupher's locs. 228X, 248, 355, 363, 474, at Vigrass' locs. 8 and 121, and at USGS Mesozoic loc. 21611 and 29402. The species ranges through the middle and upper parts of the Weberg Member. Its lowest known occurrence is at loc. V19 about 80 feet above the base of the member.

In England *Sonninia dominans* Buckman, as herein described, occurs mostly in the *Hyperlioceras discites* subzone in the basal part of the *Sonninia sowerbyi* zone, but has been recorded also (1893, pl. 90, figs. 7–9) under the name *S. palmata* Buckman from the top of the *Graphoceras concavum* zone. In Scotland it occurs with *Graphoceras* spp. probably near the top of the *G. concavum* zone (Morton, 1965, p. 99).

Sonninia (Euhoploceras) polyacantha (Waagen)

Plates 18 and 19; plate 20, figures 1, 5–7; plate 21, figures 8, 9

Ammonites polyacanthus Waagen, 1867, p. 592, pl. 29, figs. 1a, b.
Sonninia renovata Buckman, 1894, p. 433, pl. 93, figs. 1–3.
Sonninia polyacantha (Waagen). Dorn, 1935, p. 44, pl. 9, fig. 1, pl. 17, fig. 1, text fig. on pl. 4, fig. 2.
Sonninia costosa (Quenstedt). Dorn, 1935, p. 40, pl. 4, fig. 1.
Sonninia polyacantha (Waagen). Oechsle, 1958, p. 88, pl. 11, fig. 1, pl. 18, fig. 2.

This species is represented by 16 internal molds of which most are crushed laterally and none shows a complete body chamber. It is characterized by moderately evolute coiling, a slightly compressed subovate whorl section, a low steeply inclined to nearly vertical umbilical wall, an evenly rounded umbilical edge, variably weak to strong, nonspinose ribs on its small septate whorls, and moderate to strong, spinose ribs on all of its larger septate whorls and on its body chamber.

The ornamentation varies considerably in strength and density. The innermost whorls as exposed in the umbilicus bear weak fairly closely spaced radially trending ribs and weak tubercles or swellings. These are succeeded at diameters of 20 to 25 mm by weak to moderately strong ribs that trend radially on the flanks, curve forward on the venter, and are nontuberculate except for weak lateral swellings at wide intervals. Adorally the ribs gradually become fairly widely spaced; some become much coarser than others, and the coarser ribs become strongly tuberculate to spinose near the middle of the flanks at diameters ranging from 70 to 110 mm. In all specimens the change from nontuberculate to strongly tuberculate ribs occurs rather abruptly. The largest septate whorls and the body chamber bear widely spaced, fairly strong spinose ribs that trend radially on the lower parts of the flanks and curve adorally on the upper parts. From some of the spines pass pairs of secondary ribs. Some spinose ribs are separated by shorter nonspinose ribs that are weak on the flanks but may become fairly strong on the margins of the venter.

Most of the specimens are so crushed that accurate measurements cannot be made. The specimen shown on plate 20, figures 1 and 5 at a diameter of 105 mm has a whorl height of 41 mm, a whorl thickness of about 36 mm between the ribs, and an umbilical width of 38 mm. On the septate whorls of the specimen shown on plates 18 and 19 the same dimensions are 190, 74, 50, and 66 mm, respectively.

The suture line is fairly well exposed on one specimen (pl. 18, fig. 1), except for one interruption at a broken spine. It is essentially the same in plan as on *Sonninia modesta* Buckman and *S. dominans* Buckman as illustrated herein.

The Oregon specimens herein assigned to *S. polycantha* (Waagen) closely resemble the European specimens of that species, as listed in the synonymy. Some of the Oregon specimens have slightly weaker ribbing on their small septate whorls, (pl. 21, figs. 8, 9) or coarser spines on their outer whorls (pls. 18 and 19), but other Oregon specimens (pl. 20, figs. 1, 7) match very well with European specimens as illustrated. The presence of forked secondary ribs, which is a conspicuous feature of several specimens from Oregon, has been noted also in *S. polyacantha* from Europe (Dorn, 1935, p. 45).

The Oregon specimens of *Sonninia (E.) polyacantha* (Waagen) at diameters less than 70–100 mm bear rather weak ribs, as on specimens of *S. dominans* Buckman at comparable sizes. They differ from *S. dominans* at greater diameters by the abrupt appearance of prominent widely spaced spines that persist onto the body chamber and become more conspicuous than the ribs. Except for these spines they do not differ greatly from the coarsely ribbed variant of *S. dominans* (see pl. 11, fig. 4), in which the ribs on adult whorls become swollen near the middle of the flanks.

This resemblance to *S. dominans* suggests that *S. polyacantha* could be considered either a subspecies or a variety of *S. dominans*. A specific rank is favored herein because of the ease with which adult specimens of *S. polyacantha* (Waagen) and *S. dominans* Buckman may be separated, because *S. dominans* appears earlier in England and probably appears earlier in Oregon, and because *S. polyacantha* (Waagen) is recognized as a distinct species by the German authorities (Dorn, 1935, p. 44; Oechsle, 1958, p. 88) who have studied the genus *Sonninia* in considerable detail. Final determination of the validity of *S. (E.) polyacantha* (Waagen), as well as the other species of *S. (Euhoploceras)* discussed herein, must await careful stratigraphic collecting in various parts of western Europe where the beds containing *Euhoploceras* are not condensed.

Morphological intergradation of *Sonninia polyacantha* (Waagen) with *S. adicra* (Waagen) is recorded by Oechsle (1958, p. 85–89) on the basis of an occurrence in southern Germany. Nonetheless he maintains that separate specific names are justified because of differences in the development of their ornamentation. Actually the development of spines and ribs occurs in reverse order in the two taxa.

Types.—Hypotypes, CAS 13382–13386; USNM 168514.

Occurrences.—Snowshoe Formation, upper part of Weberg member at Lupher's locs. 228, 228X, 228N, 230, 361, 363, 370, 373, 573 and 581; Vigrass' loc. 123; USGS Mesozoic loc. 29828.

Sonninia polyacantha (Waagen) in Oregon has been found mostly in the limestone-bearing upper part of the Weberg Member. One specimen, however, from Vigrass' locality 123 was reported from below the middle of the member. In Germany *S. polyacantha* (Waagen) has been recorded from the lower part of the *Sonninia sowerbyi* zone (Oechsle, 1958, p. 124; Arkell, 1956, p. 124; Westermann, 1966, p. 308). In England, *S. renovata* Buckman, which is herein considered to belong to *S. polyacantha*, occurs in the *discites* subzone at the base of the *sowerbyi* zone.

Sonninia (Euhoploceras) adicra (Waagen)

Plate 13, figures 5–12; plate 14–17

Ammonites adicrus Waagen, 1867, p. 591, pl. 25, figs. la, b.
Sonninia acanthodes Buckman, 1889, p. 658, 659, pl. 22, figs. 6, 7, 22, 23.
Sonninia acanthodes Buckman, 1892, p. 319, pls. 58–60.
Sonninia irregularis Buckman, 1892, p. 320, pl. 61.
Sonninia marginata Buckman, 1892, p. 321, pl. 62, pl. 63, fig. 2, pl. 64, pl. 65, figs. 1, 2.
Sonninia submarginata Buckman, 1892, p. 329, pl. 71, figs. 1–3.
Sonninia cymatera Buckman, 1892, p. 332, pl. 73, figs. 2, 3, pl. 100, figs. 5–7.
Sonninia spinicostata Buckman, 1892, p. 337, pl. 73, figs. 4–6.
Sonninia magnispinata Buckman, 1892, p. 341, pl. 76, figs. 1–6.
Sonninia semispinata Buckman, 1892, p. 343; 1893, pl. 77, figs. 1–2.
Sonninia biplicata Buckman, 1893, p. 345, pl. 78.
Sonninia crassiformis Buckman, 1893, p. 348, pl. 78, figs. 1–6.
Sonninia crassa Buckman, 1893, p. 350, pl. 82, figs. 1, 2.
Sonninia crassibulata Buckman, 1893, p. 353, pl. 80, figs. 1–3.
Sonninia nodata Buckman, 1893, 369, pl. 89, figs. 1–3.
Sonninia paucinodata Buckman, 1893, p. 370, pl. 91, figs. 7–9.
Sonninia tridactyla Buckman, 1894, p. 393, pl. 101, figs. 1–3.
Sonninia regularis Buckman, 1894, p. 395, pl. 96, figs. 3–5.
Sonninia spinea Buckman, 1894, 405, pl. 86, figs. 4–6.
Sonninia dominica Buckman, 1894, p. 410; 1892, pl. 69.
Sonninia mutans Buckman, 1894, p. 414, pl. 91, figs. 4–6.
Sonninia subirregularis Buckman, 1894, p. 426, pl. 98, figs. 4, 5; 1893, pl. 77, figs. 6–9, pl. 88, fig. 4.

Sonninia locuples Buckman, 1894, p. 431, pl. 92, figs. 1–4, pl. 103, fig. 4; 1892, pl. 50, figs. 16–18.
Sonninia reformata Buckman, 1894, p. 434, pl. 89, figs. 6–8.
Sherbornites projectifer Buckman, 1923, v. 4, pl. 411.
Sherbornites adicrus (Waagen). Buckman, 1926, v. 6, pl. 669.
Sonninia adicra (Waagen). Dorn, 1935, p. 37, pl. 3, figs. 1, 2, pl. 6, fig. 1, pl. 10, figs. 1, 7.
Sonninia adicra (Waagen). Hiltermann, 1939, p. 150, pl. 10, figs. 3–4, text figs. 20–24.
Sonninia adicra (Waagen). Oechsle, 1958, p. 85, pl. 10, figs. 5–9, pl. 11, fig. 2, pl. 18, figs. 3–4.

This species is represented in collections from Oregon by 15 internal molds of which most have been compressed laterally. The outer three-fifths of the largest whorl of one mold (pl. 16, fig. 1) is nonseptate and may represent most of the adult body chamber.

The Oregon specimens of *Sonninia adicra* (Waagen) are characterized by moderately to fairly evolute coiling, slightly compressed subovate whorl sections, a low keel, a low steeply inclined umbilical wall that rounds evenly into the flanks, prominent lateral spines on their inner and intermediate-sized whorls, and fairly prominent nonspinose ribs on their outer whorls. On the inner whorls the spines arise near the middle of the flanks from fairly strong ribs that are separated by one or more weak ribs (pl. 13, figs. 7–10; pl. 14, fig. 1). Adorally on the intermediate-size whorls the ribs become stronger and more uniform in size, and the spines become weaker but persist to diameters of 100 to 120 mm. The outermost septate whorl and the parts of the body chambers that are preserved are ornamented only with strong ribs that trend radially or curve slightly backward on the lower parts of the flanks, curve forward on the upper parts of the flanks and on the venter, terminate rather abruptly near the low keel, and are strongest near the middle of the flanks.

The small specimen shown on plate 13, figures 11 and 12, at a diameter of 96 mm has a whorl height of 35 mm, a whorl thickness of 31 mm, and an umbilical width of 39 mm.

The suture line, exposed only on one small specimen, is essentially the same as in *Sonninia modesta* Buckman as shown and described herein.

The Oregon specimens of *Sonninia adicra* (Waagen) show appreciable variation in the strength and density of their ribbing. Some have coarse and sparse ribbing (pl. 13, fig. 10, pl. 14, fig. 5, pl. 15, fig. 5, pl. 16) as on the English specimens described by Buckman (see synonymy) under such names as *S. acanthodes*, *S. spinicostata*, *S. locuples*, *S. cymatera*, and *S. magnispinata*. Some have finer and denser ribbing (pl. 13, figs. 11, 12, pl. 14, figs. 1, 3, 6, pl. 15, fig. 4, pl. 17), as on specimens described by Buckman (see synonymy) under such names as *S. marginata*, *S. submarginata*, *S. biplicata*, *S. reformata*, *S. nodata*, and *S. dominica*. On one Oregon specimen (pl. 15, figs. 1, 2) the ribs are strong on the flanks but fade out rather abruptly on the margins of the venter, as on the holotype of *S. adicra* (Waagen) from Germany (Dorn, 1935, pl. 10, figs. 1, 7; Hiltermann, 1939, pl. 18, figs. 3, 4) and on specimens from England described by Buckman (see synonymy) under such names as *S. spinea*, *S. tridactyla*, *S. crassibullata* *S. locuples*, *S. irregularis*, *S. crassiformis*, *S. crassibultata*, *Sherbornites projectifer*, and *Sherbornites adicrus*. All these so-called species, as well as the Oregon specimens described herein under *S. adicra* (Waagen), appear to the writer to be morphological variants of a single species.

Similar conclusions concerning the relationships of *Sonninia adicra* (Waagen) with certain species as defined by Buckman were reached previously by Hiltermann (1939, p. 150–152). He restricted *S. adicra*, however, only to those specimens on which the ribs of the largest whorls become swollen near the middle of the flanks and then fade out high on the flanks or on the margins of the venter. If future studies should confirm Hiltermann's concept of *S. adicra* (Waagen), then most of the specimens from Oregon described herein under that name should be called *S. acanthodes* Buckman.

This restriction of the definition of *Sonninia adicra* (Waagen) was not accepted by Westermann (1966), who concluded, on the basis of detailed measurements, that those specimens bearing weak ventral ribbing, as on the holotype of *S. adicra*, are connected gradationally with specimens bearing strong ventral ribbing, as on the holotype of *S. acanthodes* Buckman.

Sonninia adicra (Waagen) bears coarse ribbing on its outer whorls nearly identical with that on typical specimens of *S. dominans* Buckman. It differs from that species mainly in having spines and stronger, more variable ribbing at diameters less than 100 to 120 mm. It does not develop spines on its outer whorls as on *S. polyacantha* (Waagen). These differences are not too great to preclude derivation of *S. adicra* (Waagen) from *S. dominans* Buckman which first appears at a lower stratigraphic position both in Europe and in Oregon and does not range as high as *S. adicra* (Waagen) in Europe. Retention of *S. adicra* and *S. dominans* as separate taxa is favored by these morphologic and stratigraphic differences. One of these taxa could be considered as a subspecies of the other, but from a utilitarian viewpoint the use of specific names is simpler.

Types.—Hypotypes, CAS 13387–13393, 13395, 13397; USNM 168515. The small specimens compared with the inner whorls of *S.* (*E.*) *adicra* (Waagen) (pl. 13, figs. 5–9) are assigned the numbers, CAS 13394 and 13396 and USNM 168498.

Occurrences.—Snowshoe Formation, upper part of Weberg Member at Lupher's locs. 228, 228N, 228W, 315, 491; USGS Mesozoic locs. 26765, 29403; probably present also at Lupher's loc. 230.

Sonninia adicra (Waagen) in Oregon has been found only in the upper part of the Weberg Member, mostly near the top of the member, and well above the lowest occurrences of *S. dominans* Buckman and *S. modesta* Buckman. In England *S. adicra* (Waagen), or its probable synonym *S. acanthodes* Buckman, occurs in the lower two subzones of the *Sonninia sowerbyi* zone. It is represented in the *Hyperlioceras discites* subzone by many specimens described by Buckman (1892–1894, see synomymy) and in the *Shirbuirnia trigonalis* subzone by two species described under the generic name *Sherbornites* by Buckman (see synomymy). In southern Germany, *S. adicra* has a similar range (Oechsle, 1958, p. 124).

Sonninia (Euhoploceras) crassispinata Buckman

Plate 22, figures 1, 2, 4; plate 23, figures 1–4; plate 24, figures 1, 4; plate 25, figures 17–19

Sonninia crassispinata Buckman, 1892, p. 317, pl. 57, figs. 1, 2, pl. 65, fig. 5; 1894, pl. 93, fig. 7.
Sonninia reclinans Buckman, 1894, p. 421, pl. 98, fig. 7, pl. 103, fig. 21; 1892, pl. 48, figs. 16, 17, pl. 65, figs. 34.
Sonninia gibbera Buckman, 1894, p. 421; 1893, pl. 87, figs. 4, 5, pl. 88, figs. 1–3.

This species is represented in collections from eastern Oregon by 16 molds of which most are somewhat crushed laterally and none shows the complete body chamber. It is characterized by fairly evolute coiling, ovate to circular whorl sections, a steep to vertical umbilical wall that rounds evenly into the flanks, strong to very strong ribs on most whorls, and prominent lateral spines that are present on all the preserved whorls at diameters greater than a few millimeters.

On small septate whorls, less than about 100 mm in diameter, the spines arise just below the line of involution from fairly strong radially trending ribs. Between these ribs are from one to five nonspinose ribs that are weak on the lower parts of the flanks and become a little stronger ventrally. All ribs curve forward considerably near the venter and fade out near the keel.

On larger septate whorls the spines arise near the middle of the flanks from fairly prominent primary ribs that trend radially or slightly backward on the lower parts of the flanks. During growth both spines and spinose ribs become progressively stronger and more widely spaced, whereas nonspinose ribs become weaker and fewer in numbers. From the spines arise one or two broad ribs that curve forward and fade out before reaching the keel. In addition, striae that trend parallel to the ribs are present on some internal molds.

Adorally on the nonseptate whorl, represented partially on three specimens, the primary ribs and spines become even stronger for at least one-third of a whorl. Near the adoral end of the largest whorl fragment (pl. 22, fig. 4), however, both ribs and spines become slightly weaker.

The specimen shown on plate 23, figures 2–4 at a diameter of 130 mm has a whorl height of 46 mm, a whorl thickness of 46 mm between the spines, and an umbilical width of 48 mm. On the smaller specimen shown on plate 25, figures 18 and 19, the same dimensions are 98, 38, 37, and 34 mm, respectively.

The suture line cannot be traced.

The Oregon specimens, just described, are closely similar to *Sonninia crassispinata* Buckman from England and to its synonyms *S. gibbera* Buckman and *S. reclinans* Buckman. They differ mainly by having somewhat stronger ribs and spines on their nonseptate whorls than is shown on the only illustrated adult specimen of *S. crassispinata* Buckman (1892, pl. 57). They bear essentially the same relationships to the Oregon specimens herein identified with *S. adicra* (Waagen) as the English specimens of *S. crassispinata* Buckman bear to the German specimens of *S. adicra* (Waagen) and to its probable English equivalent *S. acanthodes* Buckman. In both Oregon and Europe the specimens herein assigned to *S. crassispinata* differ from those assigned to *S. adicra* in having a rounder, stouter whorl section; stronger spines that persist onto the body whorl instead of being present only on whorls of small to intermediate sizes; and much coarser and more widely spaced ribs at most growth stages. As these differences are consistent and as specimens showing intermediate characteristics are not present, at least in Oregon collections, *S. crassispinata* is herein rated as a species rather than a subspecies or a variety of *S. adicra* (Waagen).

Types.—Hypotypes, CAS 13398; 13399, 13401–13403; USNM 168516, 168517.

Occurrences.—Snowshoe Formation, upper part of Weberg Member at Lupher's locs. 228N, 353, 361, 370, 578, 605, Vigrass' loc. 20b, USGS Mesozoic locs. 21612, 26762, and 26766.

Sonninia crassispinata Buckman in Oregon occurs only in the upper limestone part of the Weberg Member, well above the lowest occurrences of *S. modesta* Buckman and *S. dominans* Buckman.

Sonninia crassispinata Buckman is recorded in England from the *Hyperlioceras discites* subzone in the basal part of the *Sonninia sowerbyi zone* (Buckman, 1892, p. 317; 1894, p. 421), in Scotland from the next younger *Shirbuirnia trigonalis* subzone (Morton, 1965, p. 199), in the southern part of European USSR from beds containing *Sonninia sowerbyi* and *Hyperlioceras discites*

(Sasanov, 1964, table 2 on p. 794), and in Turkey from beds containing *Docidoceras*, *Fontannesia*, *Eudmetoceras* (*Euaptetoceras*), and *Bradfordia* (Bremer, 1966, p. 161).

Sonninia (Euhoploceras) cf. S. (E.) crassispinata Buckman

Plate 22, figure 3; plate 24, figure 5

Two internal molds from Oregon differ from *S. crassispinata* (Buckman), as described herein, in lacking spines on their small whorls at diameters between 15 to 45 mm. Instead, those whorls bear ribs that are flexuous, closely spaced, and in part paired. The succeeding whorl bears widely spaced spines that are separated by four to eight gently flexuous to nearly radial ribs. The largest preserved septate whorl bears prominent spines as in the Oregon specimens of *S. crassispinata.* Overall, the appearance of these molds suggests that they represent a variant of that species.

Figured specimens.—CAS 13400; Stanford University Museum Paleontology 10022.

Occurrences.—Snowshoe Formation, upper part of Weberg Member at Lupher's loc. 228X and Vigrass' loc. 8.

Subgenus PAPILLICERAS Buckman, 1920

Sonninia (Papilliceras) stantoni (Crickmay)

Plate 26, figures 1–10, 12, 13

Papilliceras stantoni Crickmay, 1933, p. 910, pl. 29, figs. 1, 2, pl. 32, fig. 1.
Papilliceras stantoni Crickmay. Lupher, 1941, p. 262.

This species is represented in eastern Oregon by 58 molds, of which most are from Lupher's loc. 57.

The Oregon specimens are not as stout as the holotype illustrated by Crickmay (1933, pl. 32, fig. 1), but all are more or less compressed laterally. Their coiling is fairly evolute and becomes more so during growth. The inner whorls embrace each other about two-fifths and the outer whorls about one-fourth. The flanks vary from gently rounded on the small inner whorls to nearly flat on the largest whorls. The venter is narrowly to moderately rounded and bears a single weak keel. The umbilicus is fairly wide. The umbilical wall is low, steeply inclined on the inner whorls, nearly vertical on the outer whorls, and rounds evenly into the flanks. The adult body chamber is unknown.

The ornamentation consists of a row of prominent medium lateral tubercles, of fairly strong ribs, and of faint growth lines. The ribs on the small inner whorls are high, narrow, and are separated by somewhat wider interspaces. Most of the ribs begin singly but some arise in pairs near the line of involution, trend nearly radially on the flanks, curve gently forward near the venter, and then terminate abruptly before reaching the keel. During growth the ribs gradually become much more widely spaced, higher and broader near the middle of the flanks, and weaker near the umbilicus and venter. Bifurcation and trifurcation of the ribs occur at the tubercles on some small and intermediate sized whorls.

The tubercles are round and prominent on the inner whorls and become spinose on the outer whorls. On the inner whorls the tubercles arise abruptly from the ribs at shell diameters of 12–20 mm and are sporadic in distribution. On some small whorls every third or fourth rib bears a tubercle. On other small whorls the tuberculate ribs may be separated by many nontuberculate ribs. Adorally on intermediate-sized whorls the distribution of tubercles becomes more regular. On the largest preserved whorls every rib bears a tubercle, and both ribs and tubercles are evenly spaced.

The specimens available are too compressed to be measured accurately. The suture line is not preserved.

This species was compared by Crickmay (1933, p. 911) with *Papilliceras acantherum* Buckman (1921, pls. 205 A, B) from the *Otoites sauzei* zone of England. It differs, however, by having sharper and more closely spaced ribs at comparable sizes. Its inner whorls resemble those of *P. papillatum* Buckman (1920, pl. 150 A, B), but its outer whorls bear sparser and stronger ribs and spines. Its outer whorls bear much stronger ribs and spines than on *S. mesacantha* (Waagen) (1867, p. 594, pl. 28, figs. 1a, b; Dorn, 1935, pl. 8, figs. 1, 4).

Types.—Hypotypes, CAS 13404–13411; USNM 168518–168521.

Occurrences.—Snowshoe Formation undifferentiated in the Seneca area at USGS Mesozoic locs. 21617, 28026, and Lupher's loc. 57; top of Weberg Member at Mesozoic loc. 21611; Warm Springs Member at Mesozoic loc. 29241, Vigrass' loc. 18, and Lupher's loc. 311. It ranges from the top of the Weberg Member into the upper part of the Warm Springs Member.

Sonninia (Papilliceras) cf. S. (P.) arenata (Quenstedt)

Plate 26, figure 11

cf. *Ammonites arenatus* Quenstedt, 1886, pl. 60, fig. 10.
cf. *Sonninia arenata* Quenstedt. Dorn, 1935, p. 38, pl. 7, figs. 1, 2.
cf. *Sonninia blackwelderi* Crickmay, 1933, p. 911, pl. 30, figs. 1–4.

Three small compressed molds bear fine growth striae and weak widely spaced ribs. The ribs bear weak tubercles near the middle of the flanks on the largest preserved whorls. Their general appearance is closely similar to that of the holotype of *S.* (*P.*) *arenata* (Quenstedt) as refigured by Dorn (1935, pl. 7, fig. 1), as well as to that of the fragmentary holotype of *S.* (*P.*) *blackwelderi* Crickmay.

Figured specimen.—USNM 168522.

Occurrence.—Snowshoe Formation, upper part of Warm Springs Member at USGS Mesozoic loc. 29241.

Sonninia (Papilliceras) cf. P. (S.) juramontana (Crickmay)

Plate 27, figure 1

cf. *Papilliceras juramontanum* Crickmay, 1933, p. 911, pl. 31.

This species is represented by one laterally crushed internal mold that shows nearly two whorls but does not show the innermost whorls. The smallest exposed whorl up to a diameter of about 58 mm bears variably weak radially trending ribs that are faint near the umbilicus and become slightly stronger ventrally. The outermost preserved whorl embraces about one-fourth of the preceding whorl and bears 34 ribs that trend radially across most of the flanks but curve gently forward high on the flanks and on the margins of the venter. These ribs adorally gradually become more widely spaced, thicker and stronger on the lower half of the flanks, and broader and weaker on the upper half of the flanks. This change in ribbing corresponds with the appearance of a row of median lateral tubercles on 22 ribs that occupy the outer four-fifths of the whorl.

This specimen differs from the Oregon specimens herein compared with *S.* (*P.*) *espinazitensis* Tornquist in being more evolute and in its largest whorl having stronger and more closely spaced ribs on the lower parts of the flanks. Its ribs are more comparable in strength and spacing with those on the holotype of *S.* (*P.*) *juramontana* (Crickmay) (1933, pl. 31) at a similar size. That specimen may differ by having tubercles and spines on its small inner whorls, but both specimens are too poorly preserved for close comparisons.

Figured specimen.—CAS 13412.

Occurrence.—Snowshoe Formation, Warm Springs Member, at Lupher's loc. 206.

Sonninia (Papilliceras) cf. S. (P.) espinazitensis Tornquist

Plate 27, figures 4–6

cf. *Sonninia espinazitensis* Tornquist, 1898, Palaeont. Abh. Jena, v. 8, no. 2, p. 20, pl. 3, figs. 2, 3, pl. 4, fig. 1.

The species is represented by four laterally crushed internal molds. The outer whorl embraces about half of the preceding whorl. The whorl shape before crushing was probably ovate and higher than wide. The adult body chamber is unknown.

The ornamentation consists of radially trending ribs and of round tubercles that arise from the ribs near the middle of the flanks at diameters greater than about 85 mm. On the smallest whorls the ornamention consists entirely of variably weak, fairly closely spaced radial ribs that become stronger ventrally and curve slightly forward on the venter. Some of the ribs arise near the umbilical seam, some arise by furcation low on the flanks, and some arise freely at various heights on the flanks. Adorally on whorls of intermediate size the ribs gradually become a little stronger, less variable in strength, and more widely spaced. After the appearance of tubercles, the ribs rather abruptly become widely spaced, uniformly strong on the lower parts of the flanks, and weak to indistinct on the upper parts of the flanks. This change occurs in about one-fourth of a whorl. The tubercles similarly change from weak to prominent in about half a whorl.

The Oregon specimens closely resemble *Sonninia espinazitensis* Tornquist from Argentina and are possibly within the range of variation of that species. Their ribbing is a little coarser than on one specimen figured by Tornquist (1898, pl. 3, fig. 2) and nearly as coarse as on the largest specimen figured by Tornquist (1898, pl. 4, fig. 1). The Oregon specimens possibly differ by an earlier development of lateral tubercles. *S.* (*P.*) *pseudoarenata* Maubeuge (1951, p. 48, pl. 13, fig. 3a, b) has much coarser ribbing on its inner whorls and probably weaker tubercles on its outer whorls.

Figured specimens.—USNM 168523; CAS 13413.

Occurrence.—Snowshoe Formation, near and below middle of Weberg Member at USGS Mesozoic loc. 26763, Lupher's loc. 360 and Vigrass' loc. V120.

Genus WITCHELLIA Buckman, 1889

Witchellia connata (Buckman)

Plate 20, figure 4; plate 21, figures 1–7, 10, 11

Zugella connata Buckman, 1927, v. 7 pl. 750.

This species is represented by 36 fragmentary and partly crushed molds. The shell is compressed, has flattened flanks, and is moderately involute. The whorls embrace about one-half of the preceding whorls. The venter bears a fairly low keel that is bordered by furrows. The umbilicus is shallow and moderately narrow. The umbilical wall is low, gently inclined and rounds evenly into the flanks. The adult body chamber is unknown. On the largest specimens the body chamber occupies about three-fifth of a whorl.

The shell is ornamented with sharp, fairly strong ribs that become stronger ventrally and are a little narrower than the inner spaces. These ribs arise singly or in pairs near the umbilicus, pass radially or slightly forward across the flanks, and curve gently forward on the venter where they terminate abruptly near the ventral furrows.

The Oregon specimens are virtually identical with *Witchellia connata* (Buckman) (1927, pl. 750) in ribbing and coiling and are considered to be within the range of variation of that species.

Types.—Hypotypes, USNM 168524–168529; CAS 13413, 13414; Stanford University Museum Paleontology 10023.

Occurrences.—Snowshoe Formation, undifferentiated at Lupher's loc. 57 and USGS Mesozoic loc. 28026; lower member at Mesozoic loc. 29230; middle member at Mesozoic loc. 26774; Warm Springs Member at USGS Mesozoic loc. 29395, 29807, 29808, Dickinson's loc. 94 (=V4) and Lupher's loc. 116. This species ranges from near the base to near the top of the Warm Springs Member. In England *Zugella connata* Buckman is recorded questionably from the *Shirbuirnia trigonalis* subzone of the *Sonninia sowerbyi* zone. (See Davis, in Buckman, 1930 v. 7, p. 36.)

Witchellia sp.

Plate 20, figures 2, 3

The genus *Witchellia* is represented in the Warm Springs Member of the Snowshoe Formation by three specimens in addition to those referred to *W. connata* (Buckman). One of these specimens, illustrated herein, shows the bisulcate venter and rounded umbilical margin that characterize the genus. Its surface bears very weak ribs that incline slightly forward on the flanks and curve forward on the margins of the venter.

Figured specimen.—Stanford University Museum of Paleontology 10024.

Occurrence.—Snowshoe Formation, Warm Springs Members, at Dickinson's loc. D94 (=V4).

Subgenus LATIWITCHELLIA Imlay, n. subgen.

This subgenus differs from *Witchellia* Buckman (1889, p. 658; Arkell and others, 1957, p. L270) in having more evolute coiling, a relatively broader whorl section that does not become higher and compressed on the body chamber, less common rib furcation near the base of the flanks, only slight weakening of its ribs adorally on the body chamber, and blunt nodes high on the flanks on some coarsely ribbed variants.

The type species is *Witchellia* (*Latiwitchellia*) *evoluta* Imlay, n. sp.

Latiwitchellia shows some resemblance to *Zugophorites* Buckman (1922, p. 341), *Gelasinites* Buckman (1925, pl. 593a, b), and *Zugella* Buckman (1927, pl. 750) which are considered to be synonyms of *Witchellia* (Arkell and others, 1957, p. L270. It differs from all in being a little more evolute, in its body chamber not becoming appreciably higher or smoother adorally, and in bearing tubercles on the flanks. It differs from *Zugella* also in its ribs bifurcating less commonly low on the flanks.

Latiwitchellia is associated in eastern Oregon with ammonite genera and species that correlate with the lowest part of the *Sonninia sowerbyi* zone of Europe. It occurs, therefore, in slightly older beds than *Zugophorites* and *Gelasinites* of Buckman which are the oldest known European representatives of *Witchellia* and occur in the *Shirbuirnia trigonalis* subzone of the *Sonninia sowerbyi* Zone. It is undoubtedly older, also, than *Zugella* Buckman which is reported questionably from the *Shirbuirnia trigonalis* subzone (Davis, in Buckman, 1930, v. 7, p. 36).

Witchellia (Latiwitchellia) evoluta Imlay, n. sp.

Plates 31–33

This species is represented by 52 molds, of which most are crushed laterally and retain very little shell material.

The shell is compressed to moderately compressed and is evolute. The whorls are ovate to subquadrate in section, higher than wide, and embrace each other about one-fifth. The flanks are nearly flat and round evenly into the venter. The venter is gently rounded to almost flat and bears a low keel that is bordered by furrows. The umbilical wall is low, inclines steeply at its base, and rounds evenly into the flanks. The adult body chamber occupies about three-fifths of a whorl. The adult aperture inclines gently forward on the flanks and projects strongly forward on the venter. On the flanks of internal molds the aperture is marked by a deep constriction that is followed by a swelling. Such a constriction is not present on the shell.

The ornamentation consists of nodes and of rectiradiate to rursiradiate ribs that bend sharply forward high on the flanks. The ribs vary considerably in strength from one specimen to another and likewise vary during growth on a single specimen. The nodes develop high on the flanks at the points where the flank ribs bend forward, occur mostly on the intermediate and outer whorls of coarsely ribbed variants (pl. 31) but occur also on specimens whose ribs are only moderately coarse. Of the 52 specimens available, 18 have moderate to coarse ribs and are nodate, four have fairly fine ribs, and the remainder have ribs intermediate in coarseness between the extremes. Some nodate specimens are no more coarsely ribbed than some non-nodate specimens. All variants occur together and range through the upper part of the Weberg Member.

On typical specimens such as the holotype (pl. 32, figs. 1, 2, 5, 6) the innermost whorls bear ribs that are broad, low and nearly rectiradiate on the lower parts of the flanks, become narrower, higher and generally rursiradiate on the middle parts, become still higher and projected adorally high on the flanks and on the venter, and then terminate abruptly at the furrows bordering the keel. Most of these ribs are simple, but some bifurcate or are swollen on the middle third of the flanks and some arise freely on the flanks.

On the intermediate and outer septate whorls of typical specimens, the ribs are moderately to fairly strong, become slightly stronger ventrally, are mostly simple, but some bifurcate low on the flanks, and a few arise freely near the middle of the flanks. Some ribs on the flanks trend nearly radially and others are slightly rursiradiate. All ribs project forward high on the flanks and on the venter and then terminate abruptly at the ventral furrows. The ribs are strongest at the point of greatest curvature high on the flanks. On the body chamber of typical specimens the ribs gradaully become slightly weaker adorally, particularly on the lower parts of the flanks but persist distinctly to the aperture.

The nodate, moderate (pl. 32) to coarsely ribbed variant (pl. 31) differs from typical specimens, such as the holotype, in its flank ribs being generally coarser, sparser and more rursiradiate, in its whorls being generally stouter and more subquadrate, and in bearing nodes high on the flanks. These nodes may be rounded or elongated spirally, are particularly prominent on the outer two septate whorls, may occur on consecutive ribs, or sporadically, and do not occur on the adoral half of the body chamber.

The finely ribbed variant (pl. 33) differs from typical specimens in its ribs being much weaker, lower and more variable in strength on its intermediate and outer whorls. Tubercles are not present, although one adult near the adapical end of its body chamber bears one rib that is strongly swollen ventrally.

The suture line has an extremely broad, irregularly rounded first lateral saddle. The first lateral lobe is trifid, is moderate in width and length, is about the same length as the ventral lobe, and is considerably longer than the second lateral lobe. The suspensive lobe rises slightly to the umbilical seam.

The holotype at a maximum diameter of 92 mm has a whorl height of 25 mm, a whorl thickness of 23 mm, and an umbilical width of 48 mm. On the largest adult nodate variant, the same dimensions are 104, 30, 25 and 48 mm, respectively. On the largest adult fine-ribbed variant, the same dimensions are 96, 25, 23, and 49 mm, respectively.

Types.—Holotype, USNM 168530; paratypes, USNM 168531–168533; paratypes, CAS 13416–13428.

Occurrences.—Snowshoe Formation, upper part of Weberg Member. The typical species occurs at Lupher's locs. 228, 228N, 228W, 361, 370, 371, 373, 563, and 580, at Vigrass' locs. 128 and 241, and at USGS Mesozoic locs. 21611, 21612, 26766, 29403, and 29828. The nodate variant occurs at Lupher's locs. 228, 228N, 228W, 307, 355, 361, and 584, at Vigrass' locs. 16, 152 and 235, and at USGS Mesozoic loc. 29829. The finely ribbed variant occurs at Lupher's locs. 228 and 584 and at USGS Mesozoic locs. 26766 and 29828.

Genus DORSETENSIA (Buckman), 1892

Dorsetensia cf. D. pulchra Buckman

Plate 30, figures 1–4, 7, 8

cf. *Dorsetensia pulchra* Buckman, 1892, p. 306, pl. 52, figs. 25–27.
cf. *Dorsetensia pulchra* Buckman. Dorn, 1935, p. 99, pl. 18, fig. 3.

This species, represented by 33 poorly preserved compressed molds, is assigned to *Dorsetensia* instead of *Witchellia* because it is fairly evolute, has a low vertical umbilical wall that rounds abruptly into the flanks, and a single keel that is not bordered by furrows. The whorls overlap about one-third of the preceding whorls. The ribs on the flanks of the inner whorls are thin, cross the flanks nearly radially, curve forward near the venter, and arise singly or in pairs near the umbilicus. Adorally the ribs become broader, lower and more widely spaced. On the largest whorls the ribs are irregularly spaced, very low, and in part are replaced by striae.

This Oregon species may be identical with *D. pulchra* Buckman, but it appears to differ in being slightly more evolute and in some of its ribs arising in pairs. It differs from *D. diversistriata* Imlay, n. sp. in being more evolute, in bearing stronger ribbing on its inner whorls, and in having much smoother, less striate outer whorls. Similar appearing ammonites, from southwestern British Columbia, possibly belonging to *Dorsetensia*, were described as *Witchellia*? sp. by Frebold (in Frebold and others, 1969, p. 25, pl. 4, figs. 6, 7).

Figured specimens.—USNM 168534; CAS 13429.

Occurrences.—Snowshoe Formation, near top of Warm Springs Member, at USGS Mesozoic locs. 29241, 29395, and Lupher's loc. 109.

Dorsetensia cf. D. subtexta Buckman

Plate 28, figures 1–7; plate 29, figure 7

cf. *Dorsetensia subtexta* Buckman, 1892, p. 309, pl. 54, figs. 3–5, pl. 55, figs. 1, 2.
cf. *Dorsetensia subtexta* Buckman. Dorn, 1935, p. 103, pl. 21, fig. 2, pl. 23, fig. 1, pl. 25, fig. 7, pl. 29, fig. 4
cf. *Dorsetensia liostraca subtexta* Buckman, Huf. 1968, p. 103–107, pl. 41, fig. 1, pls. 42–46, pl. 47, fig. 1.

One species of *Dorsetensia* in Oregon is represented by four fairly large specimens and by 35 immature specimens of various sizes. It is characterized by a fairly high whorl section, flattened flanks, a steplike umbilicus, and variably weak, gently flexuous ribs. Its whorls embrace about one-half of the preceding whorls. All these features, except a slightly stouter whorl section, appear to be identical with those shown on published illustrations of *Dorsetensia subtexta* Buckman from Europe.

Figured specimens.—USNM 168535, 168536; CAS 13430, 13431.

Occurrences.—Snowshoe Formation, lower member at Lupher's loc. 75; Warm Springs Member at Lupher's loc. 206 and USGS Mesozoic loc. 29239; Basey Member at USGS Mesozoic loc. 26769, 29812, 29818. This species ranges through the upper two-thirds of the Warm Springs Member and the lower third of the Basey Member.

Dorsetensia cf. D. complanata Buckman

Plate 29, figures 5, 6

cf. *Dorsetensia complanata* Buckman, 1892, p. 306, pl. 53, figs. 1–10, pl. 54, figs. 1, 2.

Three specimens from Oregon bear fairly strong, very widely spaced, rectiradiate or slightly rursiradiate ribs similar to those on the septate whorls of one specimen of *Dorsetensia* figured by Buckman (1892, pl. 54, fig. 1). The Oregon specimens appear to have slightly stronger and less flexuous ribbing and to be less evolute. Their ribs are considerably more widely spaced than on *D. edouardiana* (d'Orbigny) (1843, pl. 130, figs. 3–5). The assignment to *Dorsetensia* rather than *Witchellia* is based on the presence of a simple keel that is not bordered by furrows.

Figured specimens.—USNM 168537.

Occurrence.—Snowshoe Formation, a little below middle of Warm Springs Member at USGS Mesozoic loc. 29396.

Dorsetensia aff. D. edouardiana (d'Orbigny)

Plate 30, figures 9–12

[For synonymy see Huf, 1968, p. 72, 73]

Two external molds from eastern Oregon show parts of two whorls. They have fairly evolute coiling, flattened flanks, a single fairly high keel that is not bordered by furrows, and an umbilical wall that is low, vertical and rounds abruptly into the flanks. Part of the outer whorl of the largest specimen is nonseptate and embraces about one-third of the preceding whorl. The ribs on the septate whorls are variably low, fairly widely spaced, trend radially or slightly forward on the flanks, and curve gently forward on the margins of the venter. The ribs on the partial nonseptate whorl differ by being much stronger.

The suture line partly preserved on the larger specimen is characterized by the ventral lobe being slightly longer than the first lateral lobe.

The Oregon species is assigned to *Dorsetensia* rather than to *Witchellia* because it has an abrupt umbilical edge and lacks furrows on its venter. Its ribbing becomes coarser than on most species of *Dorsetensia* but bears some resemblance to ribbing on *D. edouardiana* (d'Orbigny) (1843, pl. 130, figs. 3–5). The Oregon species differs from the holotype of *D. edouardiana* at a comparable size in having more evolute coiling, weaker ribs on its smaller whorl, and coarser and sparser ribs on its larger whorl. The ribbing on the largest Oregon specimen closely resembles that on an ammonite assigned to *Witchellia edouardiana* (d'Orbigny) by Dorn (1935, p. 112, pl. 6, fig. 2). That ammonite, however, is reported to have furrows on its venter and hence probably actually belongs to *Witchellia.*

Figured specimens.—USNM 168538; Stanford University Museum Paleontology 10025 and 10037.

Occurrences.—Snowshoe Formation, near top of Warm Springs Member at Dickinson's loc. 97; in lower 300 feet of Basey Member at USGS Mesozoic loc. 29812, which is in the lower sixth to seventh of the member.

Dorsetensia sp. undet.

Plate 30, figures 5, 6

One small undeformed septate specimen from a concretion is the best preserved representative of *Dorsetensia* that has been found in eastern Oregon. Its shell is compressed and moderately evolute. The outer whorl is nearly twice as high as wide and embraces about one-half of the next inner whorl. The flanks are flattened below but round evenly above into a narrowly arched venter. The venter bears a fairly low keel that is not bordered by furrows. The umbilical wall is low. The umbilical edge is rounded on the inner whorls exposed in the umbilicus but near the adoral end of the specimen becomes sharp.

The innermost whorls, as exposed in the umbilicus, bear strong widely spaced ribs. The outermost whorl bears variably strong widely spaced flexous ribs that curve strongly forward on the venter. Many of the ribs divide at or below the middle of the flanks. Near the adoral end of the specimen the ribs fade rather abruptly and are replaced by flexous striae that persist for at least one-fourth of a whorl.

The specimen at a diameter of 41 mm has a whorl height of 18.5 mm, a whorl thickness of 11.5 mm, and an umbilical width of 12 mm.

This specimen differs from the inner whorls of the species herein compared with *D. pulchra* Buckman in having sparser and more flexuous ribs that bifurcate higher on the flanks and fade out at an earlier growth stage.

Figured specimen.—CAS 13442.

Occurrence.—Snowshoe Formation, 60 feet below top of middle member at Lupher's loc. 128.

Dorsetensia oregonensis Imlay, n. sp.

Plate 29, figures 1–4

This species is represented by about 135 compressed specimens preserved in gray to black thinly laminated silty claystone. The only specimens that are fairly well preserved are from Lupher's loc. 272 where the claystone has been hardened by igneous intrusions.

Dorsetensia oregonensis has a compressed shell, flattened flanks, a narrow venter, and fairly evolute coiling. Its outermost whorls overlap from one-fourth to one-third of the preceding whorl. Its venter bears a single fairly low keel that is not bordered by furrows. The umbilicus is shallow and moderate in width. The umbilical wall on the largest preserved whorl is low, vertical, rounds abruptly into the flanks, and adorally on the body chamber develops a sharp umbilical edge. The body chamber is incomplete but is represented by at least half a whorl.

The ribs on the inner whorls are stout, become stronger ventrally, and are about as wide as the interspaces. They begin on the umbilical wall, are radial to gently flexuous on the flanks, curve slightly forward on the venter, and fade near the keel. The ribs near the adapical end of the body chamber weaken and broaden rather abruptly, but adorally on some specimens become strong again on the lower parts of the flanks.

The specimens are too poorly preserved to permit making accurate measurements or to trace the suture lines.

This species bears a general resemblance to *D. adnata* (Imlay) (1964a, p. B34, pl. 6, figs. 6–10) from Alaska, but its coiling is more evolute, its ribs are much stronger on its septate whorls, and its body chamber tends to become smooth or faintly ribbed. It has much denser ribbing on its septate whorls than occurs on *D. complanata* Buckman (1892, p. 306, pl. 53, figs. 1–10, pl. 54, figs. 1, 2).

Types.—Holotype, CAS 13432; paratypes, CAS 13433–13435.

Occurrences.—Snowshoe Formation undifferentiated at Lupher's loc. 272; middle member at Lupher's loc. 74 and USGS Mesozoic locs. 26776, 27578; Basey Member at USGS Mesozoic locs. 26769, 29816, 29818, and Dickinson's loc. 101; upper part of Warm Springs Member at Dickinson's loc. 97.

The species ranges from near the top of the Warm Springs Member (loc. D97) to near the middle of the Basey Member (Mesozoic loc. 29816). It also ranges throughout the middle member of the Snowshoe Formation.

Dorsetensia diversistriata Imlay, n. sp.

Plate 29, figures 8–14

The species is represented by 15 laterally crushed molds. Before crushing, the shell probably had a compressed form and flattened flanks. The whorls embrace from one-half to three-fifths of the preceding whorl. The venter bears a single keel that is not bordered by furrows. The umbilicus is shallow and moderately narrow. The umbilical wall is low, vertical, and rounds fairly abruptly into the flanks. The body chamber is unknown.

The ribs on the small exposed inner whorls are fine, closely-spaced, fairly regular, incline slightly forward on the flanks, curve weakly forward on the venter, arise singly or in pairs near the umbilicus, become stronger ventrally, and fade out before reaching the keel. During growth the ribbing gradually becomes highly variable in strength and spacing, and the entire surface of the shell becomes covered with fine striae.

The ribs on the largest preserved whorls vary in strength from very weak to moderately weak, are highest near the middle of the flanks, are broadest on the venter, are variably but widely spaced, arise singly near the umbilicus, are radial or incline slightly forward on the flanks, and curve gently forward on the venter.

Dimensions cannot be determined or the suture line traced because of poor preservation.

Dorsetensia diversistriata is characterized by its variably fine ribbing and by the development of abundant striae on its whorls of intermediate and large sizes. In this respect as well as in coiling it shows considerable resemblance to *Dorsetensia hyalina* (Buckman) (1924, pl. 519) from the *Otoites sauzei* zone of England, but differs in developing stronger and much less flexuous ribbing on its outer whorls. It differs from *D. liostraca* Buckman (1892, p. 310, pl. 53, figs. 11–16, pl. 55, figs. 3–5, pl. 56, fig. 1; Dorn, 1935, pl. 11, fig. 5) in being more evolute and in developing stronger and more variable ribbing. *Witchellia simulans* (Buckman) (1926, pl. 631) has a higher keel, a rounder umbilical wall, and weaker, less variable ribbing.

Types.—Holotype, CAS 13436, paratypes, CAS 13437–13441.

Occurrence.—Snowshoe Formation in Seneca area at Lupher's loc. 57.

Genus PELEKODITES Buckman, 1923

Pelekodites webergi Imlay, n. sp.

Plate 34, figures 19–34

This species is represented by 34 internal molds. The shell is very small and highly evolute. The whorl section is ovate and higher than wide. The venter is narrow, somewhat flattened, and bears a low keel. The umbilical wall is low and rounds evenly into the flanks. The body chamber occupies about three-fifths of a whorl and terminates in narrow elongate lateral lappets which are preserved on a number of specimens.

The inner septate whorls are nearly smooth, or bear faint undulations. The outermost septate whorl bears faint, broad, backwardly inclined ribs that become slightly stronger ventrally. The body chamber bears broad, low, rather widely spaced ribs that curve forward on the lower third of the flanks, curve strongly backward on the middle and upper parts of the flanks, curve forward on the venter, and then fade out before reaching the keel. Most ribs remain simple, but some bifurcate near the middle of the flanks. Some secondary ribs arise freely on the middle of the flanks. The forward curvature of the ribs at about the top of the lower third of the flanks becomes greater toward the aperture.

The only available suture line that can be traced accurately is exposed on an immature specimen. It has a fairly broad first lateral saddle and a small trifid first lateral lobe that is as long as, or slightly longer than, the ventral lobe.

The specimen shown on plate 34, figures 32 and 33, appears to be only slightly compressed. At a diameter of 26 mm, it has a whorl height of 8 mm, a whorl thickness of 6½ mm, and an umbilical width of 10.5 mm.

Pelekodites webergi resembles *P. buckman* (Haug) (1893, p. 292, pl. 9, figs. 4a, b; Huf, 1968, p. 44, pl. 3, figs. 1–4, pl. 4, figs. 1–3) in size and in most rib characteristics. It differs by having slightly more evolute coiling, a little stronger ribbing, and a higher sharper keel. None of the specimens are as smooth as some of those of *P. buckmani* (Haug) illustrated by Huf (1968, pl. 3, figs. 2, 4, 5, pl. 4, figs. 1, 2). *P. boweri* (Buckman) (1905, Suppl. p. CXCI, pl. 24, figs. 1–4; Huf, 1968, p. 36–44, pl. 1, figs. 6, 7, pl. 2, figs. 1–5; see synonomy in Huf, 1968, p. 36, 37) averages larger in size, has somewhat stronger and less backwardly inclined ribbing, and shows less rib furcation.

This species is named in honor of Melvin Weberg, from whose ranch many of the fossils described herein have been collected.

Types.—Holotype, CAS 13443; paratypes, CAS 13444, 13445; paratypes, USNM 168539–168543; Stanford University Museum Paleontology 10026.

Occurrences.—Snowshoe Formation, middle and upper part of Weberg Member at USGS Mesozoic loc. 21612, 26761, 26766, and 29828; Lupher's locs. 229, 370, 474, and 596; Vigrass' loc. 205.

Pelekodites silviesensis Imlay n. sp.

Plate 34, figures 5–18

The species is represented by 105 internal and external molds of which most are preserved in a dark gray noncalcareous to slightly calcareous mudstone, but a few are preserved in calcareous concretions.

The shell is small and highly evolute. The whorl section is ovate and higher than wide. The venter is narrow and bears a low blunt keel. The umbilical wall is low, vertical at its base, and rounds evenly into the flanks. The body chamber occupies about three-fourths of a whorl and terminates in an elongate lateral lappet. Such lappets are preserved on many specimens, and their former presence is indicated on others.

The ribs are flexuous, moderately spaced and fairly strong. They are highest near the middle of the flanks and become a little broader and lower ventrally. They curve forward on the lower third of the flanks, recurve strongly backward on the upper two-thirds of the flanks, and then curve slightly forward near the keel. Most ribs remain simple, but some bifurcate on the lower third of the flanks. On the innermost whorls, as exposed in the umbilicus, the ribs are swollen low on the flanks but are not distinctly tuberculate.

The suture line cannot be traced. The dimensions cannot be measured accurately because none of the specimens show the completed whorl section.

Pelekodites silviesensis, Imlay, n.s.p. is nearly identical in appearance with *P. schlumbergeri* (Haug) (1893, p. 296, pl. 8, figs. 6a,b; Huf, 1968, p. 31, pl. 1, figs. 4,5) from the European zone of *Sonninia sowerbyi*. It differs by having some forked ribs and being slightly more evolute. It differs in the same respects from *P. nannomorphus* (Buckman) (1923, p. 445), which Huf (1968, p. 31) includes in the synonymy of *P. schlumbergeri* (Haug), and Westermann (1969, p. 115) considers as probably a strongly ornate variant of *Pelekodites pelekus Buckman*. It differs also by ranging upward into slightly younger beds that are correlated with the European subzone of *Otoites sauzei*. *Pelekodites* cf. *P. pelekus* Buckman from Alaska (Westermann, 1969, py. 126, pl. 32, figs. 1a,b, 2a,b) differs from the *P. silviesensis* Imlay, n. sp. in having weaker ribbing and attaining a smaller adult size, but is possibly within the range of variation of that species.

Types.—Holotype, CAS 13446; paratypes CAS, 13447–13453; paratypes, USNM 168544–168548.

Occurrences.—Snowshoe Formation in Seneca area at Lupher's locs. 57 and 272; upper part of lower member as USGS Mesozoic locs. 29230 and 26758 (Dickinson's loc. 109); lower part of middle member at Mesozoic loc. 26773 and 27578; Warm Springs Member at USGS Mesozoic locs. 29241, 29239, 29399, and Dickinson's loc. 97; Basey Member at Dickinson's locs. 100 and 101 and Mesozoic locs. 29812 and 29818. The species occurs in the upper two-thirds of the Warm Springs Member and the lower third of the Basey Member.

Pelekodites dobsonensis Imlay, n. sp.

Plate 34, figures 1–4

Seven compressed molds are characterized by evolute coiling; faint broad ribs on their smallest septate whorls; low, broad, rather closely spaced, mostly unforked, backwardly inclined ribs on their outer two septate whorls; and weaker, more backwardly inclined, more widely spaced ribs on their body chamber. Adorally on the body chamber the ribs gradually become much weaker. Lateral lappets are not preserved, but their former presence is indicated by the curvature of the ribs near the adoral end of the body chamber. The body chamber occupies about three-fourths of a whorl. The venter bears a low keel.

Pelekodites dobsonensis, Imlay, n. sp. differs from *P. silviesensis* Imlay, n. sp. in being much larger and in having much broader and lower ribs on its outer septate whorls and much weaker ribs on its smallest septate whorls. It also appears to be less evolute. Its ribs are weaker and more backwardly inclined than those of *Poecilomorphus arisdorfensis* Maubeuge (1955, p. 35, pl. 6, figs. 6a-c) from lower Bajocian beds in Switzerland. It differs from *Pelekodites? sp.* from the Cook Inlet area, Alaska (Imlay, 1964a, p. B36, pl. 6, figs. 4, 5, 11) in having slightly stronger and more rursiradiate ribbing.

Types.—Holotype, USNM 168549; paratypes, USNM 168550–168552.

Occurence.—Snowshoe Formation, near middle of Basey Member at USGS Mesozoic loc. 29816.

Genus POECILOMORPHUS Buckman, 1889

Poecilomorphus varius Imlay, n. sp.

Plate 25, figures 1–16

The species is represented by 68 laterally crushed internal and external molds preserved in a matrix of brown noncalcareous siltstone. The shell is moderately involute and before compression was probably elliptical in section. The venter bears a fairly low, rounded keel that, on the internal mold, is bordered by weak furrows. The umbilical wall on the small inner whorls is low, steep and rounds evenly into the flanks. On the larger whorls the umbilical wall is low, vertical, rounds fairly abruptly into the flanks, but does not have a distinct umbilical edge. The body chamber occupies at least three-fifths of a whorl but is incompletely preserved. The aperture is unknown.

The shell is ornamented with strongly falcate ribs that become stronger ventrally and adorally, that terminate abruptly on the venter near the keel, and that vary considerably in coarseness and density. Of the 60 specimens present, 27 have fairly coarse ribbing (pl. 25, figs. 10–16), 17 have fairly fine ribbing (pl. 25, figs. 1–3), and the remainder have ribbing of intermediate coarseness (pl. 25, figs. 4–8).

Falcate ribs first appear on the upper parts of the flanks at whorl diameters of about five mm, but within half a whorl appear also lower on the flanks. Most of these ribs are simple, but some bifurcate between the umbilical edge and the middle of the flanks, and some arise freely on the flanks. These ribs, and especially the forked ribs, are fairly strong on the lower parts of the flanks and become even stronger ventrally. During subsequent growth the ribbing on the lower parts of the flanks gradually becomes weaker and striate, whereas the ribbing on the upper parts becomes stronger. This change is most noticeable at a diameter of about 18 mm on the finely ribbed variant and about 25 mm on the coarsely ribbed variant.

The preservation of the specimens is too poor for making accurate measurements or for preparation of the suture line.

The coarsely ribbed variant of *Poecilomorphus varius* Imlay, n. sp. shows some resemblance to *Poecilomorphus angulinus* Buckman (1927, pl. 757) from the *Stephanoceras humphriesianum* zone in England but differs in having stronger and more falcate ribbing. In these respects it resembles *P. primiferus* Buckman (1927, pl. 756 a, b) but differs in having fewer forked ribs. The coarsely ribbed variant of *P. varius* Imlay, n. sp. also closely resembles *Graphoceras crickmayi* Frebold (in Frebold and others, 1969, p. 22, 32, pl. 2, figs. 2–4) from British Columbia but differs in not being slightly concave on the lower parts of its flanks.

The intermediate and finely ribbed variants of the Oregon species closely resemble *P. regulatus* Buckman (1927, pl. 746) to which they were compared by Ralph Lupher in labels accompanying the specimens. They appear, however, to have sharper ribbing ventrally. As all three species described by Buckman were obtained from a single bed (Davies, in Buckman, 1930, p. 34) they may represent variants of a single species comparable in range of variation with the Oregon species.

Types.—Holotype, CAS 13454; paratypes, CAS 13455–13466; paratypes, USNM 168553, 168554.

Occurrences.—Snowshoe Formation undifferentiated near Seneca at Lupher's locs. 28 and 136 and at USGS Mesozoic locs. 29790 and 29792; lower two-thirds of middle member near Izee at USGS Mesozoic locs. 26759 and 27363. *Poecilomorphus* cf. *P. varius* Imlay, n. sp. occurs above the middle of the Basey Member at Mesozoic loc. 29815 and Vigrass' loc. 146 and near the top of the Basey Member at USGS Mesozoic loc. 28384.

Family STRIGOCERATIDAE Buckman, 1924
Genus PRAESTRIGITES Buckman, 1924

Praestrigites cf. P. deltotus (Buckman)

Plate 35, figures 1–9, 11–14

cf. *Deltostrigites deltotus* Buckman, 1924, v. 5, pl. 467.

The genus *Praestrigites* is represented by 7 internal molds of various sizes. These molds are discoidal, strongly compressed, and have a minute umbilicus and a hollow floored keel. The body chamber is incomplete and is represented on the largest specimen by about one-fifth of a whorl.

The ribs on the small septate whorls are low, fairly broad, closely spaced and gently flexuous on the flanks, incline slightly forward near the venter, and terminate near the keel. The ribs begin near the umbilicus as faint broad swellings. Some primary ribs divide between the middle and the upper fourth of the flanks into slightly higher and narrower ribs. Many secondary ribs arise freely along the zone of furcation.

Adorally on the largest septate whorls the ribs become indistinct dorsally, lower and broader ventrally, and nearly disappear on the adoral part of the largest septate whorl.

The largest specimen near the adapical end of its body chamber has a diameter of 88 mm, a whorl height of 53 mm, and a whorl thickness of 22 mm.

The suture line is imperfectly preserved. The first lateral saddle is moderately broad. The first lateral lobe is trifid and slightly longer than the ventral lobe. The suspensive lobe descends evenly to the umbilicus.

The largest specimens of *Praestrigites* from Oregon agree very well in all characteristics with the holotype of *Praestrigites deltotus* (Buckman) but cannot be identified positively because the ribbing on the inner whorls of that species is unknown. *P. praenuntius* Buckman (1924, pl. 466) apparently differs by having finer ribs that do not become as broad ventrally.

Figured specimens.—USNM 168555; CAS 13468–13470.

Occurrences.—Weberg Member of Snowshoe Formation at USGS Mesozoic loc. 21610 and Lupher's locs. 207, 228N, 366, and 467. The species ranges throughout most of the Weberg Member (Dickinson and Vigrass, 1965, p. 51). It is associated with *Tmetoceras* (L207, L366, L467) in the lower part of its range and with *Latiwitchellia* and *Sonninia* in the upper part.

Genus STRIGOCERAS Quenstedt, 1886

Strigoceras cf. S. languidum (Buckman)

Plate 36, figures 13, 17–21

cf. *Leptostrigites languidus* Buckman, 1924, v. 5, pl. 477a, b.

Three internal molds are characterized by a discoidal, compressed shape, a hollow floored keel, a minute umbilicus, faint spiral fluting near the middle of the flanks, and low broad ribs on the upper parts of the flanks. The ribs incline gently backward across most of the upper half of the flanks and then curve forward high on the flanks.

These specimens, as far as their preservation permits comparisons, bear ribbing and spiral fluting comparable in strength with that on *S. languidum* (Buckman) and much weaker than that on *S. compressum* (Buckman) (1924, v. 5, pl. 468).

Figured specimens.—Stanford University Museum of Paleontology 10027; CAS 13471, 13472.

Occurrences.—Snowshoe Formation, middle and upper parts of Werberg Member at Lupher's loc. 371 and 460 and Vigrass' loc. 205.

Strigoceras sp. undet.

Plate 36, figures 14–16

One small specimen is assigned to *Strigoceras* rather than to *Praestrigites* because it has weak spiral fluting and faint spiral lines. It has slightly weaker and denser ribbing than the specimens herein compared with *S. languidum* (Buckman) (1924, pl. 477a, b) but is otherwise similar and could belong to the same species.

Figured specimen.—USNM 168556.

Occurrence.—Snowshoe Formation, upper part of Weberg Member at USGS Mesozoic loc. 26766.

Genus HEBETOXYITES Buckman, 1924

Hebetoxyites cf. H. hebes Buckman

Plate 36, figures 1–4, 8–10

cf. *Hebetoxyites hebes* Buckman, 1924, v. 5, pl. 475.

The genus, *Hebetoxyites*, is represented by eight internal molds which are compressed, discoidal, bear a minute umbilicus and have a narrowly rounded venter. The umbilical wall is low, vertical, and rounds abruptly into the flanks. The body chamber is unknown.

The ribs are weak, widely spaced and falcoid. They vary from very weak to indistinct on the lower part of the flanks and are moderately weak on the upper part. They become slightly stronger during growth and then nearly fade out on the adoral part of the largest septate whorl. The ribs on the lower part of the flanks are nearly straight and incline slightly forward. They curve backward a little above the middle of the flanks, then curve forward on the ventral margin, and fade out on the venter. Some of the specimens bear a faint, broad spiral ridge near the middle of the flanks.

The smaller specimen illustrated, at a diameter of 43 mm has a whorl height of 24 mm, a whorl thickness of 10 mm, and an umbilical width of 4 mm.

The suture line has moderately broad lobes and saddles. The first lateral lobe is much longer than the ventral lobe and only a little longer than the second lateral lobe. The suspensive lobe is incompletely preserved but apparently descends evenly toward the umbilicus.

The Oregon specimens of *Hebetoxyites* differ from *H. hebes* Buckman (1924, pl. 475) in having straighter ribs on the lower part of the flanks and more strongly recurved ribs on the upper part. The shape of their ribs more closely resembles that on *H. clypeus* Buckman (1924, p. 496b) which species is distinguished by having much stronger ribs ventrally.

Figured specimens.—CAS 13473, 13474.

Occurrences.—Snowshoe Formation, middle and upper parts of Weberg Member at USGS Mesozoic loc. 21610 and Lupher's locs. 225, 226, 475 and 584.

Family HAPLOCERATIDAE Zittel, 1884

Genus LISSOCERAS Bayle, 1879

Lissoceras hydei Imlay, n. sp.

Plate 40, figures 24–33

This species is represented by 30 specimens of which most have been crushed laterally. The shell is compressed and moderately involute. The whorls are elliptical in section, higher than wide, and are thickest a little below the middle of the flanks. The flanks are gently convex, converging above to a moderately rounded venter. The umbilicus is fairly narrow. The umbilical wall is low and vertical at its base and rounds evenly into the flanks. The body chamber is incomplete but occupies at least three-fourths of a whorl.

The separate whorls bear fine, closely spaced ribs that begin faintly near the umbilicus, become stronger ventrally, incline forward on the lower third of the flanks, incline backward on the remainder of the flanks and then terminate rather abruptly at the edge of a narrow smooth midventral area. During growth the ribs remain faint to weak on the lower third of the flanks but become much stronger and more backwardly inclined on the upper parts of the flanks. Furcation of ribs near the middle of the flanks occur rarely on some of the most strongly ribbed specimens. Adorally on the body whorl the ribs fade out almost completely on the lower third of the flanks, but become even stronger on the upper third. A smooth midventral band is present on at least part of the body whorl and probably persists on the entire whorl.

The specimens are too crushed to be measured accurately. The suture line is imperfectly preserved and cannot be traced.

Lissoceras hydei Imlay, n, sp. is characterized by a moderately involute compressed shell, sharp backwardly inclined ribbing, a smooth midventral area, and an evenly rounded umbilical edge. Its general appearance is similar to that of *Bradfordia helenae* (Renz) (1925, p. 28, pl. 2, figs. 3, 4) and *B. inclusa* Buckman (1910, pl. 9, figs. 2, 3), but it differs from all described species of *Bradfordia* in its umbilical wall rounding evenly into the flanks instead of forming a sharp or raised edge. In this feature, as well as in the others listed, it greatly resembles *Lissoceras semicostulatum* Buckman (1923, pl. 400) from the *Sonninia sowerbyi* zone of England but differs in having much coarser ribbing. It differs from an Alaskan species, described as *L.* cf. *L. semicostulatum* (Buckman) (Imlay, 1964a, p. B–38, pl. 4, figs. 7, 8) in having much sharper ribbing that inclines backward more strongly. Overall, its characteristics appear to be intermediate between those of *Lissoceras* and *Bradfordia*, which genera are closely related, according to Arkell (in Arkell and others, 1957, p. L274, L275).

This species is named in honor of the rancher Emil Hyde of the Izee area, Oregon. Many fossils described herein and in other publications were collected on his property.

Types.—Holotype, CAS 13475; paratypes, CAS 13476–13482; paratype USNM 168557.

Occurrences.—Snowshoe Formation undifferentiated in Seneca area at Lupher's loc. 57 and USGS Mesozoic locs. 21617 and 28027; near middle of lower member near Izee at Lupher's loc. 75, Dickinson's loc. 108 and Mesozoic loc. 29230; Warm Springs Member at Mesozoic loc. 29241.

Lissoceras? sp.

Plate 36, figures 5–7, 11, 12

This species is represented by one small internal mold. The shell is compressed and involute. The whorls are elliptical in section, nearly twice as high as wide, are widest near the umbilicus, and embrace about two-thirds of the preceding whorls. The flanks are nearly flat and converge in their upper third to a narrowly arched, almost sharp venter. The umbilicus is fairly narrow and steplike. The umbilical wall is low, vertical, and rounds fairly abruptly into the flanks. The incomplete body chamber comprises at least half a whorl.

The shell bears faint gently flexuous ribs that become slightly stronger ventrally and adorally. These incline forward on the lower part of the flanks, recurve backward just above the middle of the flanks, and then curve forward again high on the flanks and on the venter.

The suture line is simple. The first and second lateral saddles are broad. The first lateral lobe is fairly stout, trifid, and considerably longer than the ventral lobe.

The specimen at a maximum diameter of 31.5 mm, has a whorl height of 15 mm, a whorl thickness of 8 mm, and an umbilical width of 6 mm.

The Oregon specimen of *Lissoceras?* sp. in shape and ornamentation resembles *Lissoceras psilodiscus* (Schloenbach) as figured by Arkell (Arkell and others, 1957, p. L272, figs. 1a, b), but its suture line has much broader and simpler saddles and lobes that are similar to those on the Tithonian genus *Pseudolissoceras* (Arkell and others, 1957, pl. L272, fig. 2c).

Figured specimen.—USNM 168558.

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Occurrence.—Snowshoe Formation, upper part of Weberg Member at USGS Mesozoic loc. 21610.

Family OPPELIIDAE Bonarelli, 1894
Genus OPPELIA Waagen, 1869

Oppelia cf. O. subradiata (J. de C. Sowerby)

Plate 40, figure 13

The genus *Oppelia* is represented by part of an external mold and an attached sutured fragment. The mold bears falcoid ribbing that is faint on the lower and middle parts of the flanks, is fairly strong and closely spaced on the upper part of the flanks, and then weakens on the margin of the venter. Its general appearance is similar to that of the genotype of *O. subradiata* (J. de C. Sowerby) (Arkell, 1951, p. 50, 51, text fig. 11).

Figured specimen.—CAS 13483.

Occurrence.—Snowshoe Formation, undifferentiated near Seneca at Lupher's loc. 8.

Family OTOITIDAE Mascke, 1907
Genus DOCIDOCERAS Buckman, 1919

Docidoceras lupheri Imlay, no. sp.

Plate 38, figures 8, 9, 12, 14–17

The species is represented by five internal molds of which two have adult apertures. The shells are compressed and fairly evolute. The body whorl at its adapical end embraces about one-third of the preceding whorl, but becomes retracted during growth and at its adoral end embraces only about one-fourth. The whorls are ovate in section and slightly wider than high. The flanks and venter are evenly convex. The umbilicus is fairly wide and moderate in depth. The umbilical wall is nearly vertical at its base, steeply inclined above, and rounds evenly into the flanks. The body chamber occupies a little more than one complete whorl. The aperture is marked by a constriction that is followed by a collar. The collar is narrow on the lower parts of the flanks and fairly broad on the venter.

The outermost three septate whorls bear narrow, rather widely spaced primary ribs that are weak near the line of involution but become fairly strong ventrally and terminate in radially elongate tubercles at the base of the flanks. From the tubercles pass two or three secondary ribs that are a little weaker than the primary ribs and that cross the venter transversely. Many forked ribs are separated by secondary ribs that begin freely on the flanks along the zone of furcation. As a result secondary ribs outnumber primary ribs about three to one. The holotype and the specimen from Lupher's loc. 408 have slightly coarser and sparser ribbing than the other specimens.

On the body chamber both ribs and tubercles gradually become stronger and sparser adorally except near the aperture where the tubercles almost disappear and the secondary ribs arise mostly in pairs.

The holotype at a maximum diameter of 67 mm has a whorl height of 19 mm, a whorl thickness of 24 mm, and an umbilical width of 35 mm.

The suture line cannot be traced.

Docidoceras lupheri Imlay, n. sp. is characterized by the presence of small tubercles at the base of the flanks on the body whorl as well as on the septate whorls, by its ribs commonly branching in three's and by having a compressed whorl section. Among described species, it shows considerable resemblance to *D. zemistephanoides* Géczy (1967, p. 233,, pl. 58, figs. 2, 5, pl. 60, fig. 3) from Hungary but differs in being much more compressed and only half as large. It differs from *D. longalvum* (Vacek) (1886, pl. 17, figs. 1, 2; Westermann, 1964b, pl. 6, figs. 1, 2) in being much smaller, in having fewer secondary ribs, and more distinct tubercles that are lower on the flanks. *D.* aff. *D. longalvum* (Vacek) from the Alaska Peninsula (Westermann, 1969, p. 134, pl. 32, figs. 5a–c, pl. 33, text fig. 44 on p. 135) has a stouter whorl section, coarser ornamentation, an apparently nearly smooth body chamber, and is much larger.

The Oregon species is not assigned to *Stephanoceras* because its ribs branch much lower on the flanks than is characteristic of that genus. It differs from *Pseudotoites* (Arkell, 1954, p. 572–577, pl. 32, figs. 2–4, pls. 33–37, pl. 38, figs. 1–6, pl. 40) in having a pronounced instead of a weak apertural collar, more evolute inner whorls, and weaker tubercles on its adult body whorl.

This species in named in honor of Ralph L. Lupher.

Types.—Holotype, CAS 13484; paratypes, CAS 13485, 13486; paratype, USNM 168559.

Occurrences.—Snowshoe Formation, Weberg Member at USGS Mesozoic loc. 29828 and Lupher's locs. 103, 228, 228N, and 408. The species occurs in the lower half of the limestone division of the Weberg Member, or in the middle of the range of *Sonninia* (*Euhoploceras*).

Docidoceras warmspringsense Imlay, n. sp.

Plate 38, figures 1–7, 13

This species is represented by seven molds, of which four bear adult apertures. The shells are moderately compressed and fairly evolute. The adult body whorl embraces about two-fifths of the preceding whorl and is slightly retracted near the aperture. The whorls are depressed ovate in section and considerably broader than high. The flanks are strongly convex. The venter is broadly rounded. The umbilicus is wide and fairly shallow. The umbilical wall is steeply inclined and rounds evenly into the flanks. The body chamber occupies nearly a complete whorl. The aperture on the internal mold is marked by a constriction that is followed by a collar which is broad on the venter and narrow on the lower parts of the flanks.

The ornamentation on the inner septate whorls, as shown in the umbilicus, consists of strong primary ribs that are strongest low on the flanks and that give rise to pairs of slightly weaker secondary ribs near the line of involution. On the outer septate whorl the primary ribs are strong, are swollen a little below the middle of the flanks, and give rise to two or three slightly weaker secondary ribs that cross the venter transversely. Some short ribs arise freely on the flanks between pairs of ribs.

The suture line, drawn near the adapical end of the body chamber, has very broad irregularly shaped saddles. The first lateral lobe is fairly narrow, trifid, and a little longer than the ventral lobe. The suspensive lobe trends nearly straight to the umbilical seam.

The holotype, which has been somewhat crushed laterally, at a maximum diameter of 57 mm, has a whorl height of 17 mm, a whorl thickness of 24 mm, and an umbilical width of 27 mm. On the paratype shown on plate 38, figures 6 and 7, the same dimensions are 55, 19, 24, and 25 mm, respectively.

Docidoceras warmspringsense Imlay, n. sp. resembles *D. planulatum* Buckman (1921, pl. 264) in coiling whorl shape, strength of secondary ribs, and number of secondary ribs relative to the primary ribs. It differs by having wider spaced and much stronger primary ribs.

Types.—Holotype, CAS 13487; paratypes, CAS 13488, 13489.

Occurrences.—Snowshoe Formation, middle and upper parts of Weberg Member at Lupher's locs. 226, 228N, 306, 352, and 371.

Docidoceras sparsicostatum Imlay, n. sp.

Plate 37, figures 1–3, 5–12, 15, 16

This species is represented by 16 internal molds. The shell is fairly stout and moderately evolute. The whorls are depressed ovate in section and variably wider than high. The largest preserved whorls embrace nearly half of the preceding whorls. The flanks are moderately to strongly convex. The venter is regularly to broadly rounded. The umbilicus is moderate in width and fairly deep. The umbilical wall is steeply inclined and rounds evenly into the flanks. The body chamber on the holotype occupies three-fourths of a whorl and is incomplete.

The inner septate whorls, as exposed in the umbilicus, bear sharp, widely spaced, forwardly inclined primary ribs. The outer septate whorls bear similar primary ribs that become higher and more widely spaced adorally and are strongest near the middle of the flanks. From these ribs pass two or three lower and broader secondary ribs that arch gently forward on the venter. Other ribs arise freely near the zone of furcation and result in nearly four secondary ribs for each primary rib. Adorally on the body chamber the primary ribs gradually become much higher and broader and very widely spaced.

Docidoceras sparisicostatum Imlay, n. sp. shows considerable variation in whorl shape and in the strength and spacing of its primary and secondary ribs. Within the species, the holotype has a fairly depressed whorl section, very coarse and widely spaced primary ribs, and moderately fine secondary ribs. The paratype shown on plate 37, figures 1–3, has the most depressed whorl section, finer than average secondary ribs, and moderately spaced but fairly coarse primary ribs. The paratype shown on plate 37, figures 15 and 16, has the least depressed whorl section, fairly coarse secondary ribs, and widely spaced but only moderately coarse primary ribs. These specimens show that the species varies considerably but overall is characterized by its primary ribs being forwardly inclined, moderate to coarse, and moderately to widely spaced.

The holotype at a diameter of 70 mm has a whorl height of 24 mm, a whorl thickness of 30 mm, and an umbilical width of 31 mm. On the paratype shown on plate 37, figures 10, 15, and 16, the same dimensions are 58, 20, 26, and 24 mm, respectively.

The suture line has moderately broad, irregularly bifid saddles, a short ventral lobe, and a long slender irregularly trifid first lateral lobe. The suspensive lobe trends nearly straight to the umbilical seam.

This species is distinguished from all described species of *Docidoceras* by its coarse primary ribs being more widely spaced.

Types.—Holotype, Stanford University Museum Paleontology 10028; paratype, USNM 168560; paratypes CAS 13490, 13491.

Occurrences.—Snowshoe Formation, Weberg Member, at USGS Mesozoic locs. 26760, 27581 and 29825; Lupher's locs. 212, 214, 224, 226 and 368, and Vigrass' locs. 11, 86, and 87. The species ranges throughout the upper two-thirds of the Weberg Member above beds characterized by *Tmetoceras*.

Docidoceras cf. D. liebi Maubeuge

Plate 37, figures 4, 13, 14

cf. *Docidoceras liebi* Maubeuge, 1955, p. 42, pl. 9, figs. 1a–d, 2.

This species is represented by three internal molds. The shell is stout. The whorls are depressed ovate in section, much wider than high, and become more depressed during growth. The septate whorls embrace about three-fifths of the next inner whorl. The body whorl becomes eccentric during growth, and near its adoral end embraces only about one-fourth of the preceding whorl. The flanks are strongly convex. The venter is broadly convex and becomes broader during growth. The umbilicus is moderate in width and very deep. The umbilical wall is steeply inclined and rounds evenly into the flanks. The body chamber (not shown) is incomplete and the aperture is not preserved.

The ribs on the septate whorls are fine, closely spaced, and become slightly coarser adorally. The primary ribs are moderately sharp, incline slightly forward and terminate in acute tubercles at about two-fifths of the height of the flanks. From the tubercles pass three or four weak secondary ribs that arch gently forward on the venter. A few secondary ribs arise freely on the flanks. The outer septate whorl of the largest specimen bears 27 primary ribs and about 106 secondary ribs. The body chamber (not illustrated) on its flanks bears traces of broad, rather widely spaced primary ribs that apparently terminate in lateral swellings, but the venter is too corroded to show any ribbing.

The largest Oregon specimen at a diameter of 77 mm, has a whorl height of 26 mm, a whorl thickness about 40 mm, and an umbilical width of 35 mm. The suture line cannot be traced.

The two smaller specimens of *Docidoceras* cf. *D. liebi* Maubeuge from Oregon are nearly identical in shape and ribbing with *Docidoceras liebi* Maubeuge (1955, p. 42, pl. 9, figs. 1, 2) from the *Sonninia sowerbyi* zone of Switzerland. They appear to be a little less involute and may bear stronger tubercles. The larger septate specimens from Oregon are decidedly less evolute. *D.? paucinodosum* Westermann (1969, p. 153, pl. 44, figs. 1–3) has similarly fine and closely spaced secondary ribs but much sparser and weaker primary ribs, a higher whorl section, and more evolute coiling.

Figured specimens.—CAS 13492, 13493.

Occurrences.—Snowshoe Formation, upper part of Weberg Member, at Lupher's locs. 361 and 575.

Genus EMILEIA Buckman, 1898

Emileia buddenhageni Imlay, n. sp.

Plate 39, figures 8–11, 13, 15

This species is represented by five fairly complete specimens and seven fragments. All are crushed laterally.

The shell is small for the genus. The inner whorls overlap each other about three-fourths; the outer whorl overlaps about one-half. The body chamber occupies about four-fifths of a whorl. The aperture on the internal mold is marked by a pronounced forwardly inclined constriction that is followed by a collar.

On the small inner whorls the primary ribs are moderately strong, moderately spaced, begin at the umbilicus, become stronger ventrally, trend radially to near the middle of the flanks and then divide into two or three weaker secondary ribs that also trend radially across the flanks and cross the venter transversely. Some ribs arise freely on the flanks. The ribs do not bear tubercles. During growth the primary ribs gradually become a little shorter, very widely spaced, and relatively much stronger than the secondary ribs. Secondary ribs outnumber primary ribs about 3 to 1 on the inner whorls and 4 to 1 on the largest whorls.

The suture line cannot be traced accurately. All specimens are too crushed to make meaningful measurements.

Emileia buddenhageni Imlay, n. sp. is characterized by fairly coarse ribbing for the genus and, in particular, by long, strong and widely spaced primary ribs. Among described species it closely resembles the holotype of *E. bulligera* Buckman (1927, pl. 732a–c) in coiling and style of ribbing. It differs by being much smaller, by having shorter primary ribs on its outer whorl and much weaker primary ribs on its inner whorls. It differs from *E. multifida* Buckman (1927, pl. 733) in its primary ribs being much stronger than its secondary ribs. *E. brocchii* (Sowerby) (Buckman, 1927, pl. 710a–d) has more secondary ribs per primary rib.

The species is named in honor of H. J. Buddenhagen who has spent many field seasons mapping and studying the Jurassic rocks of eastern Oregon.

Types.—Holotype, USNM 168562; paratypes, USNM 168563–168565.

Occurrence.—Snowshoe Formation, lower part of Warm Springs Member at USGS Mesozoic loc. 29241. Questionably present at Lupher's loc. 109 near top of Warm Springs Member.

Emileia sp. undet.

Plate 39, figures 5, 12, 14

This species is represented by six laterally crushed molds of which three represent inner whorls and three represent adult whorls.

The shell is small for the genus. The inner whorls overlap each other about three-fourths and the outer whorl about one-half.

On the smallest preserved septate whorls the primary ribs are moderately strong, fairly widely spaced, trend radially and terminate on the edge of the umbilicus in radially elongate swellings. From these pass two or three weaker, radial trending secondary ribs. All secondary ribs widen slightly ventrally.

During subsequent growth the swellings disappear, the primary ribs extend across the lower third of the flanks, and the secondary ribs arise in bundles of three to four and become much weaker relative to the primary ribs. Adorally on the body chamber all ribs become inclined forward and become much weaker, and near the aperture are replaced by striae of irregular strength.

The suture line cannot be traced.

The ribbing of *Emileia* sp. undet. bears a little resemblance to that of *E. multifida* Buckman (1927, pl. 733) but differs in having shorter and stronger primary ribs, finer and denser secondary ribs, and in the development of striation on the adult body chamber.

Figured specimens.—USNM 168566; Stanford University Museum Paleontology 10029.

Occurrences.—Snowshoe Formation, middle to upper part of Warm Springs Member at USGS Mesozoic loc. 29241 and Dickinson's loc. D94.

Genus OTOITES Mascke, 1907

Otoites contractus (J. de C. Sowerby)

Plate 39, figures 1–4, 6, 7

[For synonymy see Westermann, 1954, p. 88, 92]

The species is represented in eastern Oregon by 30 molds that show different growth stages and some variation in ribbing. Most of these specimens of *Otoites contractus* (J. de C. Sowerby) have very coarse ribbing similar to that on the holotype (Buckman, 1920, pl. 158) from England and on some of the specimens from Germany illustrated by Westermann (1954, pl. 1, fig. 5). They also closely resemble a specimen from Argentina (Gottsche, 1878, pl. 2, figs. 4a, b) that Westermann (1954, p. 94) considers to belong to a subspecies of *E. contractus.* Some of the specimens are a little finer ribbed than the others but resemble a specimen from Germany that has been assigned to *E. contractus* by Westermann (1954, pl. 2, fig. 1).

The coarsely ribbed variant (pl. 39, figs. 2–4, 6) bears three secondary ribs per primary rib at the adapical end of the body whorl, but toward the aperture the number of secondary ribs decreases to two for each primary rib. On the most finely ribbed variant (pl. 39, figs. 1 and 7) the number of secondary ribs per primary rib decreases adorally on the body whorl from four to three.

Types.—Hypotypes, USNM 168567–168572.

Occurrences.—Snowshoe Formation undifferentiated at Lupher's loc. 57 and probably at USGS Mesozoic loc. 29413; upper part of Warm Springs Member at USGS Mesozoic locs. 29241, 29395, and 29808 and Lupher's loc. L109.

Family SPHAEROCERATIDAE Buckman, 1920

Genus CHONDROCERAS Mascke, 1907

Chondroceras allani (McLearn)

Plate 40, figures 11, 12

[For synonymy see Imlay, 1964a, p. B42]

This species is represented in eastern Oregon by 13 molds. On the penultimate whorl the primary ribs are moderately sharp and divide below the middle of the flanks into two or three weaker secondary ribs. Other secondary ribs arise by intercalation low on the flanks. On the body whorl all ribbing becomes coarser and sparser adorally and secondary ribs become fewer relative to the primary ribs.

The few specimens of *Chondroceras allani* available from Oregon show some variation in coarseness of ribbing comparable with that in collections of the species from Alaska (USGS Mesozoic locs. 19981, 20000, 20025) and Alberta (Mesozoic loc. 14630). The species is readily distinguished from *C. defontii* McLearn (1927, pl. 1, fig. 3; 1929, pl. 12, figs. 1–3) in having appreciably coarser ribbing on its penultimate whorl and on the adapical end of the body whorl.

Figured specimens.—USNM 168573, 168574.

Occurrences.—Snowshoe Formation undifferentiated at USGS Mesozoic locs. 26770, 29413, and probably also at Lupher's loc. 28; upper part of Basey Member at Mesozoic loc. 28384.

Chondroceras n. sp. undet.

Plate 40, figures 8–10

Six laterally compressed internal molds represent a distinctive species characterized by its small size, involute coiling, and sharp forwardly inclined ribbing. The body chamber occupies about three-fourths of a whorl, becomes scaphitoid near the aperture, and is terminated by a constriction and a collar. The primary ribs are high, rather widely spaced and forwardly inclined. Most of them bifurcate at, or a little below the middle of the flanks into slightly weaker secondary ribs that also incline forward. Some primary ribs remain undivided, and some secondary ribs arise freely near the middle of the flanks. Secondary ribs outnumber primary ribs slightly more than 2 to 1. Adorally the ribbing becomes higher, sharper, and more widely spaced. The suture line cannot be traced accurately.

Chondroceras n. sp. undet. bears a general resemblance to some small adult specimens of *Chondroceras* from Europe described as *C. orbignyanum crassicostatum* Westermann (1956a, p. 79, pl. 5, fig. 8a–d, pl. 6, figs. 3–5), but differs in being much more tightly coiled and in its ribs branching higher on the flanks.

Figured specimens.—CAS 13494–13496.

Occurrence.—Snowshoe Formation at Lupher's loc. 28.

Genus SPHAEROCERAS Bayle, 1878

Sphaeroceras cf. S. brongniarti (J. de C. Sowerby)

Plate 40, figures 17–23

The genus *Sphaeroceras* is represented near Seneca in eastern Oregon by molds of four tiny adult specimens. Three of the specimens have been deformed, but one (pl. 40, figs. 20–22) shows the globular shape that is characteristic of the genus. On all specimens the septate part of the body whorl has an extremely narrow umbilicus, and the adoral part of the body whorl is abruptly contracted from the septate part of the shell. The aperture terminates in a flared collar that is followed by a constriction and then by a smooth area that is projected on the venter.

The ribbing is low and weak on the internal molds but fairly sharp on the external molds. The primary ribs are variable in strength. They begin at the umbilicus, trend radially on the lowest part of the flanks, and then curve forward to the middle of the flanks where some of them divide into pairs of slightly weaker secondary ribs. All secondary ribs arch gently forward on the venter.

The suture line cannot be traced accurately.

The undeformed specimen near the aperture has a maximum diameter of 16 mm, a thickness of 10.5 mm, and a whorl height of 5.5 mm. About half a whorl from the aperture the same dimensions are 12.5, 9.0, and 6.0 mm respectively.

These Oregon specimens of *Sphaeroceras*, although too poorly preserved for exact specific identification, have all the features of *S. brongniarti* (J. de C. Sowerby) (Arkell, 1952a, p. 77, text-fig. 20, nos. 1 and 2; Roman and Petouraud, 1927, p. 46, pl. 5, figs. 6a, b; Westermann, 1956a, p. 28–34, pl. 14, figs. 1–6) and probably are within the range of variation of that species.

Figured specimens.—USNM 168575–168577; CAS 13497.

Occurrences.—Snowshoe Formation undifferentiated near Seneca at Lupher's loc. 8 and at USGS Mesozoic locs. 28017, 28018, and 29236. At the last three localities it is associated with *Spiroceras*.

Sphaeroceras sp.

Plate 40, figures 14–16

This species is represented by six very small molds of which most are deformed, four bear adult apertures, and all represent the body whorl. The shape of this whorl is nearly globular on the least deformed specimens. The septate part of the whorl has a very narrow umbilicus. The body chamber occupies about three-fifths of a whorl and is somewhat contracted from the septate part of the whorl. The aperture terminates in a flared collar that is followed by a smooth area.

The ribs are fine and fairly sharp. The primary ribs begin at the umbilicus, incline slightly forward on the lower parts of the flank, and some divide into slightly weaker secondary ribs near or below the middle of the flanks. A few secondary ribs arise freely on the middle third of the flanks. All secondary ribs arch gently forward on the venter.

The suture line cannot be traced, and accurate measurements cannot be made.

Sphaeroceras sp. differs from *S. brongniarti* (J. de C. Sowerby) (Arkell, 1952, p. 77, text fig. 20, nos. 1 and 2) and from the specimens herein compared with that species in being considerably smaller and in having a slightly larger umbilicus on the septate part of the body whorl.

Figured specimens.—USNM 168578, 168579.

Occurrences.—Snowshoe Formation, from 600–1000 feet above the base of the Basey Member in its lower middle part at USGS Mesozoic locs. 29813, 29814, and 29816.

Genus MEGASPHAEROCERAS Imlay, 1962

Megasphaeroceras rotundum Imlay

Plate 40, figures 4–7

Megasphaeroceras rotundum Imlay, 1962, p. A10, pl. 3, figs. 1, 4–12.
cf. *Megasphaeroceras* cf. *M. rotundum* Imlay, 1967, p. 96, pl. 14, figs. 1–6, 9–16, pl. 16, figs. 1–4.

Four crushed septate specimens from Oregon are characterized by an extremely small umbilicus, and by fine, sharp, closely spaced ribs. Most primary ribs bifurcate low on the flanks into slightly finer and sharper secondary ribs. Most pairs of forked ribs are separated by one or two secondary ribs that arise freely on the flanks near the zone of furcation. These features are identical with those on the most densely ribbed variant of *Megasphaeroceras rotundum* from Alaska (Imlay, 1962, pl. 3, fig. 8) and are only slightly finer than on one specimen of *Megasphaeroceras* from the western interior region (Imlay, 1967, pl. 16, figs. 1–4).

Types.—Hypotypes CAS 13498–13501.

Occurrence.—Snowshoe Formation undifferentiated near Seneca at Lupher's loc. 28.

Family STEPHANOCERATIDAE Neumayr, 1875

Genus NORMANNITES Munier-Chalmas, 1892

Normannites (Normannites) orbignyi Buckman

Plate 41, figures 9, 10, 18, 20

Normannites orbignyi Buckman, 1927, v. 7, pl. 734, figs. 1–3.
N. (*N.*) *orbignyi* Buckman, Westermann, 1954, p. 138,, pl. 5, figs. 3, 4, pl. 6, fig. 1.

Normannites (*Normannites*) *orbignyi* Buckman is represented by seven internal molds. The coiling is evolute. The outermost half whorl of the largest mold is nonseptate and probably represents part of the body chamber. Lateral lappets are not preserved. The primary ribs are sharp, high, moderately spaced, trend nearly radial, or incline slightly forward, and terminate at or below the middle of the flanks in small, pointed tubercles. From the tubercles pass pairs of sharp secondary ribs that are slightly weaker than the primary ribs. On one mold the secondary ribs incline abruptly forward from the tubercles. On the other molds the secondary ribs incline only slightly forward.

These Oregon specimens, as far as preservation permits comparisons, are identical in appearance with *N. orbignyi* Buckman. Their ribbing may be slightly weaker than on the specimen figured by Buckman (1927, pl. 734), but is essentially identical with that on some specimens figured by Westermann (1954, pl. 5, fig. 4a, pl. 6, fig. 1).

Figured specimens.—USNM 168580–168583.

Occurrences.—Snowshoe Formation undifferentiated near Emigrant Creek at USGS Mesozoic locs. 26772, 27579, and near Seneca at Mesozoic locs. 26777, 29415, and 29790; above middle of Basey Member at Mesozoic loc. 29815.

Normannites (Normannites) n. sp. aff. N. (N.) orbignyi Buckman

Plate 41, figures 14–16

Seven fragmentary molds differ from *N.* (*N.*) *orbignyi* Buckman (1927, pl. 734), as well as from the Oregon specimens herein compared with that species in having a broader whorl section, higher and sharper ribs on their body whorl, and apparently finer and more closely spaced ribs on their septate whorls. None of the European specimens assigned to *N.* (*N.*) *orbignyi* (Buckman) or to its subspecies by Westermann (1954, pl. 5, figs. 3, 4, pl. 6, figs. 1, 3–5, pl. 7, pl. 8, fig. 1) has nearly as sharp ribbing.

Figured specimens. —USNM 16884, 168585.

Occurrences.—Snowshoe Formation undifferentiated near Seneca at USGS Mesozoic locs. 25821, 28020, 29231, and 29232.

Normannites (Normannites) cf. N. (N.) braikenridgii (J. de C. Sowerby)

Plate 41, figure 17

One species is represented by seven small molds of which three retain lateral lappets. The body whorl overlaps nearly half of the preceding whorl. The ribs are high, sharp, and fairly closely spaced. The primary ribs incline slightly forward on the lower third of the flanks and terminate in small tubercles. From the tubercles pass pairs of secondary ribs that likewise incline slightly forward on the flanks and are nearly as strong as the primary ribs. On the adoral third of the body chamber some primary ribs remain simple, and some secondary ribs are loosely connected with the primary ribs. Tuberculation becomes weak near the aperture. The specimens are too crushed for accurate measurements. The suture line is not preserved.

This species resembles *Normannites braikenridgii* (Sowerby) (Buckman, 1914, pl. 81; Westermann, 1954, pl. 9, figs. 1a–c) in coiling, tuberculation, strength and density of ribbing, and in their secondary ribs being nearly as strong as their primary ribs. It differs by being much smaller. In this respect it shows more resemblance to some small ammonites that have been described as *N. braikenridgii ventriplanus* Westermann (1954, p. 169, pl. 9, figs. 5–7).

Figured specimen.—CAS 13502.

Occurrence.—Snowshoe Formation at Lupher's loc. 57.

Normannites (Normannites) cf. N. (N.) quenstedti Roche

Plate 41, figures 11–13

cf. *Ammonites braikenridgii* Sowerby. Quenstdt, 1886, v. 2, p. 525, pl. 65, fig. 5.
cf. *Normannites quenstedti Roche*, 1939, p. 221.
cf. *N.* (*N.*) *quenstedt* Roche. Westermann, 1954, p. 179, pl. 11, figs. 2–4.

This species is represented by two molds of which one shows part of the body whorl including the lateral lappet. The other specimen has an ovate whorl section, and a fairly wide, moderately deep umbilicus. Its outermost whorl emprace about three-fifths of the preceding whorl. Its ribs are high, sharp, fairly closely spaced, incline gently forward on the flanks, and cross the venter transversely. The primary ribs terminate in weak tubercles at about two-fifths of the height of the flanks. From the tubercles pass pairs of slightly weaker ribs. The suture line is not preserved.

The Oregon specimens greatly resemble the type specimens of *N.* (*N.*) *quenstedti* Roche in size, evolution, strength of ribbing, and in furcation of ribs slightly below the middle of the flanks. Its ribbing is slightly denser than on the holotype figured by Westermann (1954, pl. 11, figs. 2a–c) but is comparable in density with one hypotype (Westermann, 1954, pl. 11, figs. 3a, b). *N.* (*N.*) *braikenridgii* (J. de C. Sowerby), as figured by Westermann (1954, pl. 9, figs. 1–7) has sharper and denser ribbing and rib furcation occurs a little lower on the flanks.

Figured specimens.—CAS 13503 and 13549.

Occurrence.—Snowshoe Formation at Lupher's loc. 8.

Subgenus ITINSAITES McLearn, 1927

Normannites (Itinsaites) crickmayi (McLearn)

Plate 41, figures 2–5

[For synonymy see Imlay, 1964a, p. B43, B44].

This species is represented in eastern Oregon by 32 laterally crushed specimens, of which 5 show parts of the lateral lappets of adults. The specimens have a fairly wide umbilicus, which on the largest specimen widens near the aperture owing to contraction of the body chamber. The ribbing is fairly coarse and widely spaced. The primary ribs are appreciably stronger than the secondary ribs, curve slightly forward on the lower two-fifths of the flanks, and terminate in acute tubercles. From the tubercles pass two or three secondary ribs that incline gently forward on the flanks. Some secondary ribs arise freely along the zone of furcation. Secondary ribs outnumber primary ribs about 2½ to 1 on the septate whorls and on the adapical part of the body chamber. Near the aperture there are about two secondary ribs for each primary rib.

The Oregon species of *Normannites* (*Itinsaites*) *crickmayi* does not develop as coarse ribbing on its body chamber as does the holotype of *N.* (*I.*) *crickmayi* McLearn (1927, pl. 1, figs. 5, 6), but its ribbing is nearly as coarse as that on a specimen identified with that species by Imlay (1964a, p. B43, pl. 14, figs. 6–8).

Types.—Hypotypes, USNM 168586–168589.

Occurrences.—Snowshoe Formation undifferentiated near Emigrant Creek at USGS Mesozoic locs. 26770, 26772, and 29410; near Seneca at Mesozoic locs. 29413 and 29790 and questionably at Mesozoic locs. 25692 and 25824. Questionably present in the Izee area from Lupher's loc. 109 near the top of the Warm Spring Member. Present in Suplee area at Mesozoic loc. 29815 in the Basey Member.

Normannites (Itinsaites) formosus (Buckman)

Plate 41, figure 19

Epalxites formosus Buckman, 1920, v. 3, pl. 151, figs. 1–3.
Itinsaites formosus (Buckman). Westermann, 1954, p. 260, pl. 22, fig. 4, pl. 25, figs. 1a–c.

One laterally compressed mold from eastern Oregon is characterized by its fairly large size, evolute coiling, prominent primary ribs that terminate in prominent tubercles near the middle of the flanks, and much weaker secondary ribs that become stronger adorally on the body chamber. These secondary ribs at the adapical end of the body whorl number three to four for each primary rib, but decrease in density adorally and near the aperture number two to three for each primary rib. The body chamber is complete, occupies about five-sixths of a whorl, and bears a lateral lappet.

The Oregon specimen of *Normannites* (*Itinsaites*) *formosus* (Buckman) resembles *N. vigorosus* (Imlay) (1962, p. A–12, pl. 4) from upper Bajocian beds in Alaska in size, evolution and vigorous ribbing but differs in having higher, sharper and more closely spaced ribs. It shows much more resemblance to *N. formosus* Buckman from which it differs in having slightly stronger primary ribs and slightly weaker secondary ribs. It is considered to be within the range of variation of that species.

Type.—Hypotype, USNM 168590.

Occurrence.—Snowshoe Formation undifferentiated near Seneca at USGS Mesozoic loc. 21617.

Normannites (Itinsaites) cf. N. (I.) gracilis (Westermann)

Plate 41, figure 21

cf. *Itinsaites gracilis* Westermann, 1954, p. 284, pl. 26, figs. 3a, b, 4.

One external mold represents most of a body whorl and a small part of a penultimate whorl. Its coiling is fairly evolute. Its body whorl bears from 30 to 34 primary ribs that are sharp, moderately spaced, incline forward on the lower two-fifths of the flanks, and terminate in small acute tubercles. The secondary ribs are much finer, denser and weaker than the primary ribs, arise from the tubercles by twos and threes, or arise freely between the tubercles. Secondary ribs outnumber primary ribs about 3 to 1 on the adapical part of the body chamber.

This species appears to differ from *N.* (*I.*) *gracilis* Westermann in its tubercles being more prominent and its secondary ribs finer.

Figured specimen.—USNM 168591.

Occurrence.—Snowshoe Formation lower part of middle member at USGS Mesozoic loc. 28029.

Normannites (Itinsaites) aff. N. (I.) itinsae (McLearn)

Plate 41, figures 6–8

This species is represented by five compressed internal molds, of which three bear lateral lappets. The coiling is fairly evolute. The body chamber occupies about three-fifths of a whorl. The primary ribs are high, sharp, moderately spaced, incline forward on the lower two-fifths of the flanks, and terminate in high, pointed tubercles that are strong except near the lateral lappets. From the tubercles pass three to four secondary ribs that are much weaker than the primary ribs. Some of the secondary ribs are indistinctly connected with the primary ribs.

This Oregon species in lateral view greatly resembles *Normannites* (*Itinsaites*) *itinsae* (McLearn) (1927, p. 73, pl. 1, fig. 7; 1929, p. 26, pl. 15, figs. 2, 3) but attains only about two-thirds of the size of that species, has somewhat denser ribbing, and retains prominent tubercles to a later growth stage.

Figured specimens.—CAS 13504–13506.

Occurrence.—Snowshoe Formation undifferentiated near Seneca at Lupher's loc. 272.

Normannites (Epalxites) cf. N. (E.) anceps (Quenstedt)

Plate 41, figure 1

cf. *Ammonites contractus anceps* Quenstedt, 1886, v. 2, p. 521, pl. 64, fig. 20.
cf. *Epalxites anceps* (Quenstedt). Westermann, 1954, p. 297, pl. 27, figs. 4a–c, pl. 28, figs. 1–3.

One internal mold of one side of an ammonite represents an adult, as shown by the presence of a lateral lappet. It is characterized by evolute coiling, by strong, rather widely spaced primary ribs, and by prominent lateral tubercles that are elongated spirally. These tubercles are particularly prominent on the inner whorls and on the adapical half of the body whorl but weaken considerably near the aperture. Secondary ribs are exposed only on the outermost fourth of the specimen near the aperture. At this place four primary ribs divide into pairs of secondary ribs and three primary ribs remain simple. In addition three secondary ribs arise freely near the middle of the flanks. All secondary ribs are lower and broader than the primary ribs.

The Oregon specimen is assigned to the subgenus *Epalxites* rather than to *Itinsaites* because of the coarseness of its primary ribs and tubercles. Its appearance in side view is similar to that of *N.* (*E.*) *anceps* (Quenstedt) as figured by Westermann (1954, pl. 27, fig. 4a, pl. 28, fig. 2). Close comparisons cannot be made, however, because of lack of knowledge concerning the shape of the whorls and the characteristics of the secondary ribs of the Oregon specimen.

Figured specimen.—USNM 168592.

Occurrence.—Snowshoe Formation undifferentiated in Seneca area at USGS Mesozoic loc. 29413.

Subgenus MASCKEITES Buckman, 1920

Normannites (Masckeites?) cf. N. (M.?) densus (Buckman)

Plate 40, figures 1, 2

cf. *Masckeites densus* Buckman, 1920, v. 3, pl. 152, figs. 1–4.
cf. *Masckeites densus* Buckman. Westermann, 1954, p. 332, pl. 32, figs. 1a–c.

Two compressed molds represent an evolute finely-ribbed species. The largest specimen shows parts of two septate whorls and a large part of a body chamber. The other specimen probably represents the adoral end of the body chamber, as indicated by the presence of a constriction. The body chamber occupies at least three-fourths of a whorl. Lateral lappets are not preserved.

The primary ribs on the septate whorls are sharp, fairly closely spaced, curve slightly forward on the lower two-fifths of the flanks, and terminate in swellings or weak tubercles. From the swellings pass pairs of weaker secondary ribs that trend nearly radially. Many rib pairs are separated by single ribs that arise freely along the zone of furcation. Adorally on the body chamber the secondary ribs gradually become nearly as strong as the primary ribs and many curve slightly backward.

The Oregon specimens in coiling and ornamention closely resemble *Normannites densus* (Buckman) from the basal part of the *Stephanoceras humphriesianum* zone of England. They possibly differ by having a longer body chamber and slightly more evolute coiling.

Figured specimens.—USNM 168593.

Occurrence.—Snowshoe Formation, Warm Springs Member, probably upper part, at USGS Mesozoic loc. 29241.

Normannites? kialagvikensis Imlay

Plate 40, figure 3

Normannites kialagvikensis Imlay, 1964a, p. B43, pl. 13, figs. 1–8, 10, 11, 17.

Three molds, one of which represents an adult ammonite, closely resemble the type specimens from Alaska in size, coiling, strong biplicate ribbing, and the presence of lateral lappets. They differ from the small septate inner whorls of *Parabigotites crassicostatus* Imlay (1964a, p. B54, pl. 29, figs. 1–16) in bearing small pointed lateral tubercles but conceivably could represent the microconch of that species.

Types.—Hypotype, CAS 13507.

Occurrence.—Snowshoe Formation undifferentiated near Seneca at Lupher's loc. 57.

Genus STEPHANOCERAS Waagen, 1869

Stephanoceras mowichense Imlay, n. sp.

Plate 45, figures 5–7

This species is represented by seven molds that are probably slightly compressed. Adult specimens are small for the genus and are highly evolute. The body chamber terminates in a broad collar. All ribs are high, thin and moderately spaced. The primary ribs arise at the umbilical seam, trend gently forward on the lower two-fifths of the flanks, and terminate in acute tubercles. The secondary ribs are somewhat weaker than the primary ribs, arise mostly in pairs from the tubercles, and trend nearly radially. A few secondary ribs arise freely near the middle of the flanks. Adorally on the body chamber the furcation points become indistinct. Near the aperture occurs an alternation of long and short unforked ribs. Small but distinct tubercles persist almost to the aperture.

Measurements cannot be made accurately or the suture line traced because of inadequate preservation of the specimens available.

Stephanoceras mowichense Imlay, n. sp., in ornamentation and size, resembles *Normannites.* It is assigned to *Stephanoceras*, however, because its aperture terminates in a collar instead of in lateral lappets. It is much smaller than any described species of *Stephanoceras.*

Types.—Holotype, USNM 168594; paratypes USNM 168595, 168596.

Occurrences.—Snowshoe Formation, near top of Warm Springs Member at USGS Mesozoic loc. 29395 and Lupher's loc. 109.

Stephanoceras sp. A

Plate 45, figure 10

This species is represented by two laterally crushed external molds. On the small septate whorls the primary ribs are low, fine, closely spaced, incline strongly forward, bifurcate a little below the line of involution and are faintly to weakly tuberculate at the furcation points. Adorally on the next to the largest whorl, the ribs become abruptly stronger. The primary ribs become moderate in height and spacing, divide near the middle of the flanks into two or three much weaker secondary ribs, and bear weak tubercles at the furcation points. Most forked ribs are separated by single ribs that arise freely near the middle of the flanks. The outermost whorl, which may be part of the body chamber, bears irregularly broad, low, flexuous striated ribs of which some divide near the middle of the flanks and bear blunt tubercles at the furcation points.

Stephanoceras sp. A. is characterized by its forwardly inclined primary ribs, by the fine and dense ribbing on its small whorls, and by the weakness of its lateral tubercles.

Figured specimen.—USNM 168597.

Occurrence.—Snowshoe Formation undifferentiated in the Seneca area at USGS Mesozoic loc. 25818. Possibly represented also by four small specimens at Lupher's loc. 8.

Stephanoceras sp. B

Plate 45, figure 9

This species, represented by one external mold, bears forwardly inclined ribs as on *Stephanoceras* sp. A. It differs by having much coarser and sparser ribbing, by its outer whorl bearing many simple ribs, and by the presence of lateral tubercles only on the outermost preserved whorl.

Figured specimen.—CAS 13548.

Occurrence.—Snowshoe Formation undifferentiated in the Seneca area at Lupher's loc. 57.

Stephanoceras sp. C

Plate 44, figures 1–6

This species is represented by 25 molds of which most are crushed. It has moderately involute coiling, a depressed subquadrate whorl section, a fairly high and nearly vertical umbilical wall, weak lateral tubercles, and high sharp wiry ribs that incline gently forward on the flanks but cross the venter transversely. Most primary ribs bifurcate at about two-fifths of the height of the flanks into slightly weaker secondary ribs. Some primary ribs remain simple and alternate with secondary ribs that begin freely near the middle of the flanks. Most furcation points are faintly swollen or weakly tuberculate. Secondary ribs outnumber primary ribs about 2½ to 1.

The suture line has a broad first lateral saddle, a long slender trifid first lateral lobe that is as long as the ventral lobe, a fairly broad and short second lateral lobe, and a retracted suspensive lobe.

The specimen on which the suture line is exposed appears to be only slightly compressed. At a diameter of 61 mm, it has a whorl height of 22 mm, a whorl thickness of 28 mm, and an umbilical width of 24 mm.

Stephanoceras sp. C differs from other species of *Stephanoceras* from eastern Oregon in its subquadrate whorl section, its fine, sharp ribs, and its weak lateral tubercles. The characteristics of its ribbing suggest that it may belong to *Cadomites* Munier-Chalmas (Arkell and others, 1957, p. L288) rather than *Stephanoceras*.

Figured specimens.—USNM 168598.

Occurrences.—Snowshoe Formation undifferentiated in the Seneca area at USGS Mesozoic loc. 29231; unnamed beds in Juniper Mountains area, Malheur County, at Mesozoic loc. 28649. Associated ammonites indicate a stratigraphic position in or near upper Bajocian beds containing *Spiroceras*.

Stephanoceras sp. D

Plate 43, figures 10–14

This species is represented by 10 crushed molds that show parts of five whorls. It is characterized by moderately evolute coiling, by high, sharp, widely spaced ribs, and by weak, radially elongate lateral tubercles at the furcation points of the ribs. On the four smallest preserved whorls the primary ribs incline backwards on the umbilical wall and then incline gently forward to the middle of the flanks where most of them divide into pairs of slightly weaker secondary ribs. A few primary ribs remain simple. A few secondary ribs arise freely near the middle of the flanks. All secondary ribs incline forward on the flanks and arch gently forward on the venter. Secondary ribs outnumber primary ribs about two to one.

The largest preserved whorl bears very strong and striated primary ribs, of which one forks near the middle of the flanks and the others remain simple. Three of the ribs bear weak lateral tubercles.

The species differs from *Stephanoceras* sp. A, described herein, in having fewer, much stronger, and more widely spaced primary ribs. The differences are particularly striking on the small inner whorls.

Figured specimens.—USNM 168599, 168600.

Occurrences.—Snowshoe Formation undifferentiated in the Seneca area at USGS Mesozoic loc. 28020. Unnamed beds in Juniper Mountain area, Malheur County, at Mesozoic loc. 28649. *Stephanoceras* sp. D at Mesozoic loc. 28020 is associated with *Normannites* and is several hundred feet higher stratigraphically than beds containing *Spiroceras* at Mesozoic locs. 28018, 28022, and 29232. At Mesozoic loc. 28649 *Stephanoceras* sp. D is associated with *Spiroceras?* and *Normannites* in beds that are 150 feet northwest along the strike from Mesozoic loc. 28650 which has furnished *Spiroceras bifurcatum* (Quenstedt).

Stephanoceras cf. nodosum (Quenstedt)

Plate 44, figures 7–11

cf. *Ammonites nodosus* Quenstedt, 1858, p. 400, pl. 54, fig. 4.
cf. *Ammonites humphriesianus nodosus* Quenstedt, 1886, p. 532, pl. 65, fig. 17.
cf. *Stephanoceras nodosum* (Quenstedt). Weisert, 1932, p. 136, pl. 15, figs. 1, 2.
cf. *Stephanoceras* cf. *S. nodosum* (Quenstedt). Imlay, 1964a, p. B46, pl. 16, figs. 7, 8.

Twenty Oregon specimens assigned to this species vary somewhat in the sparseness and coarseness of their ribs and tubercles. Some (pl. 44, figs. 8, 10) have ribs and tubercles as coarse and sparse as one specimen from Alaska (Imlay, 1964a, pl. 16, figs. 7, 8) or as on some specimens of *S. nodosum* (Quenstedt) from Germany (Quenstedt, 1886, pl. 65, fig. 17; Weisert, 1932, pl. 15, fig. 2). Others (pl. 44, figs. 7, 9, 11) have weaker and denser ribs and tubercles as in *S.* (*Skirroceras*) *macrum* (Quenstedt) (1886, pl. 65, fig. 10); Buckman, 1921, pl. 248; Weisert, 1932, pl. 15, figs. 3, 5), which Weisert (1932, p. 137) notes is transitional into *S. nodosum* (Quenstedt). The specimens from Oregon appear to be less evolute than the figured specimens of *S. macrum* (Quenstedt) and in that respect show more resemblance to *S. nodosum* (Quenstedt).

Figured specimens.—USNM 168601, 168602; CAS 13508, 13509.

Occurrences.—Snowshoe Formation, near base of middle member, at USGS Mesozoic locs. 27363 and 27578; near middle of lower member at Lupher's loc. 75; Seneca area at Lupher's locs. 28 and 57; Twelvemile Creek area at USGS Mesozoic loc. 28384 in upper part of Basey Member.

Stephanoceras aff. S. nodosum (Quenstedt)

Plate 44, figures 12, 13

One small septate specimen has fairly evolute coiling and depressed ovate whorl. The outer half whorl is deformed and partially retracted from the remainder of the specimen. The inner whorls exposed in the umbilicus bear sharp widely spaced forwardly inclined primary ribs that terminate in tubercles at the umbilical seam. The outermost exposed whorl, adapical to the deformed part, bears 16 moderately strong, very widely spaced, nearly radial primary ribs that terminate in prominent tubercles at about two-fifths of the height of the flanks. From the tubercles pass four or five weaker secondary ribs that arch forward on the venter. Adorally the primary ribs become more widely spaced and on the outermost deformed half whorl are separated by intervals of about one centimeter.

This specimen differs from *Stephanoceras nodosum* (Quenstedt) (1858, pl. 54, fig. 4; 1886, pl. 65, fig. 17) in having appreciably weaker ornamentation, more widely spaced primary ribs, and more closely spaced secondary ribs. It has weaker ornamentation and a more compressed whorl section than the *Teloceras*-like ammonite described by Westermann (1969, p. 151, pl. 43, figs. 1a, b) from the base of the *Sonninia sowerbyi* zone on the Alaska Peninsula.

Figured specimen.—Stanford University Museum Paleontology 10030.

Occurrence.—Snowshoe Formation, upper part of Weberg Member at Vigrass' loc. 162.

Subgenus SKIRROCERAS Mascke, 1907
Stephanoceras (Skirroceras) kirschneri Imlay

Plate 30, fig. 13; plate 42, figures 1–10

Stephanoceras (*Skirroceras*) *kirschneri* Imlay, 1964a, p. B47, pl. 18, figs. 1–4, pl. 19.

This species is represented in eastern Oregon by 47 specimens, of which 17 are from Lupher's loc. 272. The specimens from this locality occur in a grayish-brown thinly laminated noncalcareous mudstone that has been hardened by intrusions of nearby igneous rocks. As a consequence the fossil specimens are harder and better preserved than is normal in unaltered mudstone. In particular, rubber imprints of external molds from Lupher's loc. 272 bear much sharper ribs and more prominent tubercles than occur on the illustrated type specimens from southern Alaska which are all internal molds. One external mold from Alaska, however, has just as sharp ornamentation and is herein illustrated for comparison (pl. 30, fig. 13).

S. (*S.*) *kirschneri* Imlay, as discussed previously (Imlay, 1964a, p. B47), is nearly identical in coiling and ornamentation with *S.* (*S.*) *macrum* (Quenstedt) (1886, pl. 65, fig. 11; Buckman, 1921, pl. 248; Weisert, 1932, pl. 15, fig. 3) from Europe. Its adult whorls, however, appear to be higher and to bear laterally compressed rather than rounded tubercles.

Types.—Hypotypes, CAS 13510–13514; USNM 168603–168607.

Occurrences.—Snowshoe Formation undifferentiated in the Emigrant Creek area at USGS Mesozoic locs. 26770, 26772, and 29410; in the Seneca area at Lupher's locs. 55, 272 and Mesozoic loc. 29790; near base of middle member at Mesozoic loc. 26776; near middle of Basey Member at USGS Mesozoic locs. 27377, 27737, 29813 and 29816; probably represented also in the lower and middle parts of the Basey Member at Mesozoic loc. 29815. The lowest occurrences of *Stephanoceras kirschneri* Imlay overlap the highest occurrences of *S. juhlei* Imlay in the lower part of the middle member of the Snowshoe Formation and in equivalent beds in the basal part of the Basey Member.

Stephanoceras (Skirroceras) juhlei Imlay

Plate 43, figures 1–7, 15

Stephanoceras (*Skirroceras*) *juhlei* Imlay, 1964a, p. B47, pl. 16, figs. 1, 3–6, pl. 17.

This species is represented by 25 molds, of which 20 are from Lupher's loc. 272. Two specimens are preserved in a hard dark gray limestone and are nearly undeformed. The others are preserved in a brownish-gray, finely laminated mudstone and are crushed laterally.

The specimens of *Stephanocers* (*Skirroceras*) *juhlei* Imlay from Oregon do not show the body chamber. On one internal mold (pl. 43, fig. 15) the outermost whorl bears ribbing comparable to that on the outermost septate whorl of the Alaskan holotype (Imlay, 1964a, pl. 17). The other molds are comparable with one of the small septate paratypes of *S. juhlei* Imlay (1964a, pl. 16, figs. 1, 6). All these small specimens from Oregon and Alaska are characterized by highly evolute coiling, dense fine ribbing, by their primary ribs bearing tubercles at about two-fifths of the height of the flanks, and by their secondary ribs outnumbering the primary ribs about four to one. The external molds of the Oregon specimens, as illustrated by rubber imprints, have slightly sharper ribbing than on the small paratype from Alaska which is an internal mold and is also partially corroded. If one allows for corrosion, the appearance of this paratype is closely similar to that of an external mold from Oregon (pl. 43, fig. 7).

Stephanoceras juhlei Imlay, as discussed previously (Imlay, 1964a, p. B48), greatly resembles *S. rhytus* Buckman (1921, pl. 205a, b) but has somewhat longer primary ribs. It conceivably could be within the range of variation of that species. Both differ from the holotype of *S. baylei* (Oppel) (d'Orbigny, 1846, pl. 133) in having finer and more numerous secondary ribs. This difference is particularly noticeable on the specimens assigned to *S. baylei* (Oppel) by Fallot and Blanchet (1923, p. 155, pl. 5, figs. 1–3).

Types.—Hypotypes, CAS 13515–13520; USNM 168608; Stanford University Museum Paleontology 10031.

Occurrences.—Snowshoe Formation, uppermost bed of Weberg Member at Vigrass' loc. 130; Warm Springs Member at Lupher's loc. 311; above middle of lower member at USGS Mesozoic loc. 28028; lower part of middle member at Mesozoic loc. 27578; near base of Basey Member at Vigrass' loc. 401; Seneca area at Lupher's loc. 272, Mesozoic loc. 29233 and Vigrass' loc. 242.

Stephanoceras (Skirroceras) aff. S. (S.) juhlei Imlay

Plate 43, figures 8, 9

One specimen bears closely spaced fine secondary ribs as on *S.* (*S.*) *juhlei* Imlay, as herein illustrated, but differs in being less evolute, in having higher, longer and more closely spaced primary ribs, and in developing coarser ribbing on its outermost preserved whorl. At a comparable size, *S. rhytus* Buckman (1921, pl. 250a,b) has much shorter and weaker primary ribs.

Figured specimen.—USNM 168609.

Occurrence.—Snowshoe Formation undifferentiated in the Seneca area at USGS Mesozoic loc. 29413. Possibly represented also by three fragments at Lupher's loc. 30.

Stephanoceras (Skirroceras) cf. S. (S.) leptogyrale (Buckman)

Plate 46, figure 15

The species is represented by one fairly complete adult specimen and by six fragments, of which all are crushed laterally. These are characterized by highly evolute coiling, moderately strong and moderately spaced ribs, a row of prominent tubercles at about two-fifths of the height of the flanks, and about three secondary ribs for each primary rib. The species differs from *S.* (*S.*) *juhlei* Imlay (1964a, p. B47, pl. 16, figs. 1, 3–6, pl. 17) in having much coarser and sparser ornamentation and in attaining a much smaller size. It appears to have slightly weaker ribbing than *S.* (*S.*) *leptogyrale* (Buckman) (1924, pl. 516) from England.

Figured specimen.—USNM 168610.

Occurrence.—Snowshoe Formation, Warm Springs Member, at USGS Mesozoic loc. 29241.

Stephanoceras (Skirroceras) cf. S. (S.) dolichoecus (Buckman)

Plate 45, figures 8, 11

This species is represented by two laterally crushed specimens, of which the smallest represents eight inner whorls, and the largest represents four outer whorls. The species apparently has a total of nine whorls. The shell is compressed and highly evolute. Both flanks and venter are evenly rounded. The length of the body chamber is unknown. The aperture is marked by a trumpet-like expansion.

The inner five whorls, as exposed in the umbilicus, bear strong primary ribs that incline slightly forward and apparently are nontuberculate. Adorally on the next two whorls the primary ribs become weaker, more widely spaced, and terminate in conical tubercles at about two-fifths of the height of the flanks. From these tubercles pass pairs of fairly strong secondary ribs. Most pairs of ribs are separated by single ribs that arise freely on the flanks. Adorally on the outer two whorls the primary ribs become weaker and shorter, the secondary ribs become a little stronger than the primary ribs, and the row of conical tubercles occurs a little lower on the flanks. Near the aperture both ribs and tubercles become indistinct on the lower half of the flanks.

The specimens are too distorted for measurements, and the suture line is not exposed.

This species greatly resembles *Stephanoceras* (*Skirroceras*) *dolichoecus* (Buckman) (1921, pl. 265) in its highly evolute coiling and rib characteristics, but it is much smaller and its tubercles persist to a later growth stage.

Figured specimens.—Stanford University Museum Paleontology 10032, 10033.

Occurrences.—Snowshoe Formation, Weberg Member, upper part at Vigrass' loc. 162 and near top at Vigrass' loc. 16.

Subgenus PHAULOSTEPHANUS Buckman, 1927

Stephanoceras (Phaulostephanus?) oregonense Imlay, n. sp.

Plate 45, figures 1–4

This species is represented by nine laterally crushed molds. Its coiling is highly evolute and its outer three whorls barely embrace each other. The flanks round evenly into the umbilical wall and the venter and probably were gently convex before crushing. The body chamber occupies slightly more than one complete whorl. The aperture on the internal mold is marked by a constriction that is followed by a collar.

The body whorl of the holotype at a diameter of 90 mm has 46 primary ribs and 93 secondary ribs. On the outer two septate whorls the secondary ribs outnumber primary ribs about 2½ to 1.

On the inner septate whorls the primary ribs are closely spaced, fairly low, curve gently forward to the middle of the flanks, and terminate in swellings or in weak tubercles. From them pass from two to three slightly weaker secondary ribs that trend nearly radially. During growth all ribs gradually become stronger and more widely spaced, secondary ribs become sparser, and tuberculation becomes weaker. On the penultimate whorl and on the adapical end of the body whorl the primary ribs are swollen ventrally but are not tuberculate. On the adoral end of the body whorl the primary and secondary ribs are nearly equal in strength, and only a few of the primary ribs are swollen ventrally.

All specimens are so crushed that accurate measurements are not possible. The suture line cannot be traced.

This species greatly resembles *Stephanoceras* (*Phaulostephanus*) *paululus* (Buckman) (1927, pl. 754, figs. 1–3) but differs in being more evolute, nearly twice as large, finer ribbed, and perhaps in bearing weak tubercules on its small septate whorls. That species is reported to be nontuberculate (Arkell and others, 1957, p. L289); but, as illustrated, the swollen ventral ends of its primary ribs resemble the swollen rib ends of the Oregon species.

Types.—Holotype USNM 168611; paratypes USNM 168612, 168613.

Occurrences.—Snowshoe Formation, Warm Springs Member, in middle to upper parts, at USGS Mesozoic locs. 29395 and 29241. Probably represented also at Mesozoic loc. 29832 in the lower part of the Snowshoe Formation on the south side of Flagtail Mountain.

Genus STEMMATOCERAS Mascke, 1907

Stemmatoceras aff. S. albertense McLearn

Plate 46, figures 1–9

cf. *Stemmatoceras* n. sp. aff. *S. albertense* McLearn (Imlay, 1967, p. 91, pl. 10, figs. 1–8, pl. 16, figs. 5–7).

This species is represented by nine immature specimens that do not include any of the body whorl. The whorls are depressed, much wider than high, are widest at about three-fifths of their height, and embrace about two-fifths of the preceding whorls. The flanks are gently convex, and round evenly into a steep umbilical wall and into a broad depressed venter. The umbilicus is fairly wide.

The primary ribs are strong, fairly closely spaced, incline forward on the flanks, and terminate in small acute tubercles at about three-fifths of the height of the whorls. From the tubercles pass two, or rarely three, sharp secondary ribs that are much thinner and lower than the primary ribs, that incline forward just above the zone of tuberculation, and then cross the venter nearly transversely. Three specimens have slightly stronger and sparser ribbing than the others but otherwise appear to be identical and are herein considered to be a variant.

The largest specimen, at a whorl height of 22 mm, has a whorl thickness of 36 mm.

The suture line has broad and deeply dissected saddles. The first lateral lobe is narrow, trifid and a little shorter than the ventral lobe. The suspensive lobe is strongly retracted.

The Oregon specimens of *Stemmatoceras* show some resemblance to immature specimens of *S. albertense* McLearn from Alberta, Canada, as illustrated by Frebold (1957, pl. 21, figs. 2a, b, pl. 23, figs, lb, c) but have much more closely spaced primary ribs and fewer secondary ribs per primary. They show more resemblance to *S.* n. sp. aff. *S. albertense* McLearn from the western interior region of the United States (Imlay, 1967, pl. 10, pl. 16, figs. 5–7) but apparently have a more depressed venter, denser and longer primary ribs, and fewer secondary ribs per primary rib.

Figured specimens.—CAS 13521–13524.

Occurrence.—Snowshoe Formation undifferentiated in the Seneca area at Lupher's loc. 8.

Genus TELOCERAS Mascke, 1907

Teloceras itinsae McLearn

Plate 46, figures 10, 11, 13

Teloceras itinsae McLearn, 1932, p. 51, pl. 10 figs. 1, 2.
Teloceras itinsae McLearn. Imlay, 1964a, p. B50, pl. 23, figs. 9, 10, pl. 24, figs. 1–5, 7.

This species is represented in eastern Oregon by three small immature specimens of which the larger is comparable in size with the holotype (McLearn, 1932, pl. 10, figs. 1, 2) and with a hypotype figured by Imlay (1964a, pl. 24, fig. 2). The Oregon specimens bear stout, widely spaced, nearly radial primary ribs that terminate in pronounced conical tubercles. From each of these pass three weaker secondary ribs that incline slightly forward. In addition, successive bundles of secondary ribs are generally separated by single intercalated ribs that arise at or above the zone of tuberculation.

Types.—Hypotypes, USNM 168614–168616.

Occurrences.—Snowshoe Formation undifferentiated near Emigrant Creek at USGS Mesozoic locs. 26770 and 29410.

Genus ZEMISTEPHANUS McLearn, 1927

Zemistephanus? cf. Z. richardsoni (Whiteaves)

Plate 46, figures 12, 14

Two fragmentary ammonites from eastern Oregon are characterized by moderately evolute coiling and by stout conical tubercles that occur at the very edge of the umbilicus. From the tubercles pass bundles of two to three ribs. Between successive rib bundles are one or two intercalated ribs that arise above the zone of tuberculation. All secondary ribs incline slightly forward.

These specimens resemble both *Zemistephanus* and *Pseudotoites* in coiling and in having stout tubercles at the base of the flanks, but their fragmentary condition precludes definite generic identification. Assignment to *Zemistephanus* is favored, however, by their association with such genera as *Teloceras*, *Normannites*, and *Chondroceras*, which occur well above the known range of *Pseudotoites*. The genus *Otoites* has much more tightly coiled septate whorls than these genera and does not attain as large a size.

Among the described species of *Zemistephanus*, the Oregon specimens match closely in strength and density of ribbing *Z. richardsoni* (Whiteaves) (1876, p. 32, pl. 5, figs. 1, 2; McLearn, 1929, pl. 9, figs. 1, 2, pl. 10, fig. 2; Imlay, 1964a, pl. 25, figs. 6, 7, pl. 26, figs. 1–7). They have appreciably weaker and denser ribbing than *Z. carlottensis* (Whiteaves) (1876, p. 38, pl. 6; Arkell, 1954, figs. 11 and 12 on p. 588 and 589; Imlay, 1964a, pl. 24, fig. 6, pl. 27, figs. 1–3 pl. 28, figs. 1–3).

Figured specimens.—USNM 168617; CAS 13525.

Occurrences.—Snowshoe Formation undifferentiated near Emigrant Creek at USGS Mesozoic loc. 29410 and near Seneca at Lupher's loc. 30.

Genus LUPHERITES Imlay, n. gen.

This genus is characterized by an ovate whorl section, by moderately evolute coiling that becomes more evolute in the adult, by fine, dense, simple or forked, nontuberculate ribs on most of its septate whorls, by an abrupt change to coarse, tuberculate ribs on its body whorl, and by the presence of lateral lappets.

The type species is *Luphterites senecaensis* Imlay, n. sp. The genus is named in honor of Ralph L. Lupher who collected most of the available specimens.

Lupherites bears a general resemblance to *Polyplectites* Mascke, 1907 (See Arkell and others, 1957, p. L290; Westermann, 1954, p. 335–338). It differs, however, by lacking tubercles on most of its septate whorls, by developing coarse tuberculate ribs abruptly on its body whorl, and by having a broader first lateral saddle.

Lupherites senecaensis Imlay, n. sp.

Plate 47, figures 1–20

This species is represented by about 85 internal and external molds, of which most have been crushed laterally. The appearance of the least deformed specimens indicate that the whorls originally were ovate in section and probably a little higher than wide. The flanks are flattened in their lower parts but round evenly into an evenly rounded venter. The umbilicus is moderately wide. The umbilical wall is low, vertical at its base, and rounds evenly into the flanks. The septate whorls embrace each other about one-half. The body whorl becomes slightly retracted and embraces about two-fifths of the penultimate whorl. The body chamber occupies about three-fifths of a whorl. The aperture, preserved on several fragments, bears elongate lateral lappets.

The ribs on most of the septate whorls are fine, low, and closely spaced and are not tuberculate. They trend gently forward on the flanks and cross the venter transversely. Many of them remain simple, but some bifurcate on the middle third of the flanks. Most of the primary ribs are separated by one or two secondary ribs that arise freely on the middle third of the flanks. Tubercles are absent on most of the septate whorls and first appear on some specimens on the adapical part of the outermost septate whorl as weak radially elongate swellings.

The ribbing on the adoral part of the outermost septate whorl changes abruptly from fine and dense to coarse and sparse. This change is accompanied, or in some specimens preceded, by the development of weak lateral tubercles.

On the body chamber the primary ribs are sharp, high, and widely spaced and incline forward on the flanks. Some remain simple, and some divide on the middle third of the flanks into pairs of sharp but slightly weaker secondary ribs. Some furcation points are swollen, some are weakly tuberculate, and some are merely sharpened. Most pairs of forked ribs are separated by a secondary rib that arises freely on the upper third of the flanks. All ribs cross the venter transversely.

Dimensions cannot be measured accurately because all the specimens are deformed.

The suture line, fairly well exposed on one specimen, has moderately broad saddles and lobes. The first lateral lobe is irregularly trifid, slightly shorter than the ventral lobe, and much longer and broader than the second lateral lobe. The second lateral saddle is much smaller than the first lateral saddle.

Lupherites senecaensis Imlay, n. sp. bears a general resemblance to species of *Polyplectites* as discussed under the definition of the genus.

Types.—Holotype CAS 13526; paratypes, CAS 13527–13540; paratypes, USNM 168618, 168619.

Occurrences.—Snowshoe Formation undifferentiated near Seneca at Lupher's locs. 8 and 30. Unnamed beds in the Huntington quadrangle at USGS Mesozoic loc. 29111.

Family PERISPHINCTIDAE Steinmann, 1890

Genus LEPTOSPHINCTES Buckman, 1920

Leptosphinctes cf. L. leptus Buckman

Plate 47, figure 25

One laterally crushed, evolute ammonite, represented by both internal and external molds, shows parts of five whorls of which four are septate. The outermost whorl apparently overlaps about one-third of the next inner whorl. The venter is not exposed. The ornamentation consists of thin widely spaced, nearly radial or slightly prorsiradiate primary ribs, of which nearly half bifurcate at about two-thirds of the height of the flanks. Some of the secondary ribs are indistinctly connected with the primary ribs. The furcation points are not swollen or tuberculate. Constrictions are not present.

The suture line cannot be traced accurately but appears to be similar to that of *L. delicatus* Imlay (1962, pl. 5, fig. 8) from Alaska.

The Oregon species resembles the septate whorls of *L. leptus* Buckman (1920, pl. 160) in fineness of ribbing, but is probably more evolute.

Figured specimen.—CAS 13541.

Occurrence.—Snowshoe Formation near Seneca at Lupher's loc. 28.

Leptosphinctes cf. L. evolutus Imlay

Plate 47, figures 21–23, 26, 27

cf. *Leptosphinctes evolutus* Imlay, 1964a, p. B54, pl. 28, figs. 4–6.

One species of *Leptosphinctes* from eastern Oregon, represented by four fragmentary crushed molds, is characterized by highly evolute coiling and coarse widely spaced ribs. The smallest specimens bear very high, sharp, widely spaced primary ribs that incline forward on the flanks and terminate in swellings or weak tubercles on the margins of the venter. From these tubercles pass one or two lower and broader secondary ribs that arch gently forward on the venter and, at least on one specimen, are clearly not interrupted by a midventral furrow. One of these small specimens also bears a deep constriction.

On the two large fragments the primary ribs are even higher and more widely spaced, incline forward on the flanks, curve strongly forward on the margins of the venter and then fade out or become very weak on the venter. Most ribs remain simple, but one primary rib divides indistinctly into two secondary ribs. The venter of these large specimens is poorly exposed but appears to be nearly smooth and without a ventral furrow, such as occurs in similarly coarsely ribbed species of *Parkinsonia*.

This species of *Leptosphinctes* from eastern Oregon closely resembles the most coarsely ribbed paratype of *L. evolutus* Imlay (1964a, pl. 28, fig. 5) from the Talkeetna Mountains, Alaska. It may differ by having slightly higher ribs and fewer forked ribs on its outer whorls. None of the described European species of *Leptosphinctes* are nearly as evolute or as coarsely ribbed.

Figured specimens.—CAS 13542–13545.

Occurrence.—Near top of Snowshoe Formation undifferentiated near Seneca at Lupher's loc. 30.

Leptosphinctes sp.

Plate 47, figure 24

One fragment of a whorl bears sharp, strong primary ribs that incline slightly forward on the flanks and divide at about three-fifths of the height of the flanks into pairs of broader and lower secondary ribs. One primary rib remains simple and a few secondary ribs are indistinctly connected with primary ribs.

The ribbing is sharper and higher than in most species of *Leptosphinctes* but is comparable in coarseness with that on *L.* (*Prorsisphinctes*) *pseudomartinsi* (Siemiradzki) (Arkell and others, 1957, p. L314, fig. 395). That species differs by having more forwardly inclined ribbing on its venter.

Figured specimen.—USNM 168620.

Occurrence.—Snowshoe Formation, near base of upper member, at USGS Mesozoic loc. 26775.

Subgenus PRORSISPHINCTES Buckman, 1921

Leptosphinctes (Prorsisphinctes?) spp. juv.

Plate 47, figures 28–30

The subgenus *Prorsisphinctes* is probably represented by seven immature molds. These specimens have highly evolute coiling, forwardly inclined ribbing and some constrictions. Most primary ribs pass into pairs of slightly weaker secondary ribs at or a little above the middle of the flanks. The secondary ribs continue to incline forward on the upper parts of the flanks and arch weakly forward on the venter. Five of the specimens (pl. 47, fig. 29) from Lupher's loc. 30 represent a fairly coarsely ribbed species comparable to the inner whorls of *L.* (*P.*) *phanerus* (Buckman) (1921, pl. 211) or *L.* (*P.*) *meseres* (Buckman) (1923, pl. 446; 1927, pl. 446A). The other two specimens (pl. 47, figs. 28, 30) represent a finely ribbed species comparable to the inner whorls of *L.* (*P.*) *stomphus* (Buckman) (1921, pl. 247). Their ribs also resemble those on *Leptosphinctes leptus* Buckman (1920, pl. 160) except for being more forwardly inclined.

Figured specimens.—USNM 168621, 168622; CAS 13546.

Occurrences.—Snowshoe Formation undifferentiated near Seneca at Lupher's loc. 30. Unnamed beds in the Juniper Mountain area, Brogan quadrangle, at USGS Mesozoic localities 28649 and 28650.

Genus PARABIGOTITES Imlay, 1961

Parabigotites crassicostatus Imlay

Plate 47, figures 31–36

Dactylioceras sp. A, Kellum, Daviess and Swinney, 1945, figs. 5A–B (not C–E).

Parabigotites crassicostatus Imlay, 1961, p. 472–473, pl. 64, figs. 4–10.

Parabigotites crassicostatus Imlay, 1964a, p. B54, pl. 29, figs. 1–16.

This species is represented in eastern Oregon by six specimens that show the same characteristics and range of variation as the type specimens from Alaska. The largest specimen is finer ribbed than most of the illustrated Alaskan specimens but is similar in that respect to certain small specimens (Imlay, 1964a, pl. 29, figs. 11, 13). It matches closely also with a finely ribbed variant (see pl. 47, fig. 34) that occurs in Alaska in the Kialagvik Formation (USGS Mesozoic locs. 19773 and 21258), in association with the typical coarsely ribbed variant.

The microconch equivalent of this species could be *Normannites kialagvikensis* Imlay (1964a, p. B43, pl. 13), as once suggested by G. E. G. Westermann (written commun., Nov. 30, 1964).

Types.—Hypotypes, USNM 168623; CAS 13547; Stanford University Museum Paleontology 10034–10036.

Occurrences.—Snowshoe Formation, middle to upper parts of Warm Springs Member at Lupher's loc. 211, Dickinson's locs. 94, 96 and 98, and USGS Mesozoic loc. 29805. The species is probably represented also in the lower member of the Snowshoe Formation at USGS Mesozoic loc. 27356.

REFERENCES CITED

Arkell, W. J., 1933, The Jurassic system in Great Britain: Oxford, Clarendon Press, 681 p., 41 pls.

——— 1951, Monograph of the English Bathonian ammonites, pt. 2: London, Palaeontographical Soc. (v. 105), p. 47–72, pls. 5–8.

——— 1952a, Monograph of the English Bathonian ammonites, pt. 3: London, Palaeontographical Soc. (v. 106), p. 73–102, pls. 9–11.

——— 1952b, Jurassic ammonites from Jebel Tuwaayq, central Arabia: Royal Soc. London Philos. Trans., ser. B, v. 236, no. 633, p. 241–313, pls. 15–30.

——— 1954, The ammonites and their place in the Bajocian faunas of the world, *in* Arkell, W. J., and Playford, P. E., The Bajocian ammonites of Western Australia: Royal Soc. London Philos. Trans., ser. B. Biol. Sci. No. 651, v. 237, p. 548–604, illus.

——— 1956, Jurassic geology of the world: London, Oliver & Boyd, 806 p., 46 pls., 28 tables, 102 figs.

Arkell, W. J., and others, 1957, Mesozoic Ammonoidea, *in* Moore, R. C., ed., Treatise on invertebrate paleontology, pt. L, Mollusca 4-Cephalopoda, Ammonoidea: New York, Geol. Soc. America, and Lawrence, Univ. Kansas Press, 490 p., illus.

Bremer, Heinrich, 1966, Ammoniten aus dem unteren Bajocium und unteren Bathonium in der Umgebung von Ankara (Türkei): Neues Jahrb. Geologie u. Paläontologie Abh., v. 125, p. 155–169, pls. 15–18.

Brooks, H. C., 1967, Distinctive conglomerate layer near Lime, Baker County, Oregon: Ore Bin, v. 29, no. 6, p. 113–119.

Brown, C. E., and Thayer, T. P., 1966, Geologic map of the Canyon City quadrangle, northeastern Oregon: U.S. Geol. Survey Misc. Geol. Inv. Map I–447.

Buckman, S. S., 1887–1907, Monograph of the ammonites of the Inferior Oolite Series: London, Palaeontographical Soc., p. 1–24, pls. 1–6, 1887; p. 25–56, pls. 7–14, 1888; p. 57–144, pls. 15–23 and A, 1889; p. 145–244, pls. 24–36, 1890; p. 245–256, pls. 37–44, 1891; p. 257–344, pls. 45–76, 1892; p. 345–376, pls. 77–92, 1893; p. 377–456, pls. 93–103, 1894; Supplement, p. i–xxxii, pls. I–IV, 1898; p. xxxiii–lxiv, pls. V–XIV, 1899; p. lxv–clxviii, pls. XV–XIX, 1904; p. clxix–ccvii, pls. XX–XXIV, 1905; p. ccix–cclxii, 1907.

——— 1889. The descent of *Sonninia* and *Hammatoceras:* Geol. Soc. London Quart. Jour., v. 45, p. 651–663, pl. 22.

——— 1893, The Bajocian of the Sherborne District—its relation to subjacent and superjacent strata: Geol. Soc. London Quart. Jour., v. 49, p. 479–521.

——— 1909–1930, Type Ammonites: London, privately published, v. 1–7, v. 7 (1930) edited by A. M. Davies.

——— 1910, Certain Jurassic ('Inferior Oolite') species of ammonites and Brachiopoda: London Geol. Soc. Quart. Jour., v. 66, p. 90–108, pls. 9–12.

Buddenhagen, H. J., 1967, Structure and orogenic history of the southwestern part of the John Day Uplift, Oregon: Ore Bin, v. 29, no. 7, p. 129–138, 2 figs. and one structural cross section.

Burckhardt, Carlos, 1903, Beiträge zur Kenntniss der Jura und der Kreide-formation der Cordillere: Palaeontographica, v. 50, p. 1–144, pls. 1–16.

Callomon, J. H., 1963, Sexual dimorphism in Jurassic Ammonites: Leicester Lit. and Philos. Soc. Trans., v. 57, p. 21–56, 1 pl., 9 text figs.

Callomon, J. H., Horton, A., and Torrens, H. S., 1969, in Guides to Field Excursions from London, *in* International Field Symposium on the British Jurassic: Geology Dept., Keele Univ., Table 1—Notes on zones and sources, facing p. 8.

Cope, J. C. W., Hallam, Anthony, and Torrens, H. S., 1969, Excursion No. 1, Guide for Dorset and South Somerset, *in* International Field Symposium on the British Jurassic: Geology Dept., Keele Univ., p. A1–A71, 38 text figs.

Corvalán, J. I., 1962, Early Mesozoic biostratigraphy of the Westgate area, Churchill County, Nevada: Stanford Univ., Palo Alto, Calif., Unpub. Ph. D. thesis.

Crickmay, C. H., 1933, Mount Jura investigation: Geol. Soc. America Bull., v. 44, p. 895–926, pls. 23–34.

Detterman, R. L., and Hartsock, J. K., 1966, Geology of the Iniskin-Tuxedni region, Alaska: U.S. Geol. Survey Prof. Paper 512, 78 p., 6 pls., 7 text figs., 15 tables.

Dickinson, W. R., 1962, Petrogenetic significance of geosynclinal andesitic volcanism along the Pacific margin of North America: Geol. Soc. America Bull., v. 73, p. 1241–1256, 2 figs.

Dickinson, W. R., and Vigrass, L. W., 1965, Geology of the Suplee-Izee area, Crook, Grant and Harney Counties, Oregon. Oregon Dept. Geology and Mineral Industries Bull. 58, 109 p., illus., tables, geol. map.

Dorn, Paul, 1935, Die Hammatoceraten, Sonninien, Ludwigien, Dorsetensien und Witchellien des Suddeutschen, inbesondere Fränkischen Doggers: Palaeontographica v. 82, Abt. A, p. 1–124, pls. 1–29.

Douvillé, Henri, 1916, Les terrains secondaires dans le massif du Moghara à l'est de Suez; Paléont.: Acad. Sci. Paris Mém., ser. 2, v. 54, p. 1–184, 21 pls., 50 text figs.

Elmi, Serge, 1963a, Note sur quelques Hammatoceratinae (Ammonitina) de l'Aalenien du bassin due Rhone: Soc. Géol. France Compte Rendu, fasc. 2, p. 59–61.

——— 1963b, Les Hammatoceratinae (Ammonitina) dans le dogger inférieur du bassin rhodanien: Lyons Fac. Si. Lab. géologie Travaux, n. ser., no. 10, 144 p., 11 pls., 35 text figs.

Fallot, Paul, and Blanchet, F., 1923, Observations sur la faune des terrains Jurassiques de la region de Cardó et de Tortosa (Province de Tarragone): Inst. Catalana Hist. Nat. Trabajos v. 6, 1921–22, fasc. 11, p. 73–260 (1–188), pls. 1–13.

Frebold, Hans, 1951, Lowermost Middle Jurassic fauna in Whitesail Lake map-area, British Columbia: Canada Geol. Survey Bull. 18, p. 18–21, pl. 15.

——— 1957, The Jurassic Fernie group in the Canadian Rocky Mountains and foothills: Canada Geol. Survey Mem. 287, 197 p., 44 pls., 5 figs.

——— 1964, Lower Jurassic and Bajocian ammonoid faunas of northwestern British Columbia and southern Yukon: Canada Geol. Survey Bull. 116, 31 p., 8 pls.

Frebold, Hans, Tipper, H. W., and Coates, J. A., 1969, Toarcian and Bajocian rocks and guide ammonites from southwestern British Columbia: Canada Geol. Survey Paper 67–10, 54 p., 6 pls.

Géczy, Barnabas, 1966, Ammonides jurassiques de Csernye, Montagne Bakony, Hongrie, part 1, (Hammatoceratidae): Geologica Hungarica Ser. Palaeontologica, no. 34, 276 p., 44 pls.

——— 1967, Ammonides jurassiques de Csernye, Montagne Bakony, Hongrie, part 2. (excl. Hammatoceratidae): Geologica Hungarica Ser. Palaeontologica, no. 35, 282 p. 65 pls.

Gottsche, Carl, 1878, Uber jurassische Versteinerungen aus der Argentinischen Cordillere: Palaeontographica, Supp. 3, Lief. 2, Abt. 3, p. 1–53, pls. 1–8.

Haug, Emile, 1893, Étude sur les Ammonites de étages moyens du systeme jurassique: Soc. géol. France Bull., 3d ser., v. 20, p. 277–333, pls. 8–10.

Hayami, Itaru, 1960, Jurassic inoceramids in Japan: Tokyo Univ. Fac. Sci. Jour., sec. 2, v. 12, pt. 2, p. 277–328, pls. 15–18.

Hiltermann, Heinrich, 1939, Stratigraphie und Palaeontologie der Sonninienschichten von Osnabrück und Bielefeld. I, Teil, Stratigraphie und Ammonitenfauna: Palaeontographica, v. 90, Abt. A, p. 109–212, pls. 9–13.

Huf, Wolfgang, 1968, Über Sonninien und Dorsetensien aus dem Bajocium von Nordwestdeutschland: Geol. Jahrb. Beihefte, no. 64, 126 p., 51 pls., 6 text figs.

Imlay, R. W., 1961, New genera and subgenera of Jurassic (Bajocian) ammonites from Alaska: Jour. Paleontology, v. 35, no. 3, p. 467–474, pls. 63, 64.

——— 1962, Late Bajocian ammonites from the Cook Inlet region, Alaska: U.S. Geol. Survey Prof. Paper 418–A, p. A1–A15, 5 pls., 4 text figs.

——— 1964a, Middle Bajocian ammonites from the Cook Inlet region, Alaska: U.S. Geol. Survey Prof. Paper 418–B, p. B1–B61, 29 pls., 5 figs.

——— 1964b, Upper Jurassic mollusks from eastern Oregon and western Idaho: U.S. Geol. Survey Prof. Paper 483–D, p. D1–D21, pls. 1–4, 3 text figs.

——— 1964c, Middle and Upper Jurassic fossils from southern California: Jour. Paleontology, v. 38, p. 505–509, pl. 78.

——— 1965, Jurassic marine faunal differentiation in North America: Jour. Paleontology, v. 39, p. 1023–1038, 6 text-figs.

——— 1967, Twin Creek Limestone (Jurassic) in the western interior of the United States: U.S. Geol. Survey Prof. Paper 540, 105 p., 16 pls., 18 text figs., 12 tables.

——— 1968, Lower Jurassic (Pliensbachian and Toarcian) ammonites from eastern Oregon and California: U.S. Geol. Survey Prof. Paper 593–C, p. C1–C51, pls. 1–9, 8 text-figs.

Jefferies, R. P. S., and Minton, P., 1965, The mode of life of two Jurassic species of "*Posidonia*" (Bivalvia): Palaeontology, v. 8, pt. 1, p. 156–185, pl. 19, 12 text figs.

Kellum L. B., Daviess, S. N., and Swinney, C. M., 1945, Geology and oil possibilities of the southwestern part of the Wide Bay anticline, Alaska: U.S. Geol. Survey, 17 p., 9 pls.

Lowry, W. D., 1968, Geology of the Ironside Mountain quadrangle, Oregon: Portland, Oreg., Oregon Dept. Geology and Mineral Industries open-file report.

Lupher, R. L., 1941, Jurassic stratigraphy of central Oregon: Geol. Soc. America Bull., v. 52, p. 219–270, 4 pls., 3 text figs.

McLearn, F. H., 1926, New Jurassic species from the Hazelton group of British Columbia: Canada Natl. Mus. Bull. 44, Geol. ser., no. 46, p. 89–99, pls. 19–25.

——— 1927, Some Canadian Jurassic faunas: Royal Soc. Canada Trans., ser. 3, v. 21, sec. 4, p. 61–73, pl. 1.

——— 1929, Contributions to the stratigraphy and paleontology of Skidegate Inlet, Queen Charlotte Islands, British Columbia: Canada Nat'l. Mus. Bull. 54, Geol. ser., no. 49, p. 1–27, 16 pls.

——— 1932, Contributions to the stratigraphy and paleontology of Skidegate Inlet, Queen Charlotte Islands, British Columbia (continued): Royal Soc. Canada Proc. and Trans., 3d ser., v. 26, sec. 4, p. 51–84, pls. 1–10.

Mascke, E., 1907, Die Stephanoceras-Verwandten in den Coronatenschichten von Norddeutschland: Gottingen Univ., thesis, 38 p.

Maubeuge, P. L., 1951, Les ammonites du Bajocien de la région frontière franco-belge: Inst. Royal Sci. Nat. Belgique Mém. sér. 2, fasc. 42, 104 p., 16 pls.

——— 1955, Les ammonites aaléniennes, bajociennes et bathoniennes du Jara suisse septentrional. Part 1: Schweizer, palaeont. Gesell. Abh., v. 71, p. 1–48, pls. 1–11.

Morton, Nicol, 1965, The Bearreraig sandstone series (middle Jurassic) of Skye and Raasay: Scottish Jour. Geology, v. 1, pt. 2, p. 189–216, 9 text figs.

Neumayr, Melchior, 1871, Jurastudien, I. 3. Die Phylloceraten des Dogger und Malm: K. K. Reichsanstalt Jahrb., v. 21, p. 297–354, pls. 12–17.

Oechsle, Erich, 1958, Stratigraphie und Ammonitenfauna der Sonninien-Schichten des Filsgebiets unter besonderer Berücksichtigung der *Sowerbyi*-Zone (Mittlerer Dogger, Württemberg): Palaeontographica, v. 111, Abt. A, p. 47–129, pls. 10–20.

Orbigny, Alcide d', 1842–51, Paléontologie française: Terrains jurassiques, v. 1, Céphalopodes: Paris, Masson, 642 p., 234 pls. [For exact dates of publication see C. D. Sherborn, 1899, On the dates of Paléontologie Française of d'Orbigny: Geol. Mag., n. ser., v. 6, p. 223–225.]

Pavia, Giulio, 1969, Nouvelles données sur le Bajocien de Digne (Basses-Alpes). Coéxistence de *Normannites*, *Itinsaites*, *Stemmatoceras*, *Teloceras* avec les premiers représentants de la superfamille Perisphinctaceae à la base de la zone à subfurcatum: Soc. Géol. Italiana Boll., v. 88, p. 445–451, 4 text figs.

Pavia, Giulio, and Sturani, Carlo, 1968, Étude biostratigraphique du bajocien des chaînes subalpines aux environs de Digne (Basses-Alpes): Soc. Géol. Italiana Boll. 87, no. 2, p. 303–316, 3 text figs.

Potonie, Robert, 1929, Die ammonitischen Nebenformen des Dogger (Apsorroceras, Spiroceras, Parapatoceras): Preuss. Geol. Landesanstalt Jahrb., v. 50, p. 216–261, pls. 17–19.

Quenstedt, F. A. von, 1858, Der Jura: Tübingen, 842 p., atlas of 100 pls.

———, 1886–1887, Die Ammoniten des Schwabischen Jura, v. 2, Der Braune Jura: Stuttgart, p. 441–672, pls. 55–78, 1886; p. 673–815, pls. 79–90 (1887).

Reeside, J. B., Jr., and Cobban, W. A., 1960, Studies of the Mowry shale (Cretaceous) and contemporary formations in the United States and Canada: U.S. Geol. Survey Prof. Paper 355, 126 p., 58 pls., 30 text figs., 10 tables.

Renz, Carl, 1925, Beiträge zur Cephalopoden-fauna des älteren Doggers am Monte San Giuliano (Monte Erice) bei Trapani ina Westsizilien: Schweizer palaeont. Gesell. Abh., v. 45, p. 1–33, 2 pls.

Roche, Pierre, 1939, Aalénien et bajocien du Mâconnais et de quelques régions voisines: Lyon Univ. Fac. Lab. Géologie Travaux, pt. 35, Mém. 29, 355 p., 13 pls.

Roman, Frédéric, and Petourand, C., 1927, Étude sur la faune du Bajocien supérieur du Mont d'Or lyonnais (Ciret), Céphalopodes: Lyon Univ. Lab. Géologie Travaux, pt. 11, Mém. 9, p. 5–55, pls. 1–7.

Sapunov, I. G., 1964, A revision of several Bajocian ammonites from the ironbearing Jurassic in the Troyan region (Central Balkan Range): Bulgarian Acad. Sci., Trav. Geologie Bulgarie, Ser. Paleontologie, v. 6, p. 249–276, pls. 1–5 (Bulgarian with English abstract).

Sasanov, N. T., 1964, Stratigraphie des dépôts jurassiques de la Plateforme Russe *in* Colloque du Jurassique, Luxembourg 1962, Volume des Comptes Rendus et Mémoires: Luxembourg, Institut Grand-Ducal, Sec. Sci. naturelles, physiques et mathématiques, p. 787–806, 4 correlation tables.

Sato, Tadashi, 1954, Hammatoceras de Kitakami, Japan: Japanese Jour. Geology and Geography, v. 25, p. 81–100, pls. 7–9.

———, 1962, Études biostratigraphiques des ammonites du jurassique du Japon: Soc. géol. France Mém., new ser., v. 41, pt. 1, (mém. no. 94), 122 p., pls. 1–10.

Seyed-Emami, Kazem, 1967, Zur Ammoniten-Fauna und Stratigraphie der Badamu-Kalke bei Kerman, Iran (Jura, oberes Untertoarcium bis mittleres (Bajocium): Unpub. Ph.D. thesis, Univ. Munich, Germany, 180 p., 15 pls.

Silberling, N. J., 1959, Pre-Tertiary stratigraphy and Upper Triassic paleontology of the Union district, Shoshone Mountains, Nevada: U.S. Geol. Survey Prof. Paper 322, 67 p., 9 pls., 3 text figs.

Sturani, Carlo, 1964, La successione delle faune ad ammoniti nelle formazioni medio-giurassiche delle Prealpi Venete occidentali (regione tra il Lago di Garda e la Valle del Brenta): Padua, Univ., Ist. Geologia e Mineralogia Mem., v. 24, p. 1–63, pls. 1–6.

Tornquist, A. J. H., 1898, Der Dogger am Espinazito-Pass nebst einer zusammenstellung der jetzigen Kenntnisse von der argentinischen Juraformation: Geol. Palaeontol. Abh. Jena, neue Folge, v. 8, no. 2, p. 1–72 (135–204), pls. 1–10 (14–23).

Vacek, M., 1886, Die Fauna der Oolithe vom Cap S. Vigilio verbunden mit einer Studie über die obere Liasgrenze: K. K. Reichsanstalt Abh., v. 12, no. 3, p. 57–212, pls. 1–20.

Waagen, Wilhelm, 1867, Ueber die zone des *Ammonites sowerbyi*: Geog. Palaeont. Beitr., v. 1, Heft 3, p. 507–666, pls. 24–34. R. Oldenbourg, München, Germany.

Wagner, N. S., Brooks, H. C., and Imlay, R. W., 1963, Marine Jurassic exposures in Juniper Mountain area of eastern Oregon: Am. Assoc. Petroleum Geologists Bull., v. 47, p. 687–691, illus.

Weisert, Kurt, 1932, *Stephanoceras* im Schwabischen Braunen Jura Delta: Palaeontographica, v. 76, p. 121–191, pls. 15–19.

Westermann, G. E. G., 1954, Monographie der Otoitidae (Ammonoidea): Geol. Jahrb. Beihefte, no. 15, 364 p., 33 pls.

——— 1956a, Monographie de Bajocien Gattungen *Sphaeroceras* und *Chondroceras* (Ammonoidea): Geol. Jahrb. Beihefte, no. 24, p. 1–222, pls. 1–14, 67 text figs., 4 tables.

——— 1956b, Phylogenie der Stephanocerataceae und Perisphinctaceae des Dogger: Neues Jahrb. Geologie u. Paläontologie Abh., v. 103, p. 233–279, 9 figs., 2 tables.

——— 1964a, The ammonite fauna of the Kialagvik formation at Wide Bay, Alaska Peninsula—Part I, Lower Bajocian (Aalenian): Bull. Am. Paleontology, v. 47, no. 216, p. 329–503, pls. 44–76, 37 text figs.

——— 1964b, Sexual-Dimorphismus bei Ammonoideen und seine Bedeutung für die Taxionomie der Otoitidae (einschliesslich Sphaeroceratinae; Ammonitina, m. Jura): Palaeontographica, v. 124, Abt. A, p. 33–73, pls. 6–9, 13 text figs.

——— 1966, Covariation and taxonomy of the Jurassic ammonite *Sonninia adicra* (Waagen): Neues Jahrb. Geologie u. Paläontologie Abh., v. 124, no. 3, p. 289–312, 10 text figs.

——— 1967, Jurassique Moyen (Alpes excludes) in Lexique stratigraphique International, v. 1 (Europe), Fasc. 5 (Allemagne), p. 1–197, 11 tables.

——— 1969, The ammonite fauna of the Kialagvik Formation at Wide Bay, Alaska Peninsula. Part II. *Sonninia sowerbyi* zone (Bajocian): Bull. Am. Paleontology, v. 57, no. 255, 226 p., 47 pls., 56 text figs.

Westermann, G. E. G. and Getty, T. A., 1970, New Middle Jurassic Ammonitina from New Guinea: Bull. Am. Paleontology, v. 57, no. 256, p. 231–321, pls. 48–62, 25 text figs.

Whiteaves, J. F., 1876, On some invertebrates from the coal-bearing rocks of the Queen Charlotte Islands: Canada Geol. Survey, Mesozoic Fossils, v. 1, p. 1–92, pls. 1–10.

Wilson, Vernon, Welch, F. B. A., Robbie, J. A., and Green, G. W., 1958, Geology of the country around Bridport and Yeovil (explanation of sheets 327 and 312): Great Britain Geol. Survey Mem., England and Wales, 239 p., 7 pls. 27 text figs.

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PLATES 1–47

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PLATE 1

[All figures natural size unless otherwise indicated. Specimens shown in figs. 3-16 are from the highest beds of the Snowshoe Formation near Seneca]

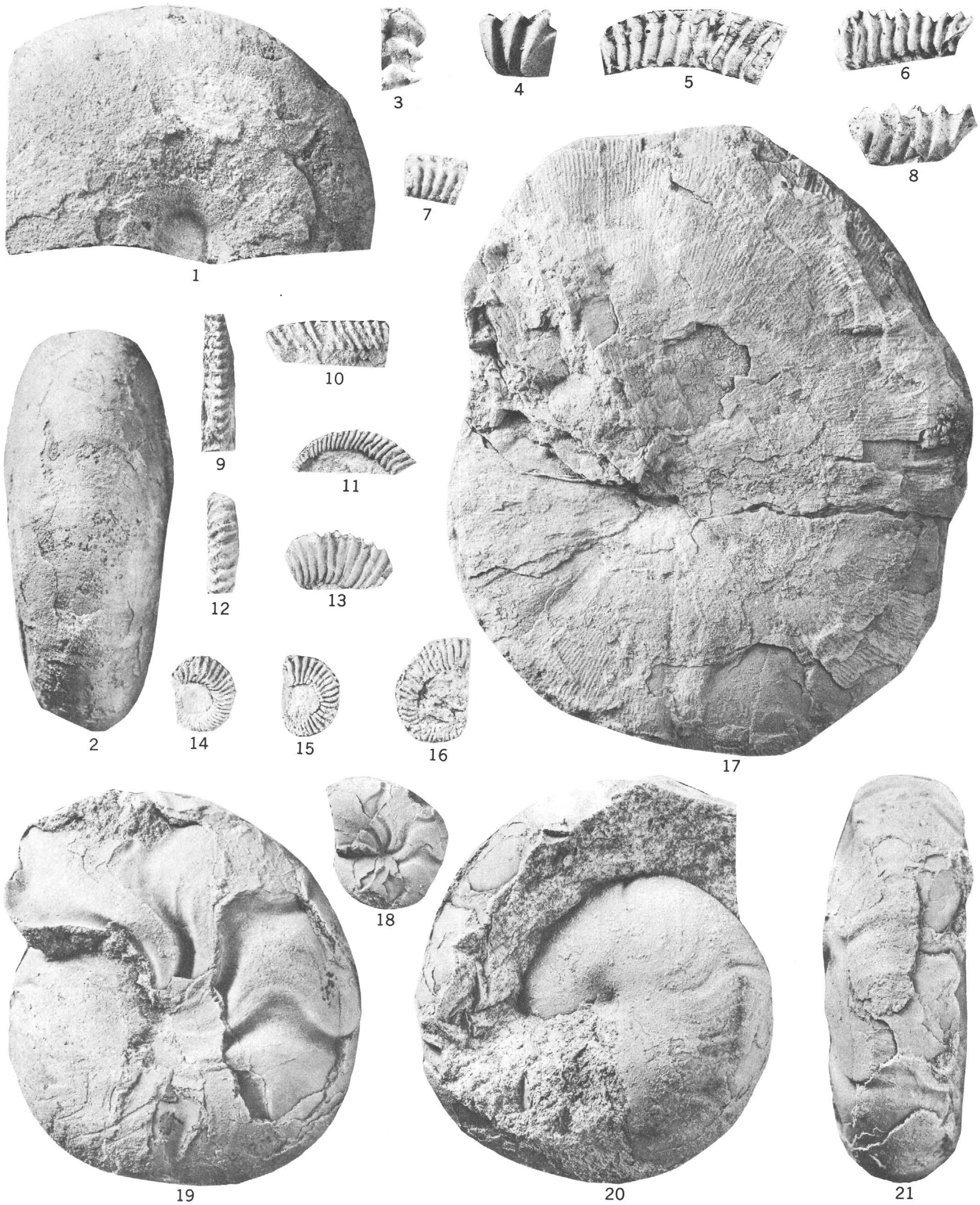
FIGURES 1, 2. *Calliphylloceras* sp. (p. 54).
Lateral and ventral views (× 2) of specimen, Stanford Univ. Mus. Paleontology 10006 from Vigrass' loc. 152. Weberg Member of the Snowshoe Formation.

3–8. *Spiroceras bifurcatum* (Quenstedt) (p. 55).
3, 4. Ventral and lateral views (× 2) of hypotype, USNM 168491 from USGS Mesozoic. 28017.
5. Hypotype, USNM 168493 from USGS Mesozoic loc. 28022.
6. Hypotype, USNM 168494 from USGS Mesozoic loc. 29232.
7. Ventro-lateral view of hypotype, USNM 168495 from USGS Mesozic loc. 29232. Shows ventral groove.
8. Hypotype, USNM 168492 from USGS Mesozoic loc. 29232. Shows weak lateral and strong ventral tubercles.

9–16. *Spiroceras annulatum* (Deshayes) (p. 55).
9, 10. Ventral and lateral views of hypotype, USNM 168502 from USGS Mesozoic loc. 28650.
11. Hypotype, USNM 168500 from USGS Mesozoic loc. 29232.
12, 13. Ventral and lateral view of hypotype, USNM 168499 from USGS Mesozoic loc. 29232.
14. Hypotype, USNM 168501 from USGS Mesozoic loc. 28018.
15. Hypotype, USNM 168496 from USGS Mesozoic loc. 29232.
16. Hypotype, USNM 168497 from USGS Mesozoic loc. 29232.

17. *Phylloceras* sp. (p. 54).
Specimen, USNM 168490 from USGS Mesozoic loc. 29790 in middle part of Snowshoe Formation near Seneca.

18–21. *Holcophylloceras* sp. (p. 54).
18. Specimen, CAS 13328 from Lupher's loc. 221.
19–21. Lateral and ventral views (× 2) of specimen, CAS 13329 from Lupher's loc. 211 in the Warm Springs Member of the Snowshoe Formation.



CALLIPHYLLOCERAS, SPIROCERAS, PHYLLOCERAS, AND *HOLCOPHYLLOCERAS*

PLATE 2

[All figures are natural size. All specimens shown in figs. 1–6 and 9 from the Weberg Member of the Snowshoe Formation]

FIGURES 1–6. *Tmetoceras scissum* (Benecke) (p. 59).

1, 2. Ventral and lateral views of hypotype, CAS 13362 from Lupher's loc. 207.

3, 4. Lateral and ventral views of hypotype, CAS 13363 from Lupher's loc. 207.

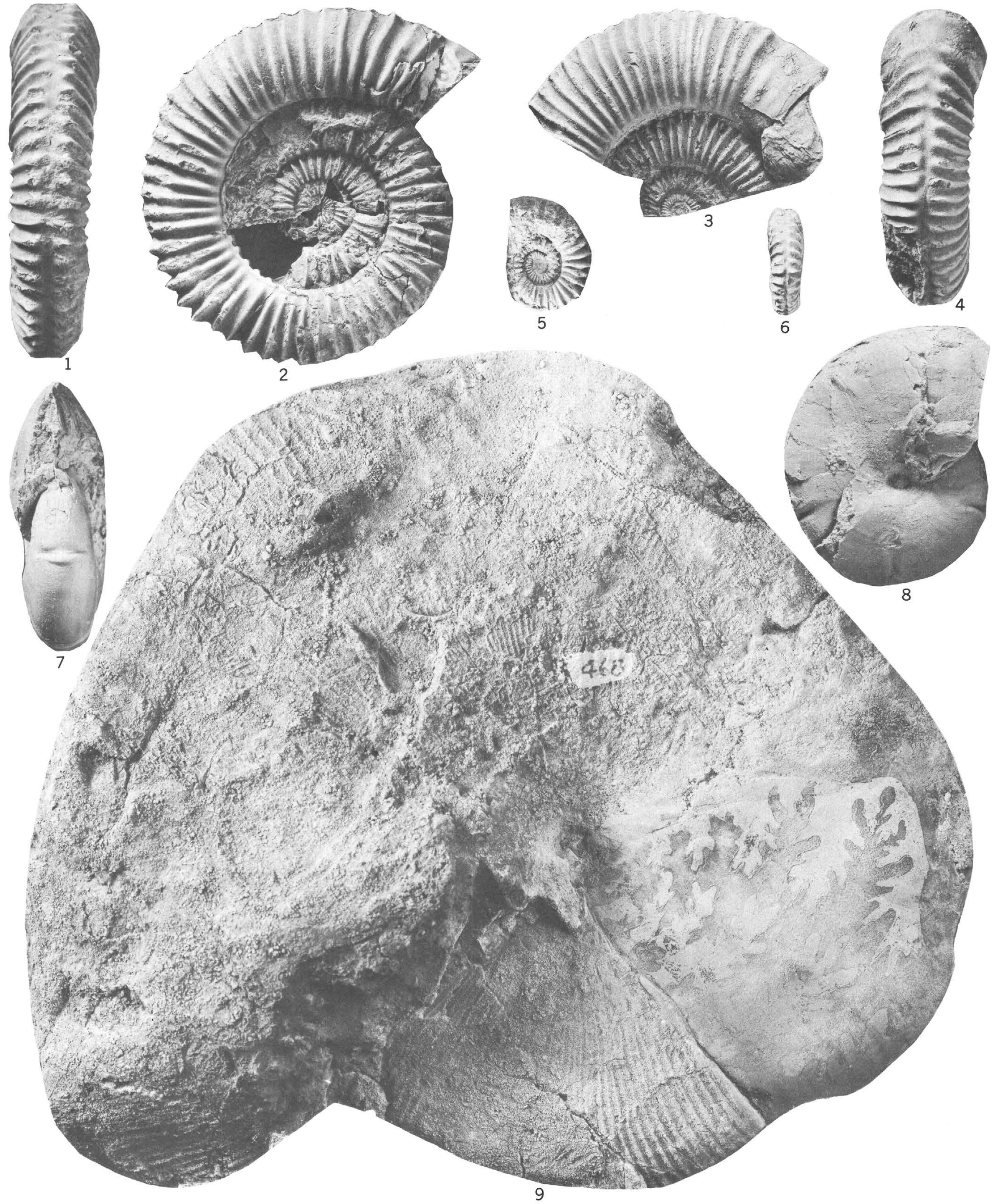
5, 6. Lateral and ventral views of hypotype, Stanford Univ. Mus. Paleontology 10019 from Vigrass's loc. 3.

7, 8. *Holcophylloceras* sp. (p. 54).

Apertural and lateral views of specimen, CAS 13330 from Lupher's loc. 235 in the Warm Springs Member of the Snowshoe Formation.

9. *Phylloceras* sp. (p. 54).

Crushed internal mold bearing some shell material.
Specimen CAS 13327 from Lupher's loc. 468.



TMETOCERAS, *HOLCOPHYLLOCERAS*, AND *PHYLLOCERAS*

PLATE 3

[All figures natural size unless otherwise indicated]

FIGURES 1–32. *Asthenoceras delicatum* Imlay, n. sp. (p. 55).

Within the species those specimens shown in figures 1–11 are the most coarsely-ribbed; in figures 12–14 are moderately-ribbed; and in figures 16–32 are the most finely ribbed. Specimens shown in figures 1, 2, 4–7, 9–11, 15–17 and 22–25 are from the Weberg Member. All others are from the Warm Springs Member of the Snowshoe Formation.

1. Paratype, CAS 13344 from Lupher's loc. 306.
2. Paratype, CAS 13345 from Lupher's loc. 306.
3. Paratype, CAS 13338 from Lupher's loc. 232.
4. Paratype, CAS 13334 from Lupher's loc. 228N.

5–7. Paratype, CAS 13336 from Lupher's loc. 228N. Note lateral lappet on fig. 5.

8. Paratype, CAS 13333 from Lupher's loc. 116.

9–11. Ventral and lateral views of paratype, CAS 13335 from Lupher's loc. 228N.

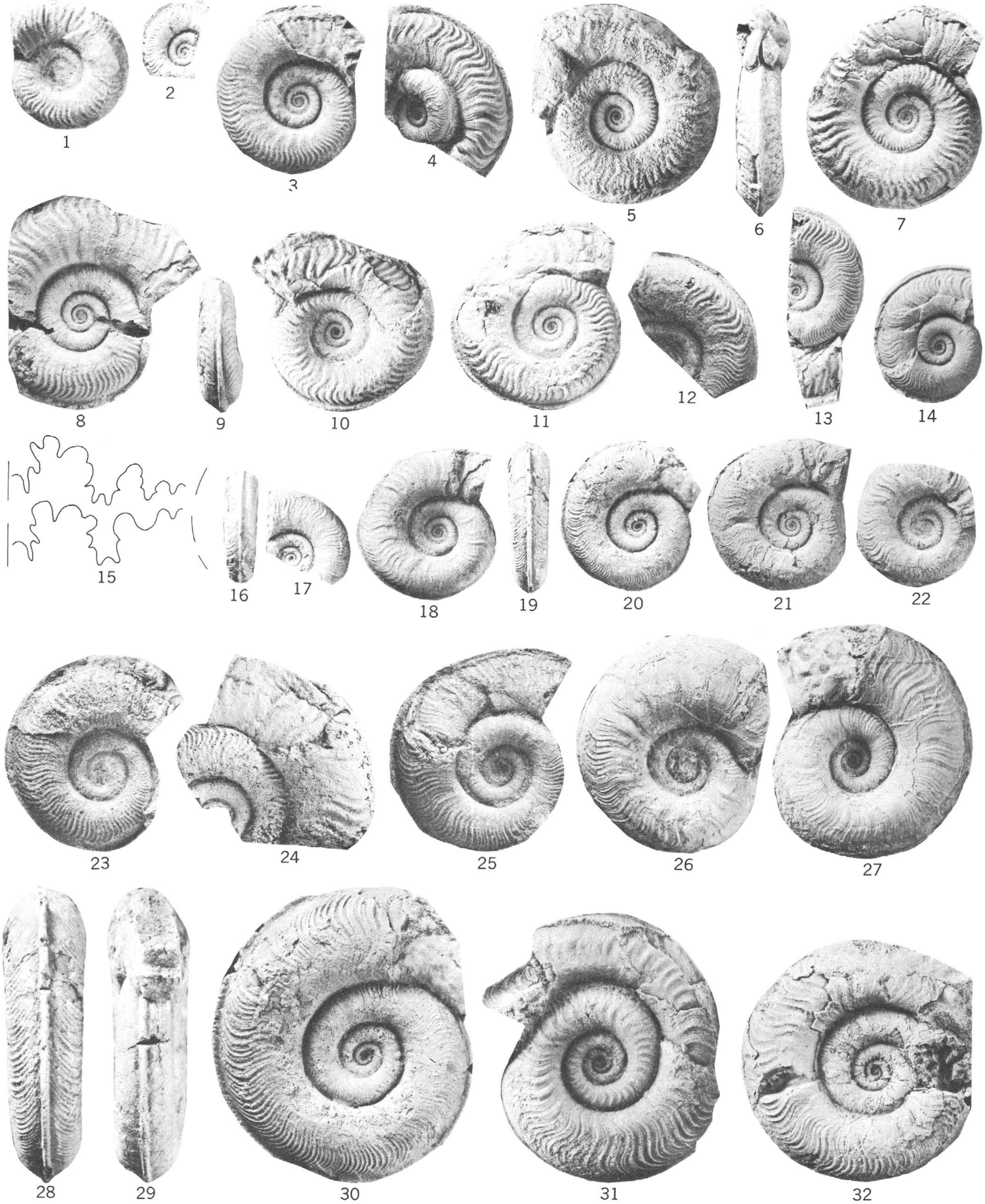
12. Paratype, Stanford Univ. Mus. Paleontology 10012 from Vigrass' loc. 10.
13. Paratype, Stanford Univ. Mus. Paleontology 10013 from Vigrass' loc. 10.
14. Paratype, Stanford Univ. Mus. Paleontology 10014 from Vigrass' loc. 18.
15. Suture line (× 2) (drawn at whorl height of 13 mm) of paratype, Stanford Univ. Mus. Paleontology 10010 from Vigrass' loc. 16.

16, 17. Paratype, CAS 13341 from Lupher's loc. 306.

18. Paratype, USNM 168503 from USGS Mesozoic loc. 29239.

19, 20, 28–30. Holotype, CAS 13331 from Lupher's loc. 116 (figures 28–30 are × 2).

21. Paratype, Stanford Univ. Mus. Paleontology 10008 from Vigrass' loc. 166.
22. Paratype, CAS 13337 from Lupher's loc. 228N.
23. Paratype, CAS 13343 from Lupher's loc. 306.
24. Paratype, CAS 13342 from Lupher's loc. 306.
25. Paratype, CAS 13340 from Lupher's loc. 305.
26. Paratype (× 2), CAS 13346 from Lupher's loc. 560. Note swellings on flanks.
27. Paratype (× 2), CAS 13347 from Lupher's loc. 561.
31. Paratype (× 2), CAS 13332 from Lupher's loc. 116. Note lateral lappet.
32. Paratype (× 2), Stanford Univ. Mus. Paleontology 10007 from Vigrass' loc. 10. Note lateral lappet.



ASTHENOCERAS

PLATE 4

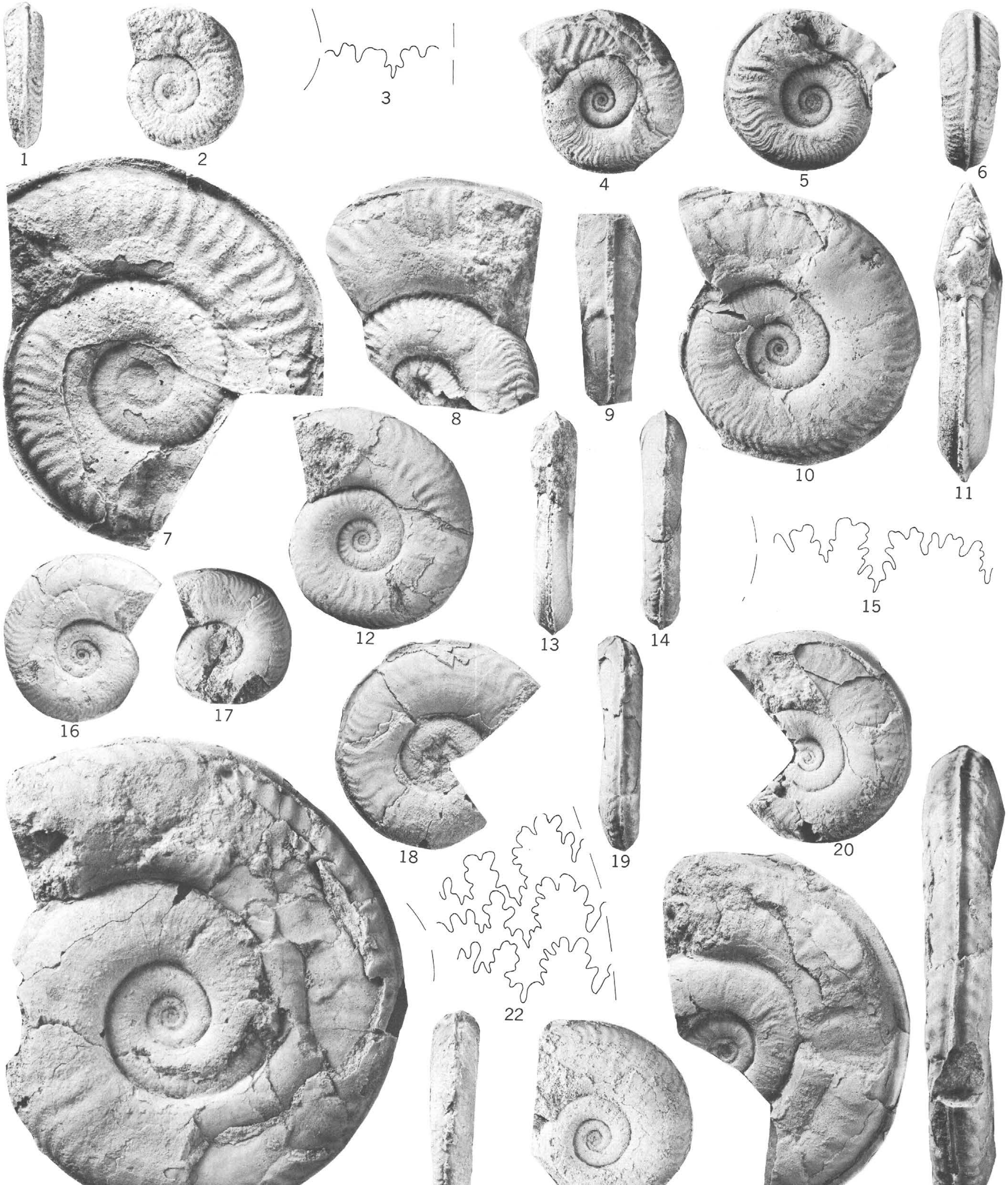
[All figures natural size unless otherwise indicated. Specimen shown in figs. 5 and 6 is from the Warm Springs Member. All others are from the Weberg Member of the Snowshoe Formation]

FIGURES 1, 2. *Asthenoceras* cf. *A. delicatum* Imlay, n. sp. (p. 33).
Ventral and lateral views of specimen, USNM 168504 from USGS Mesozoic loc. 24137 in the basal sandstone of the Tuxedni Formation, 0.53 mile S 74.5° E of mouth of Pass Creek, Talkeetna Mountains, Alaska. Specimen resembles the coarsely ribbed variant of *A. delicatum* Imlay.

3–6. *Asthenoceras delicatum* Imlay, n. sp. (p. 55).
3. Suture line (× 2) (drawn at whorl height of 10 mm). Paratype, Stanford Univ. Mus. Paleontology 10011 from Vigrass' loc. 16.
4. Paratype, Stanford Univ. Mus. Paleontology 10009 from Vigrass' loc. 16. Shows change from fine to coarse ribbing.
5, 6. Paratype, CAS 13339 from Lupher's loc. 232. This specimen is much stouter than average and shows marked change from fine to coarse ribbing.

7–15. *Fontannesia intermedia* Imlay, n. sp. (p. 57).
7. Rubber imprint of external mold. Paratype, CAS 13354 from Lupher's loc. 239.
8, 9. Paratype, Stanford Univ. Mus. Paleontology 10017 from Vigrass' loc. 16. Outer whorl is nonseptate.
10, 11, 15. Lateral and apertural views (× 1) and suture line (× 2). Holo type, CAS 13352 from Lupher's loc. 228W.
12–14. Lateral, apertural, and ventral views. Paratype, CAS 13353 from Lupher's loc. 228X.

16–26. *Fontannesia costula* Imlay, n. sp. (p. 57).
16. Paratype, CAS 13349 from Lupher's loc. 228.
17. Paratype, CAS 13350 from Lupher's loc. 228.
18–20. Paratype, Stanford Univ. Mus. Paleontology 10016 from Vigrass' loc. 241.
21, 26. Holotype, CAS 13348 from Lupher's loc. 228N. About three-fourths of outer whorl is body chamber.
22–24. Ventral and lateral views (× 1) and suture line (× 2) (drawn at whorl height of 13 mm). Paratype, Stanford Univ. Mus. Paleontology 10015 from Vigrass' loc. 8.
25. Paratype, CAS 13351 from Lupher's loc. 370.



ASTHENOCERAS AND *FONTANNESIA*

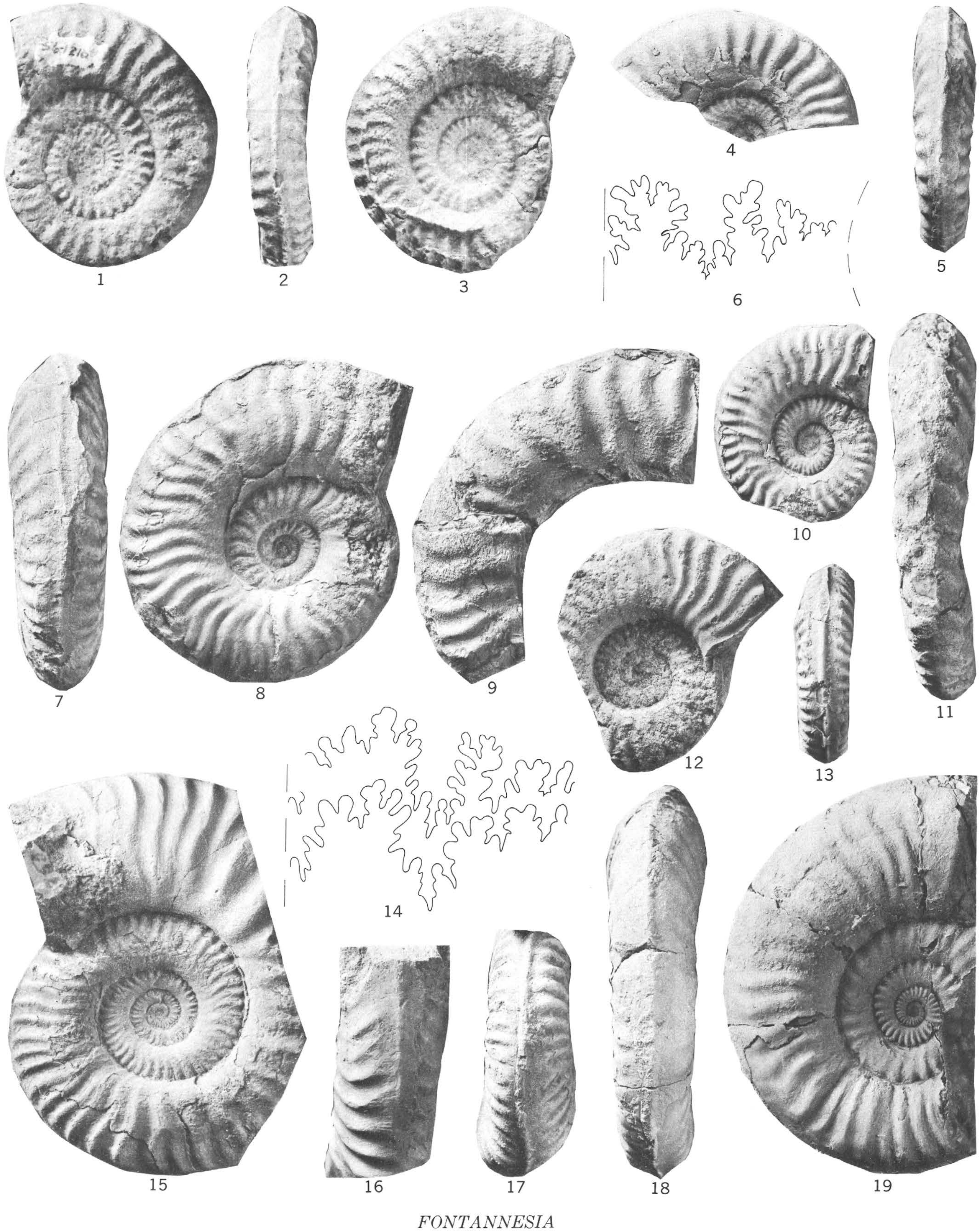
PLATE 5

[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation]

FIGURES 1–3. *Fontannesia* cf. *F. evoluta* (Buckman) (p. 59).
Specimen, Stanford Univ. Mus. Paleontology 10018 from Vigrass' loc. 121a.

4–13. *Fontannesia* cf. *F. carinata* Buckman (p. 58).
4,5. Specimen, CAS 13361 from Lupher's loc. 355.
6, 12. Suture line (× 2) and lateral view of specimen, CAS 13357 from Lupher's loc. 226.
7, 8. Specimen, CAS 13359 from Lupher's loc. 355. About three-fourths of outer whorl represents body chamber.
9, 11. Partial body chamber of specimen, CAS 13358 from Lupher's loc. 228X.
10, 13. Immature specimen, CAS 13360 from Lupher's loc. 355.

14–19. *Fontannesia* cf. *F. luculenta* Buckman (p. 58).
14–17. Suture line (× 2) (drawn at whorl height of 18.5 mm), lateral, ventral, and apertural views of specimen, CAS 13356 from Lupher's loc. 355. Figure 16 shows ventral elongation of shell.
18, 19. Specimen, CAS 13355 from Lupher's loc. 355.



FONTANNESIA

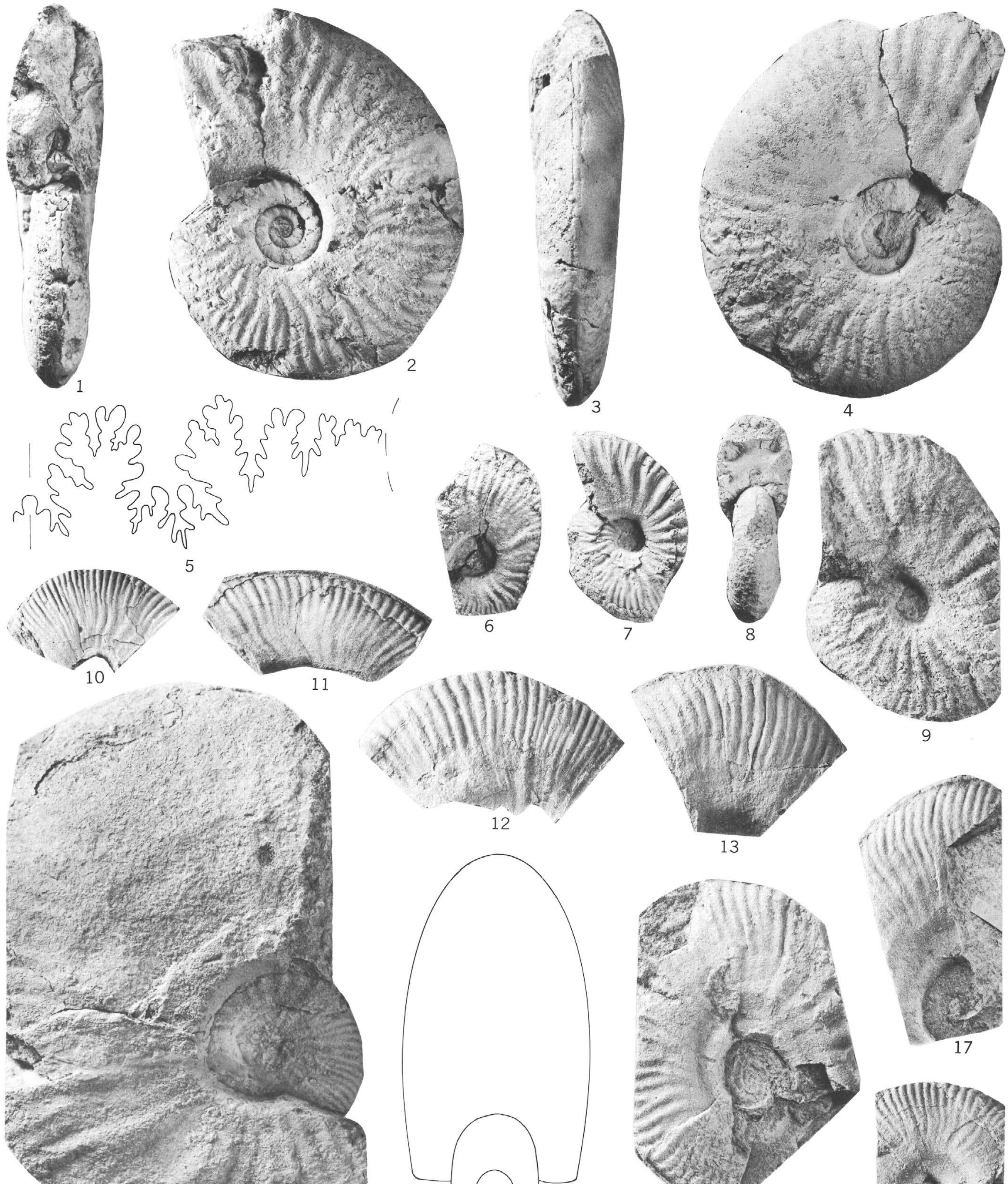
PLATE 6

[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Showshoe Formation]

FIGURES 1–5. *Eudmetoceras* (*Euaptetoceras*) cf. *E.* (*E.*) *amaltheiforme* (Vacek) (p. 60)
Apertural, lateral, and ventral views (× 1) and suture line (× 2) of specimen, CAS 13364 from Lupher's loc. 1701.

6–9. *Eudmetoceras* (*Euaptetoceras*) sp. juv. cf. *E.* (*E.*) *hauthali* (Burckhardt) (p. 60).
6. Specimen, USNM 168506a.
7, 8. Specimen, USNM 168506b.
9. Specimen, USNM 168506c. All from USGS Mesozoic loc. 29400.

10–18. *Eudmetoceras* (*Euaptetoceras*) cf. *E.* (*E.*) *klimakomphalum* (Vacek). (p. 60).
11, 16, 18. Lateral views of three crushed immature specimens, USNM 168508a–c from USGS Mesozoic loc. 29817.
10, 12, 13, 17. Lateral views of four crushed immature specimens. USNM 168507a–d from USGS Mesozoic loc. 29400.
14, 15. Lateral view and cross section of fairly large specimen, USNM 168507e from USGS Mesozic loc. 29400. About one-fourth of outer whorl is nonseptate.



EUDMETOCERAS (EUAPTETOCERAS)

PLATE 7

[All figures are natural size. All specimens shown are from the Weberg Member of the Snowshoe Formation]

FIGURES 1–5. *Sonninia* (*Euhoploceras*) *modesta* Buckman (p. 62).

1, 4. Septate hypotype, CAS 13370 from Lupher's loc. 228N. Note abrupt umbilical edge and change in coiling from moderately involute to moderately evolute. Represents a stout and fairly coarsely ribbed variant.

2, 3. Immature septate hypotype, CAS 13374 from Lupher's loc. 373. Has fairly fine ribbing.

5. Moderately large septate hypotype, CAS 13375 from Lupher's loc. 584. Note vertical umbilical wall, fairly abrupt umbilical edge, fairly stout whorl section, and moderately coarse ribbing. See cross section on pl. 9, fig. 4. Specimen develops slightly stronger and sparser ribbing than *Sonninia subcostata* Buckman (1892, pl. 86, fig. 1) or *S. multicostata* Buckman (1893, pl. 86, fig. 1), but closely resembles *S. inaequa* Buckman (1894, pl. 101, figs. 4, 5).

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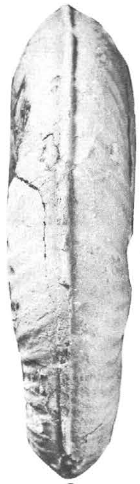

2

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4

5

SONNINIA (EUHOPLOCERAS)

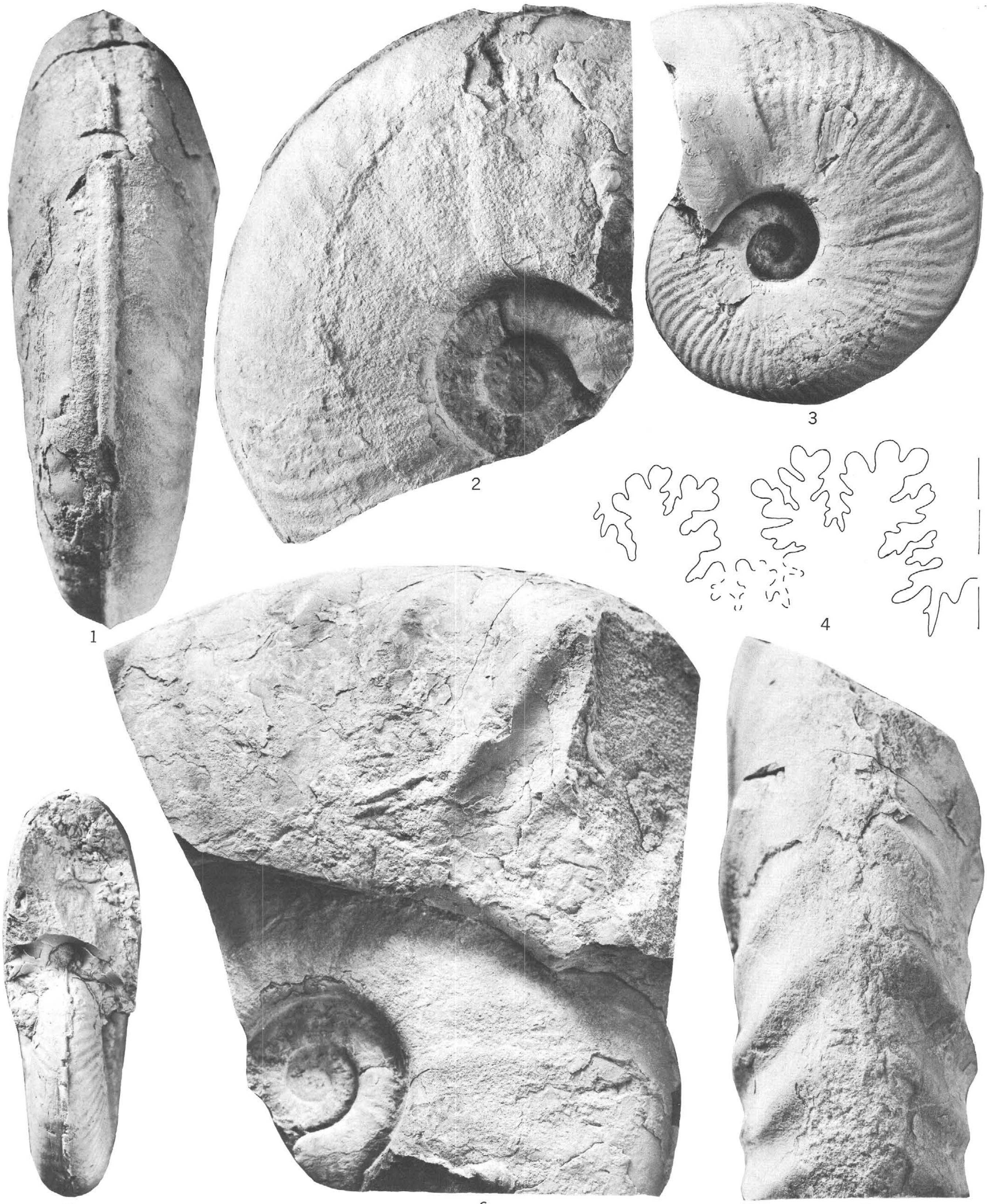
PLATE 8

[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation]

FIGURES 1–7. *Sonninia* (*Euhoploceras*) *modesta* Buckman (p. 62).

1, 2, 6, 7. Hypotype, USNM 168512 from USGS Mesozoic loc. 29828. Shows weakly-ribbed septate whorls (figs. 1, 2) and moderately-ribbed outer nonseptate whorl (figs. 6, 7) similar to those on specimen of *Sonninia modesta* Buckman (1892, pl. 68) from England. Note abrupt umbilical edge and change in amount of involution.

3–5. Suture line (× 2) and lateral and apertural views of immature septate hypotype, CAS 13373 from Lupher's loc. 306. It is moderately compressed and has fairly fine ribbing.



SONNINIA (EUHOPLOCERAS)

PLATE 9

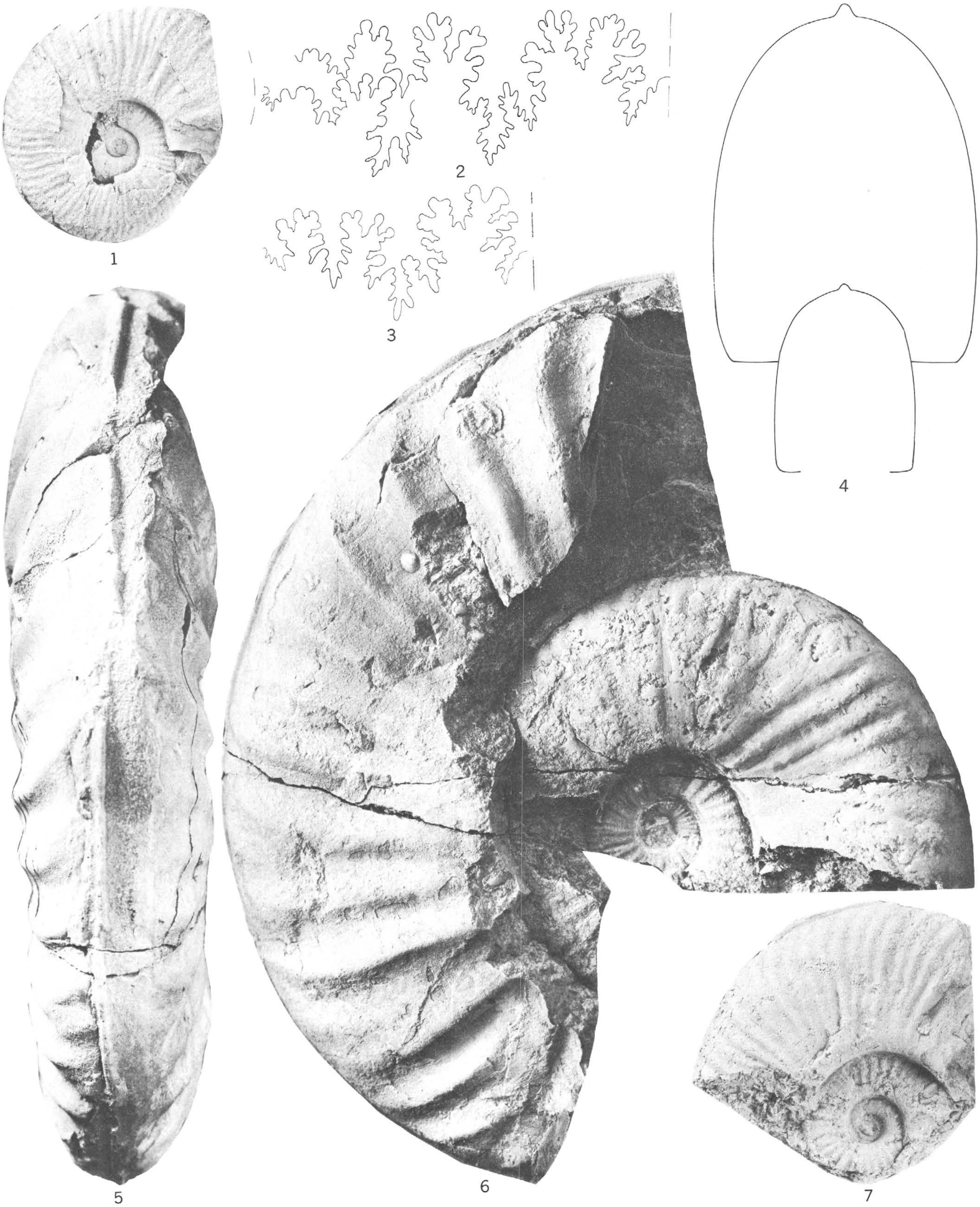
[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation]

FIGURES 1–7. *Sonninia* (*Euhoploceras*) *modesta* Buckman (p. 62).

1. Very small septate hypotype, Stanford Univ. Mus. Paleontology 10020 from Vigrass' loc. 152.
2. Suture line of hypotype, CAS 13369 from Lupher's loc. 228. Drawn at whorl height of 60 mm.
3. Suture line of hypotype, CAS 13372 from Lupher's loc. 228W. Drawn at whorl height of 48 mm.
4. Cross-section of hypotype, CAS 13375, shown on pl. 7, fig. 5.

5, 6. Hypotype, CAS 13371 from Lupher's loc. 228W. Shows change in ribbing from fairly weak on septate whorls to fairly strong on body chamber. Resembles *Sonninia subcostata* Buckman (1892, pl. 71, fig. 4) at a comparable size. Develops slightly coarser ribbing at an earlier growth stage than on a certain paratype of *S. modesta* Buckman (1892, pl. 68).

7. Small septate whorl (× 2) of hypotype, USNM 168513 from USGS Mesozoic loc. 29828. Shows nearly smooth nucleus followed by development of weak flexuous ribs.



SONNINIA (EUHOPLOCERAS)

PLATE 10

[Figure about four-fifths natural size]

FIGURE 1. *Sonninia* (*Euhoploceras*) *modesta* Buckman (p. 62).

Lateral view of large laterally crushed hypotype, CAS 13467 from Luphers' loc. 610 in Weberg Member of Snowshoe Formation. Adoral fifth or outer whorl is nonseptate and presumably represents part of the adult body chamber. Note vertical umbilical wall, abrupt umbilical edge, widening of umbilicus during growth, general smoothness of internal mold, and presence of broad radial undulations. Weathering accounts for some of the smoothness on the adapical part of the outer whorl. Note resemblance to *S. simplex* Buckman (1892, pl. 70, figs. 2–4), *S. substriata* Buckman (1892, pl. 71, fig. 6), *S. parvicostata* Buckman (1892, pl. 75, figs. 3–5), *S. modesta* Buckman (1892, pl. 68), and *S. nuda* Buckman (1893, pl. 82, figs. 3, 4).

1

SONNINIA (EUHOPLOCERAS)

PLATE 11

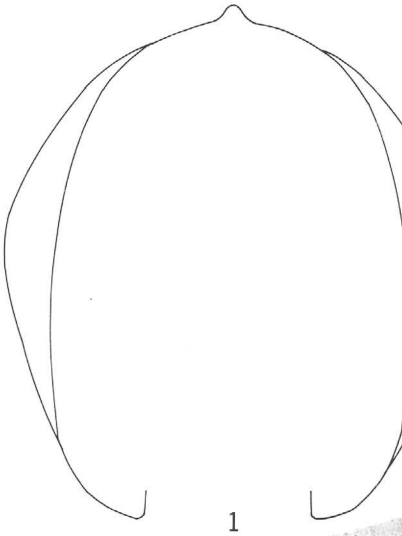
[All figures are natural size. All specimens are from the Weberg Member of the Snowshoe Formation]

FIGURES 1–4. *Sonninia (Euhoploceras) dominans* Buckman (p. 63).

1, 4. Hypotype, CAS 13378 from Lupher's loc. 228. Whorl section drawn at diameter of 180 mm. Resembles *Sonninia costigera* Buckman (1894, pl. 102) and *S. obtusiformis* Buckman (1892, pl. 72, figs. 3–5).

2. Small, immature septate hypotype, CAS 13380 from Lupher's loc. 306.

3. Suture line drawn at whorl height of 42 mm on hypotype, CAS 13377 from Lupher's loc. 226. Specimen bears ribbing comparable with that present near the adoral end of the specimen shown on pl. 12, fig. 5.



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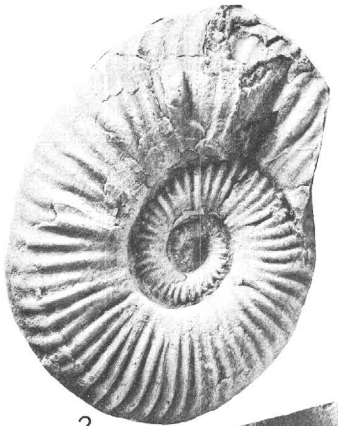

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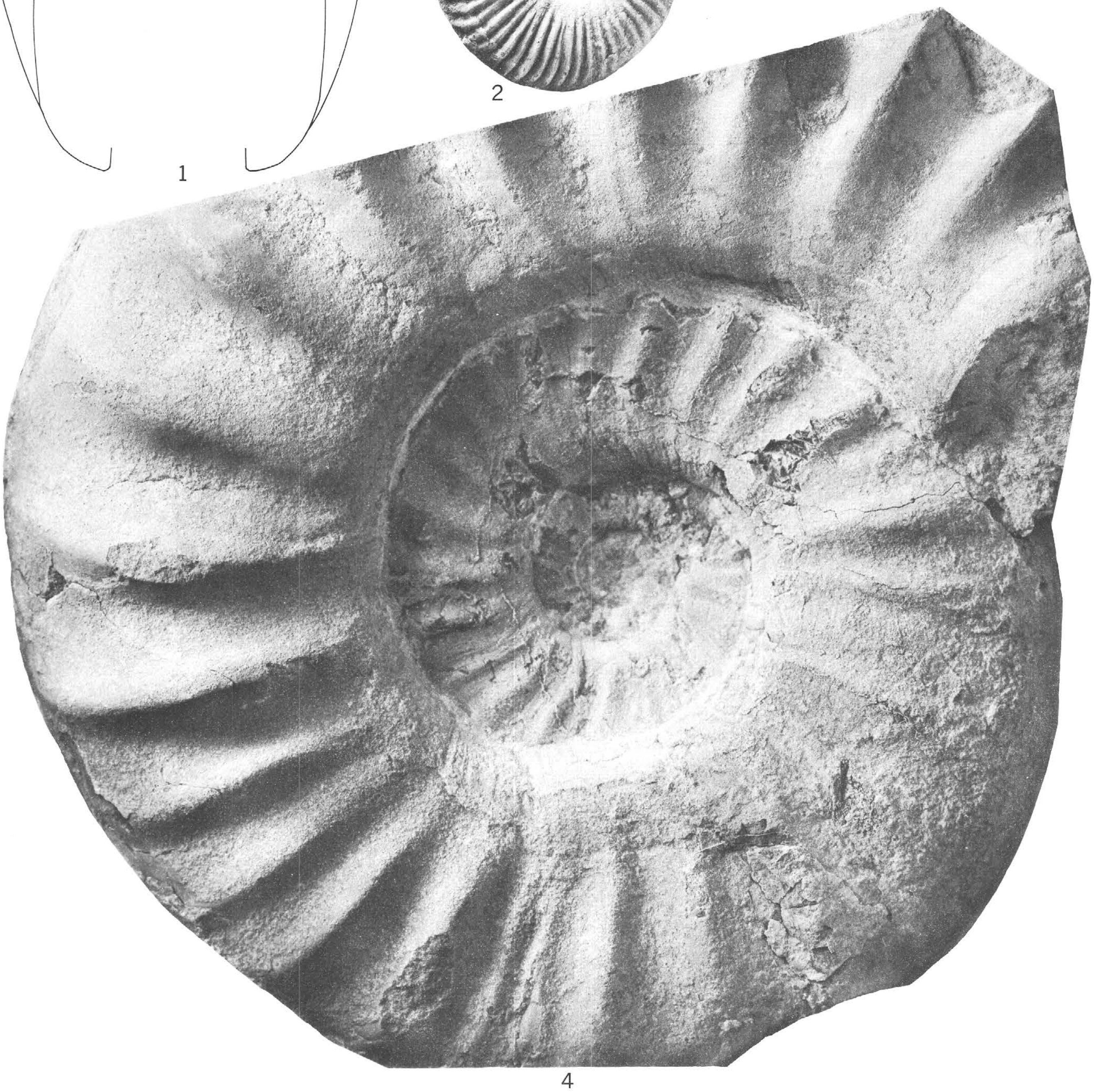

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SONNINIA (EUHOPLOCERAS)

PLATE 12

[All figures are natural size. All specimens shown are from the Weberg Member of the Snowshoe Formation]

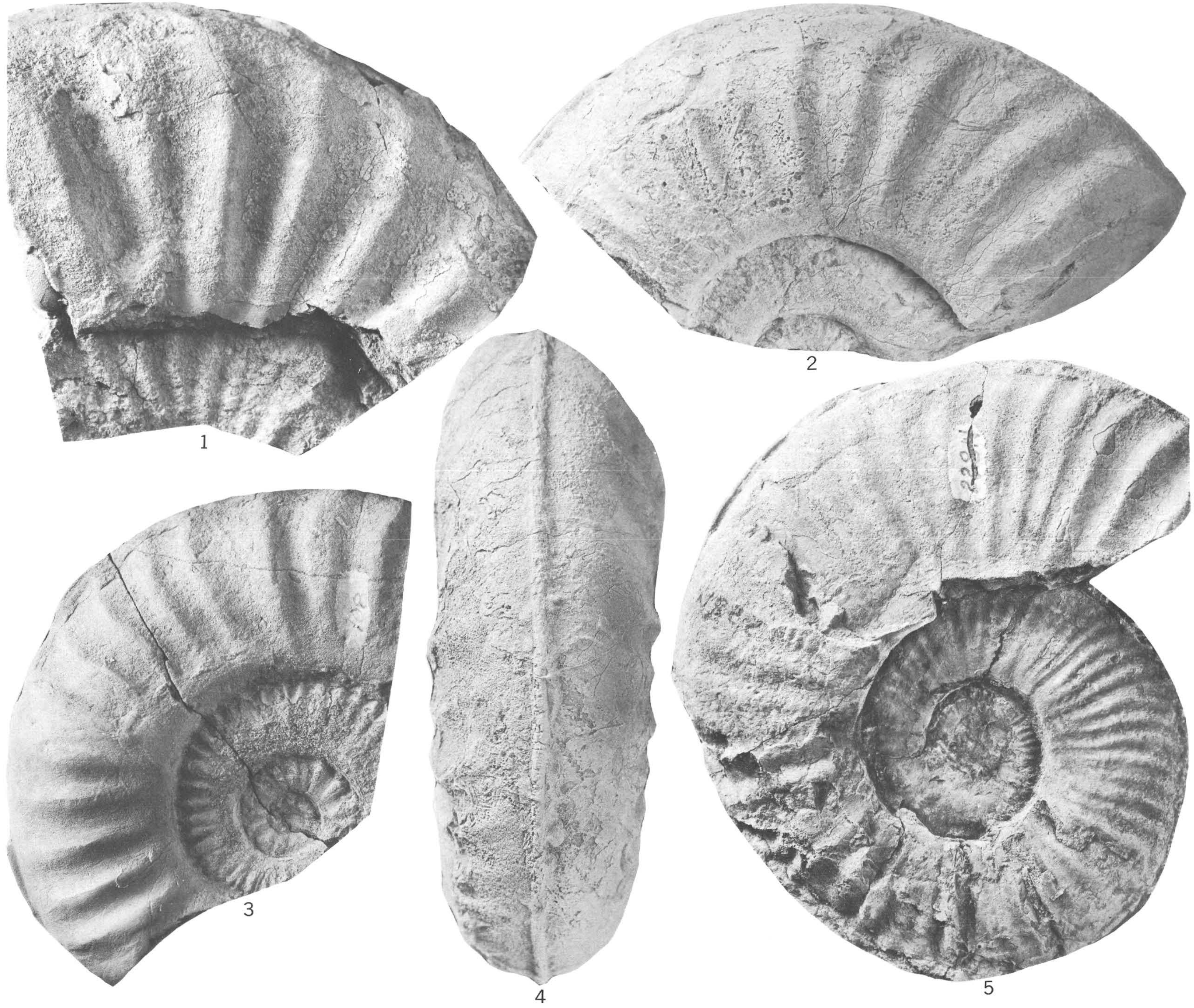
FIGURES 1–5. *Sonninia (Euhoploceras) dominans* Buckman (p. 63).

1. Hypotype, Stanford Univ. Mus. Paleontology 10021 from Vigrass' loc. 19. Resembles *Sonninia costata* Buckman (1892, pl. 74, fig. 1).

2, 4. Hypotype, CAS 13381 from Lupher's loc. 407. Resembles intermediate septate whorls of *Sonninia dominans* Buckman (1892, pl. 86).

3. Hypotype, CAS 13376 from Lupher's loc. 108. Resembles *Sonninia omphalica* Buckman (1893, pl. 83, figs. 5, 6) and *S. dominatrix* Buckman (1894, pl. 94, fig. 3).

5. Hypotype, CAS 13379 from Lupher's loc. 228N. Resembles *Sonninia multicostata* Buckman (1894, pl. 86, figs. 1, 2).



SONNINIA (EUHOPLOCERAS)

PLATE 13

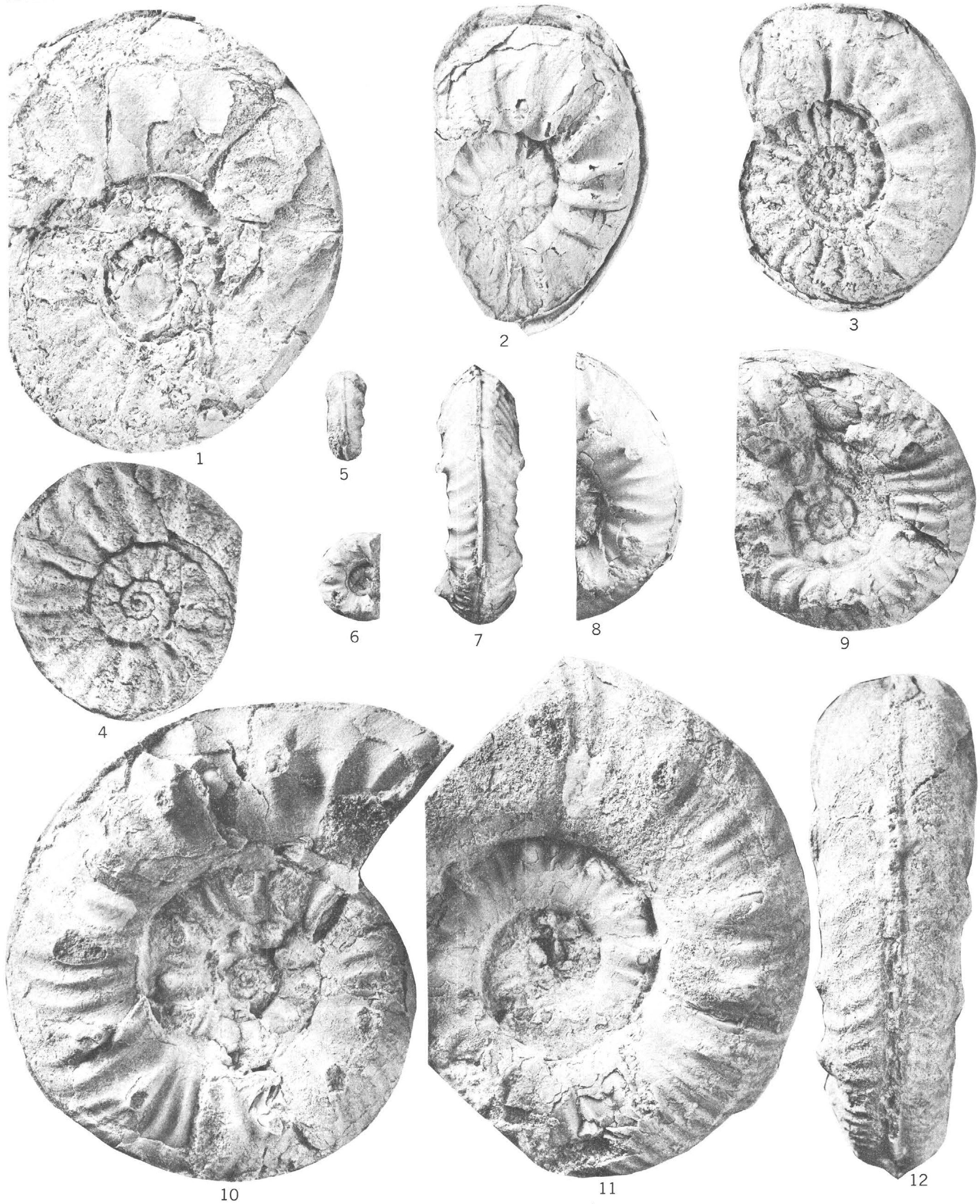
[All figures natural size unless otherwise indicated. Specimens shown in figs. 1–4 are from lowest exposed beds of Snowshoe Formation near Seneca, Oreg.; other specimens are from the Weberg Member of the Snowshoe Formation in the Suplee area, Oreg]

FIGURES 1–4. *Sonninia* cf. *S. Nodatipinguis* (Buckman) (p. 62).
All from Lupher's loc. 272.
1. Specimen, CAS 13366. About three-fifths of outer whorl is nonseptate. Note tubercles on inner whorl.
2. Rubber imprint of external mold, CAS 13365. Note strong radial-trending ribs that fade out on venter.
3. Septate and partially corroded internal mold, CAS 13368.
4. Small corroded internal mold (× 2), CAS 13367. Note tubercles on inner whorls.

5, 6. *Sonninia* (*Euhoploceras*) sp. juv. (p. 65).
5, 6. Specimen, USNM 168498 from USGS loc. 21612. Shows prominent tubercles characteristic of inner whorls of species of *Sonninia* (*Euhoploceras*) *adicra* (Waagen) or *S.* (*E.*) *crassispinata* Buckman, as described herein.

7–9. *Sonninia* (*Euhoploceras*) cf. *S.* (*E.*) *adicra* (Waagen) (p. 65).
7, 8. Internal mold with some adhering shelly material, CAS 13394 from Lupher's loc. 228N.
9. Internal mold showing strong tubercles and ribs, CAS 13396 from Lupher's loc. 407.

10–12. *Sonninia* (*Euhoploceras*) *adicra* (Waagen) (p. 65).
10. Laterally crushed internal mold of hypotype, CAS 13397 from Lupher's loc. 491. Shows strong spines characteristic of inner and intermediate whorls. Resembles inner whorles of *S. acanthodes* Buckman (1892, pls. 58–60), as well as *S. locuples* Buckman (1892, pl. 50, figs. 16, 17; 1894, pl. 92, figs. 1, 2).
11, 12. Hypotype, CAS 13392 from Lupher's loc. L228N.



SONNINIA AND *S. (EUHOPLOCERAS)*

PLATE 14

[All figures are natural size]

FIGURES 1–6. *Sonninia* (*Euhoploceras*) *adicra* (Waagen) (p. 65).

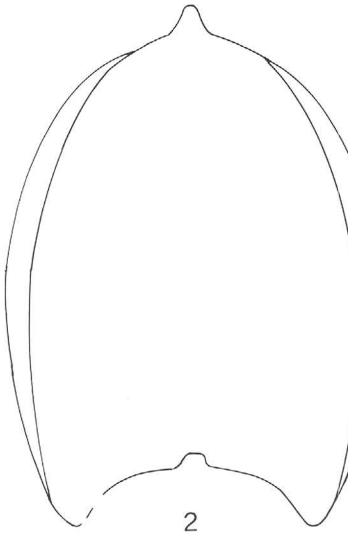
From the Weberg Member of the Snowshoe Formation.

1. Hypotype, USNM 168515 from USGS Mesozoic loc. 26765. Change from tuberculate to nontuberculate ribs occurs at an earlier growth than in some specimens.

2, 5. Hypotype, CAS 13395 from Lupher's loc. 228W. Cross section was drawn near adoral end. About one-fourth of outer whorl is nonseptate.

3, 4, 6. Hypotype, CAS 13393 from Lupher's loc. 228N. Shows tubercles on inner septate whorls similar to those shown on pl. 13, figs. 10, 11.

1



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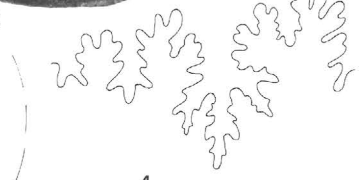

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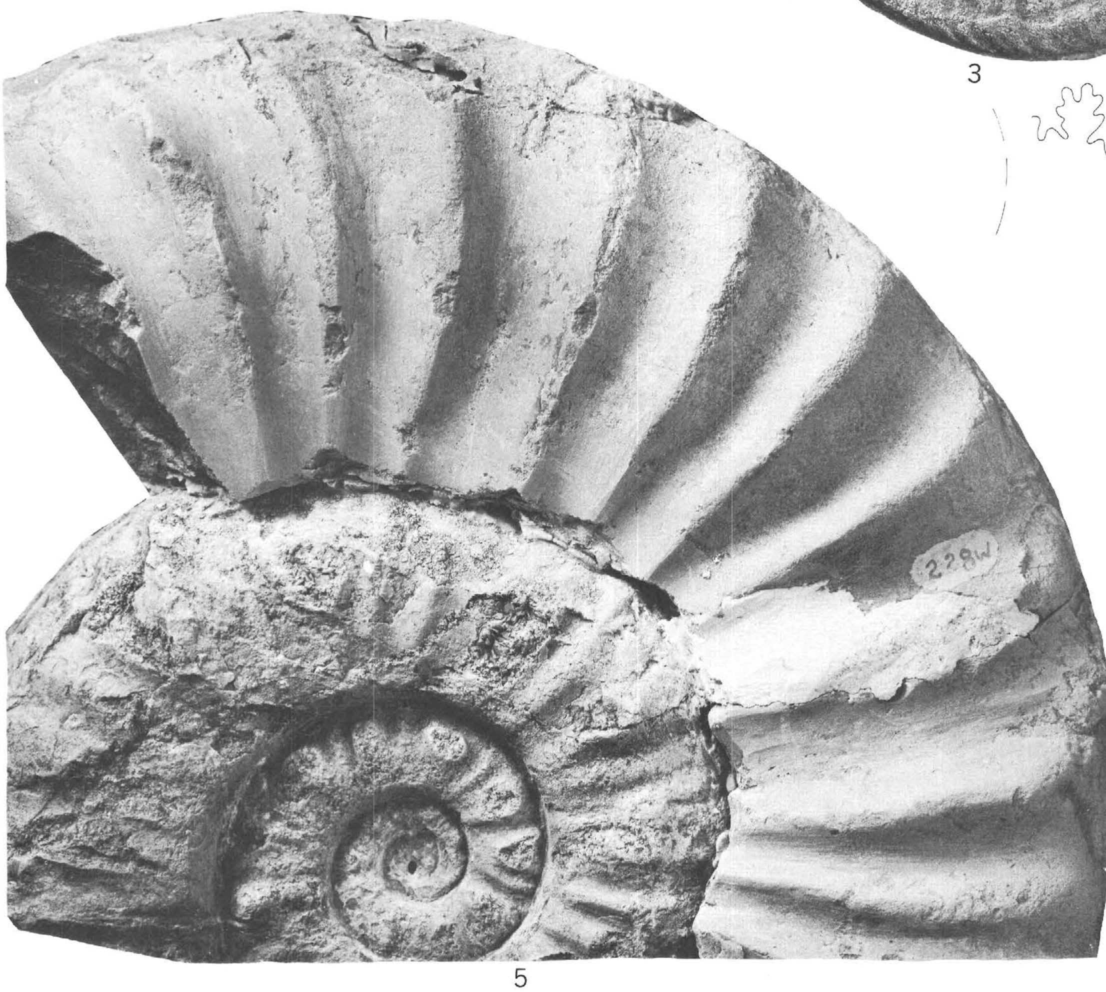


5

6

SONNINIA (EUHOPLOCERAS)

PLATE 15

[All figures are natural size]

FIGURES 1–5. *Sonninia (Euhoploceras) adicra* (Waagen) (p. 65).

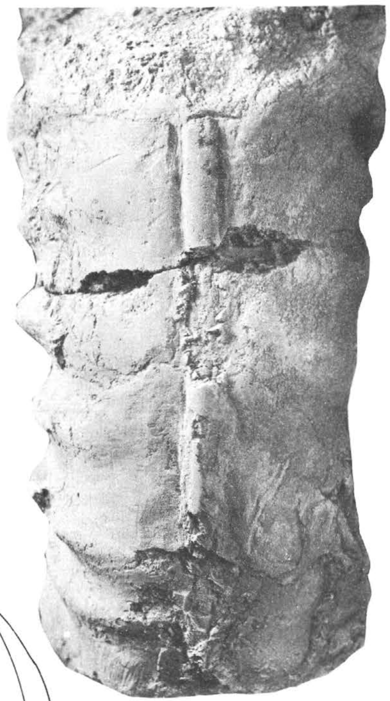
From the Weberg Member of the Snowshoe Formation.

1, 2. Lateral and ventral views of a stout hypotype, CAS 13390 from Lupher's loc. 228N. This specimen differs from other Oregon specimens assigned to *S. adicra* in its ribs fading out on the venter as on the holotype of that species (Dorn, 1935, pl. 10, fig. 7).

3, 5. Hypotype, CAS 13391 from Lupher's loc. 228N. Represents a coarsely ribbed variant of average stoutness. Resembles *S. cymatera* Buckman (1892, pl. 73, figs. 2, 3), *S. spinicostata* Buckman (1892, pl. 73, figs. 4–6), and *S. locuples* Buckman (1894, pl. 92, figs. 5–7).

4. Laterally crushed hypotype, CAS 13389 from Lupher's loc. 228N. Shows loss of tuberculation at a fairly early growth stage.

1



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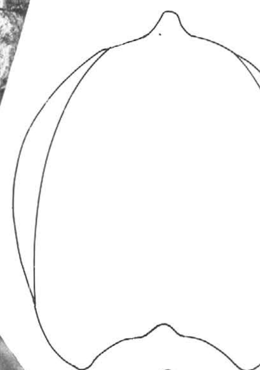

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SONNINIA (EUHOPLOCERAS)

PLATE 16

[Figure is natural size]

FIGURE 1. *Sonninia* (*Euhoploceras*) *adicra* (Waagen) (p. 65).

Laterally crushed hypotype, CAS 13388 from Lupher's loc. 228N. From the Weberg Member of the Snowshoe Formation. About three-fifths of outer whorl is nonseptate and probably represents most of body chamber. Resembles *S.* (*E.*) *acanthodes* Buckman (1892, pls. 58–60).

1

SONNINIA (EUHOPLOCERAS)

473-698 O - 73 - 10

PLATE 17

[Figure is about four-fifths natural size]

FIGURE 1. *Sonninia (Euhoploceras) adicra* (Waagen) (p. 65).

Moderately stout hypotype, CAS 13387 from Lupher's loc. 228, upper part of Weberg Member of Snowshoe Formation. As slightly less than one-fourth of the outer whorl is nonseptate, the complete adult shell must have had a diameter of at least 350 mm. This specimen is nearly identical in appearance with the large adult specimens of *Sonninia marginata* Buckman (1892, pls. 62 and 64).

1

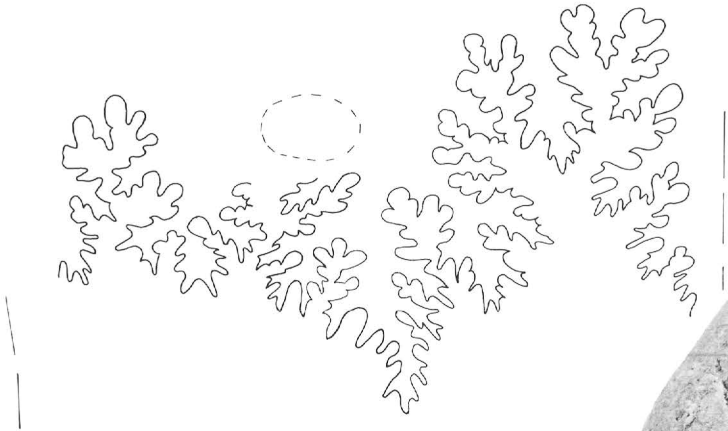
SONNINIA (EUHOPLOCERAS)

PLATE 18

[All figures natural size unless otherwise indicated]

FIGURES 1–3. *Sonninia* (*Euhoploceras*) *polyacantha* (Waagen) (p. 64).

Hypotype, CAS 13385 from Lupher's loc. 573. From Weberg Member of the Snowshoe Formation. Suture line drawn at whorl height of 70 mm. Figure 3 represents inner septate whorls of the specimen shown on plate 19 at reduced size. The cross section (× 3/5) represents the outer two whorls of the complete specimen shown on plate 19.



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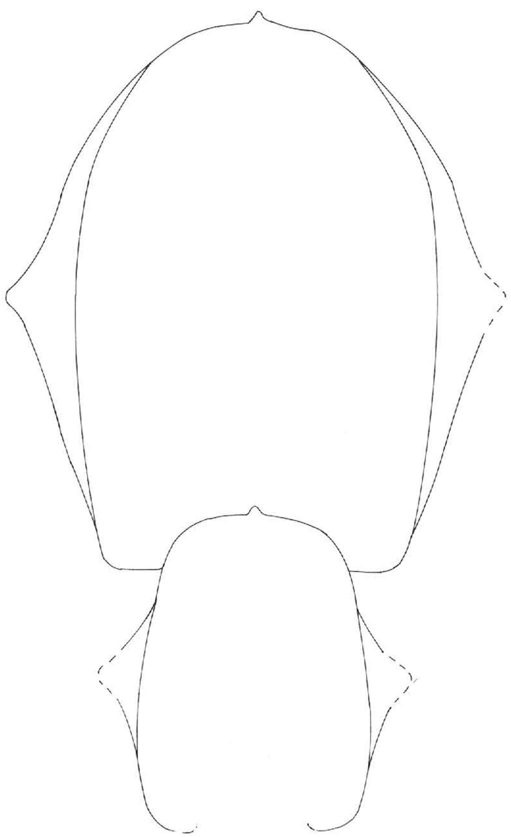

2

3

SONNINIA (EUHOPLOCERAS)

PLATE 19

[Figure reduced to three-fourths natural size]

FIGURE 1. *Sonninia (Euhoploceras) polyacantha* (Waagen) (p. 64).
Hypotype CAS 13385 from Lupher's loc. 573. Same specimen shown on plate 18. The outermost whorl is nonseptate and presumably represents part of the body chamber.

1

SONNINIA (EUHOPLOCERAS)

PLATE 20

[All figures are natural size. Specimens shown in figs. 1, 5–7, are from the Weberg Member of the Snowshoe Formation; other specimens are from the Warm Springs Member]

FIGURES 1, 5–7. *Sonninia* (*Euhoploceras*) *polyacantha* (Waagen) (p. 64).
1, 5. Hypotype, CAS 13382 from Lupher's loc. 361.
6. Hypotype, CAS 13384 from Lupher's loc. 373.
7. Hypotype, CAS 13383 from Lupher's loc. 363.

2, 3. *Witchellia* sp. (p. 70).
Specimen, Stanford Univ. Mus. Paleontology 10024 from Dickinson's loc. D94.

4. *Witchellia connata* (Buckman) (p. 69).
Hypotype, CAS 13413 from Lupher's loc. 116.


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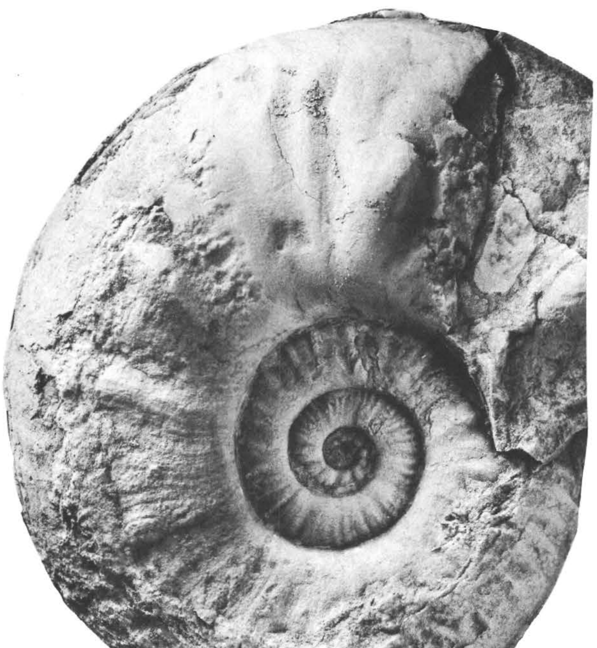
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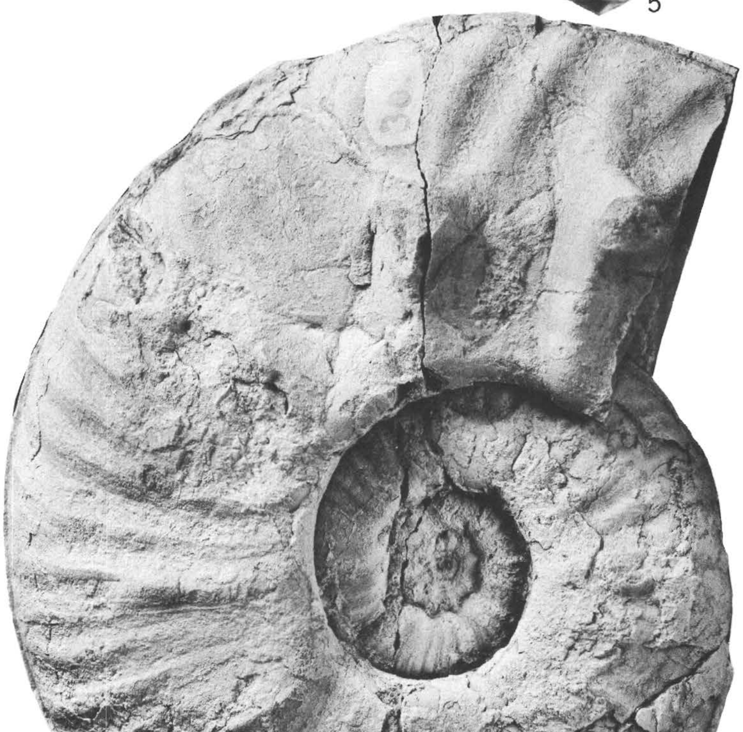

7

SONNINIA (EUHOPLOCERAS) AND *WITCHELLIA*

PLATE 21

[All figures natural size unless otherwise indicated. Specimens shown in figs. 1–7 and 11 are from the Warm Springs Member of the Snowshoe Formation; in figs. 8 and 9 from the Weberg Member; and in fig. 10 from the lower part of the Snowshoe Formation south of Seneca]

FIGURES 1–7, 10, 11. *Witchellia connata* Buckman (p. 69).

1, 2. Hypotype, Stanford Univ. Mus. Paleontology 10023 from Dickinson's loc. 94 (=V4)

3. Hypotype, USNM 168528 from USGS Mesozoic loc. 29808.

4. Hypotype, USNM 168527 from USGS Mesozoic loc. 29395.

5. Hypotype (× 2), USNM 168529 from USGS Mesozoic loc. 29807.

6. Hypotype, USNM 168526 from USGS Mesozoic loc. 29395.

7. Hypotype, USNM 168525, from USGS Mesozoic loc. 29395.

10. Hypotype, CAS 13414 from Lupher's loc. 57.

11. Hypotype, USNM 168524 from USGS Mesozoic loc. 29395.

8, 9. *Sonninia* (*Euhoploceras*) *polyacantha* (Waagen) (p. 64).

8. Hypotype, USNM 168514 from USGS Mesozoic loc. 29828.

9. Hypotype, CAS 13386 from Lupher's loc. 581.

SONNINIA (EUHOPLOCERAS) AND *WITCHELLIA*

PLATE 22

[All figures are natural size. All specimens are from the Weberg Member of the Snowshoe Formation]

FIGURES 1, 2, 4. *Sonninia* (*Euhoploceras*) *crassispinata* Buckman (p. 67).

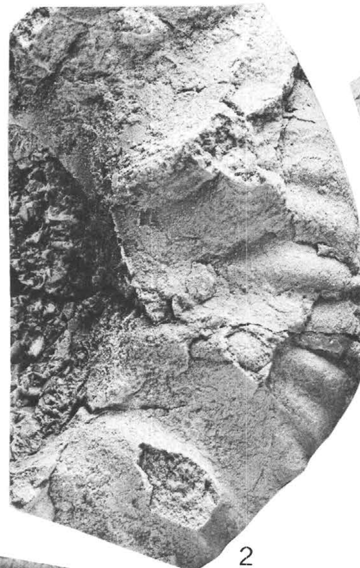
1, 2. Lateral views of hypotype, USNM 168516 from USGS Mesozoic loc. 26766.

4. Compressed hypotype, CAS 13403 from Lupher's loc. 605. Outer whorl is nonseptate and probably represents part of adult body chamber.

3. *Sonninia* (*Europloceras*) cf. *S.* (*E.*) *crassispinata* Buckman (p. 68).

Specimen, Stanford Univ. Mus. Paleontology 10022 from Vigrass' loc. 8. Note absence of spines on innermost exposed whorl at diameter between 15 to 45 mm.


1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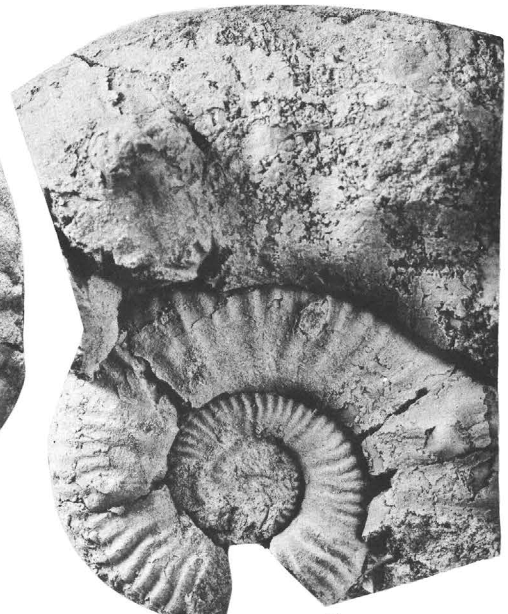
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4

SONNINIA (EUHOPLOCERAS)

PLATE 23

[All figures are natural size]

FIGURES 1–4. *Sonninia* (*Euhoploceras*) *crassispinata* Buckman (p. 67).

From the Weberg Member of the Snowshoe Formation.

1. Hypotype, USNM 168517 from USGS Mesozoic loc. 21612. About one-third of outer whorl is nonseptate.

2–4. Cross section and lateral views of hypotype, CAS 13402 from Lupher's loc. 361.

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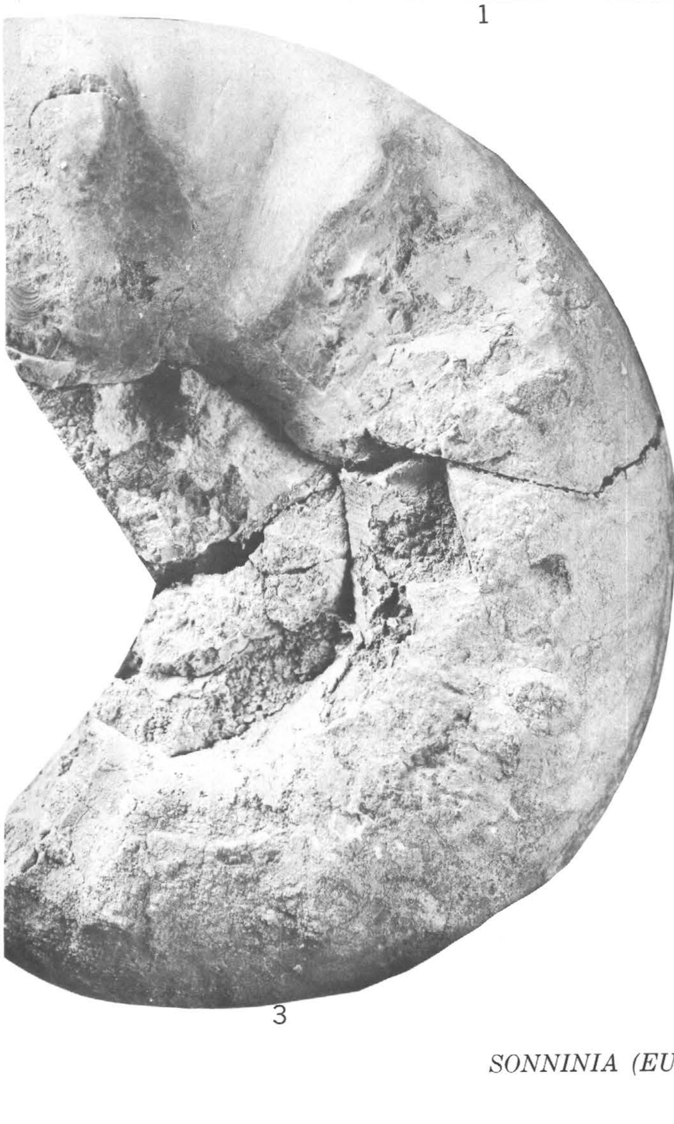

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SONNINIA (EUHOPLOCERAS)

PLATE 24

[All figures are natural size. Specimens shown in figs. 1, 4, and 5 are from the Weberg Member of the Snowshoe Formation; the other specimens are from the lower member of the Snowshoe Formation in the Izee area]

FIGURES 1, 4. *Sonninia* (*Euhoploceras*) *crassispinata* Buckman (p. 67).

1, 4. Hypotype, CAS 13398 from Lupher's loc. 228N. One-third of outer whorl is nonseptate.

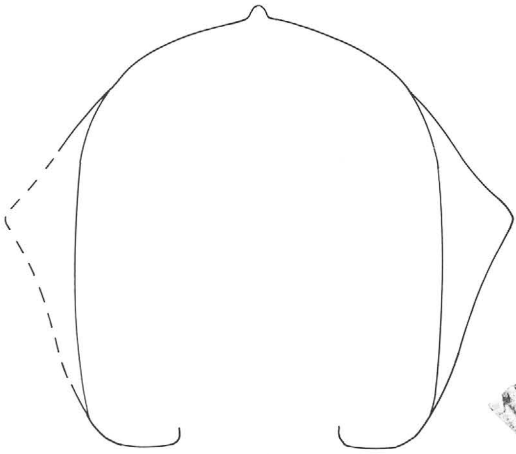
2, 3. *Planammatoceras*? cf. *P. tuberculatum* (Sato) (p. 61).

2. Crushed fragment of inner whorls of specimen USNM 168509 from USGS Mesozoic loc. 26755.

3. Crushed fragment of outer whorl of specimen USNM 168510 from USGS Mesozoic loc. 26753.

5. *Sonninia* (*Euhoploceras*) cf. *S.* (*E.*) *crassispinata* Buckman (p. 68).

Specimen, CAS 13400 from Lupher's loc. 228X. Note absence of spines on innermost exposed whorls.



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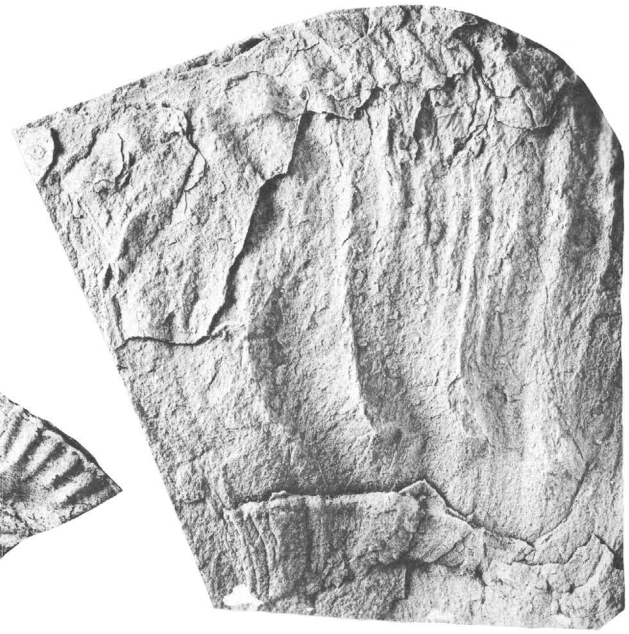

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SONNINIA (EUHOPLOCERAS) AND *PLANAMMATOCERAS*?

PLATE 25

[All figures natural size unless otherwise indicated. Specimens shown in figs. 1–10 and 12–14 are from the middle part of the Snowshoe Formation in a large shale exposure east of highway and 0.6 mile south of Seneca, Oreg. Specimens shown in figs. 11 and 15 are from lower part of middle member of Snowshoe Formation in the Izee area. Specimens shown in figs. 17–19 are from the Weberg Member of the Snowshoe Formation. Figs. 1, 3, 5, 6, 12, 14, and 16 are from rubber imprints of external molds]

FIGURES 1–16. *Poecilomorphus varius* Imlay, n. sp. (p. 75).

All specimens except those shown in figures 11, 15, 16 are from Lupher's loc. 28.

1. Paratype, CAS 13466.
2. Paratype, CAS 13465. Shows keel.
3. Paratype, CAS 13464. Shown with larger whorl at bottom.
4. Paratype, CAS 13461.
5. Paratype, CAS 13458.
6. Paratype, CAS 13460.
7. Paratype, CAS 13462.
8. Paratype, CAS 13459.
9. Paratype, CAS 13463. Shows keel.
10. Paratype, CAS 13457.
11. Paratype, USNM 168553 from USGS Mesozoic loc. 27363.
12. Paratype (× 2), CAS 13456.

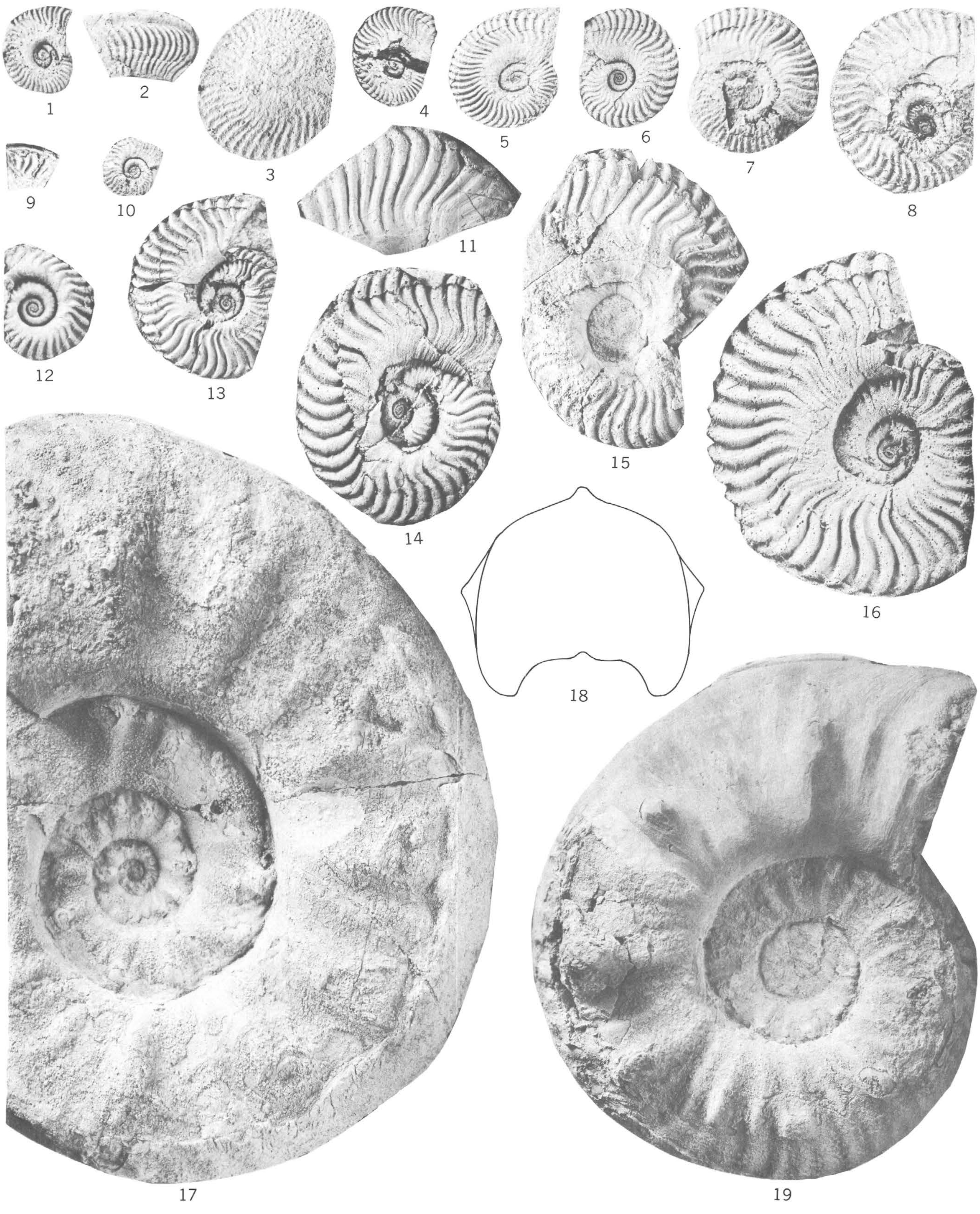
13, 16. Holotype (× 1 and × 2), CAS 13454. Figure 16 (× 2) is from a rubber imprint.

14. Paratype (× 2), CAS 13455.
15. Paratype, USNM 168554 from USGS Mesozoic loc. 27363.

17–19. *Sonninia (Euhoploceras) crassispinata* Buckman (p. 67).

17. Much weathered hypotype, CAS 13401 from Lupher's loc. 353.

18, 19. Hypotype, CAS 13399 from Lupher's loc. 228N. Cross section drawn from near adoral end.



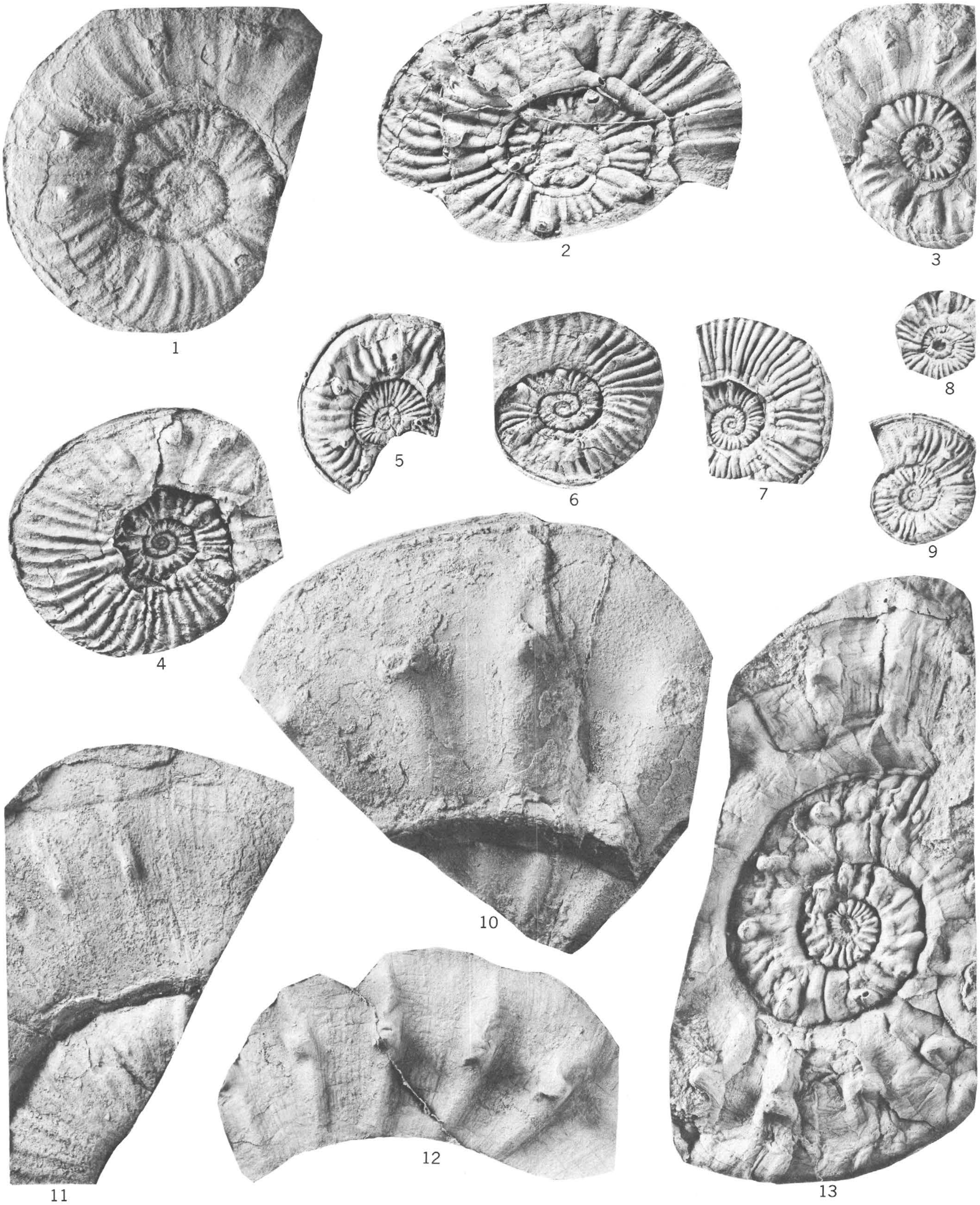
POECILOMORPHUS AND *SONNINIA (EUHOPLOCERAS)*

PLATE 26

[All figures are natural size. Specimens shown in figs. 1, 11, and 12 are from the Warm Springs Member and in fig. 10 from the Weberg Member of the Snowshoe Formation in the Suplee area. All others are from the middle part of the Snowshoe Formation in the Seneca area, Oreg. Figs. 2, 5, 7–9, 12, and 13 are from rubber imprints of external molds]

FIGURES 1–10, 12, 13. *Sonninia* (*Papilliceras*) *stantoni* (Crickmay) (p. 68).
Specimens shown in figures 4–9, 13 are from Luper's loc. 57.
1. Hypotype, USNM 168518 from USGS Mesozoic loc. 29241.
2. Hypotype, USNM 168521 from USGS Mesozoic loc. 21617.
3. Hypotype, CAS 13407 from Lupher's loc. 311.
4. Hypotype, CAS 13405.
5. Hypotype, CAS 13404.
6. Hypotype, CAS 13410.
7. Hypotype, CAS 13408.
8. Hypotype, CAS 13411.
9. Hypotype, CAS 13409.
10. Hypotype, USNM 168520 from USGS Mesozoic loc. 21611.
12. Hypotype, USNM 168519 from USGS Mesozoic loc. 29241.
13. Hypotype, CAS 13406.

11. *Sonninia* (*Papilliceras*) cf. *S.* (*P.*) *arenata* (Quenstedt) (p. 68).
Specimen, USNM 168552 from USGS Mesozoic loc. 29241.



SONNINIA (PAPILLICERAS)

PLATE 27

[All figures are natural size. Specimen shown in fig. 1 is from the Warm Springs Member of the Snowshoe Formation in the Suplee area. Specimens shown in figs. 2 and 3 are from the lower member of that formation in the Izee area and in figs. 4–6 are from the Weberg Member of the Snowshoe Formation]

FIGURE 1. *Sonninia* (*Papilliceras*) cf. *S.* (*P.*) *juramontana* (Crickmay) (p. 69).
Specimen, CAS 13412 from Lupher's loc. 206.

2, 3. *Planammatoceras*? spp. (Buckman) (p. 61).
2. Rubber imprint of external mold of specimen USNM 168511a from USGS Mesozoic loc. 26753.
3. Internal mold of specimen, USNM 168511b from USGS Mesozoic loc. 26753.

4–6. *Sonninia* (*Papilliceras*) cf. *S.* (*P.*) *espinazitensis* Tornquist (p. 69).
4. Specimen, USNM 168523 from USGS Mesozoic loc. 26763.
5, 6. Specimen, CAS 13413 from Lupher's loc. 360.

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SONNINIA (PAPILLICERAS) AND *PLANAMMATOCERAS*?

PLATE 28

[All figures are natural size. Specimens shown in figs. 1 and 2 are from Warm Springs Member; in figs. 3, 4, and 6 from the lower part of the Basey Member; and in figs. 5 and 7 from the lower member of the Snowshoe Formation]

FIGURES 1–7. *Dorsetensia* cf. *D. subtexta* Buckman (p. 71).

1, 2. Lateral and apertural views of specimen, USNM 168536 from USGS Mesozoic loc. 29239. See other view on pl. 29, fig. 7.

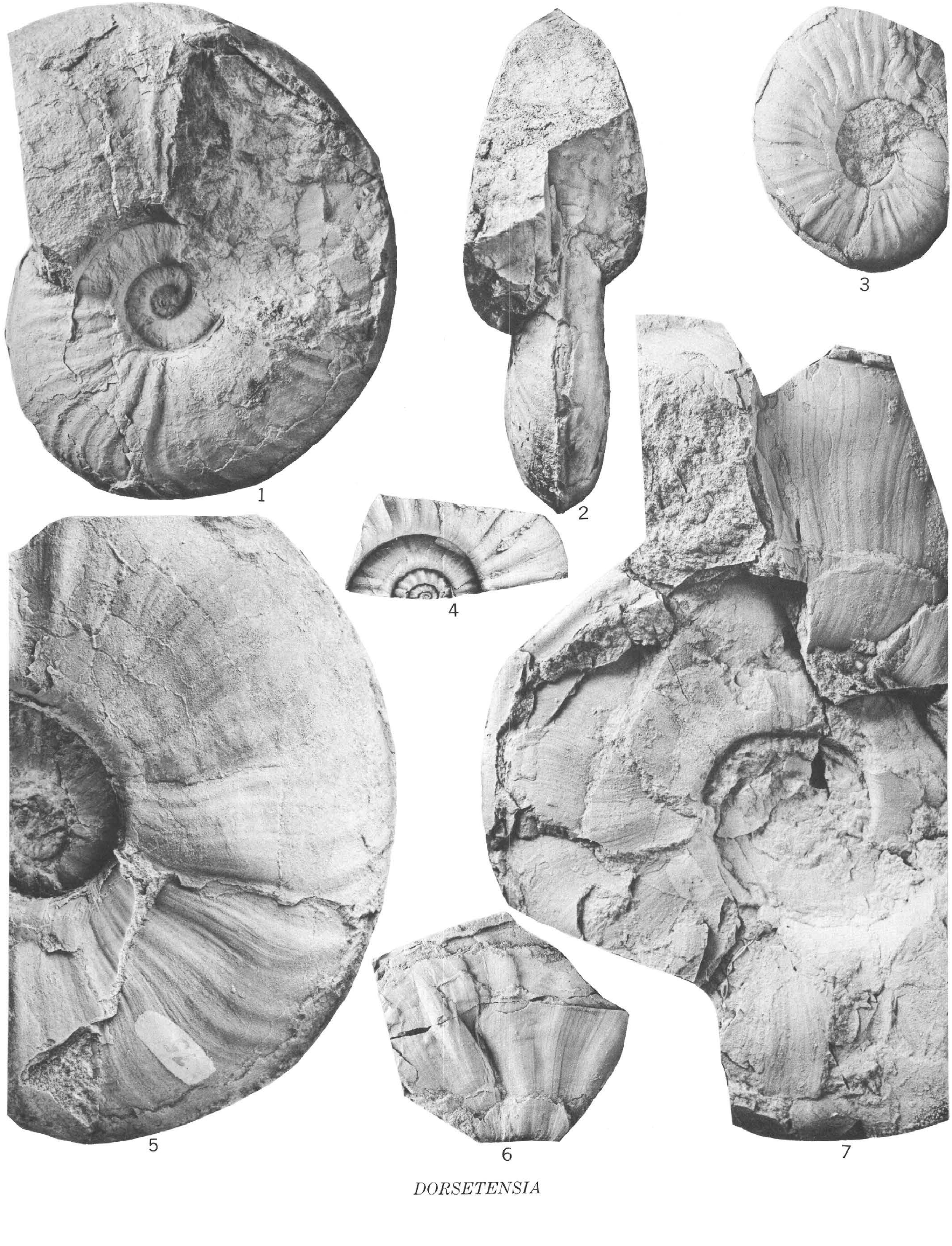
3. Rubber imprint of external mold, USNM 168535a from USGS Mesozoic loc. 29812.

4. Rubber imprint of external mold, USNM 168535b from USGS Mesozoic loc. 29812.

5. External mold, CAS 13430 from Lupher's loc. 75. Outer whorl is nonseptate.

6. Internal mold bearing some shell material, USNM 168535c from USGS Mesozoic loc. 29812.

7. Crushed internal mold bearing some shell material, CAS 13431 from Lupher's loc. 75.



DORSETENSIA

PLATE 29

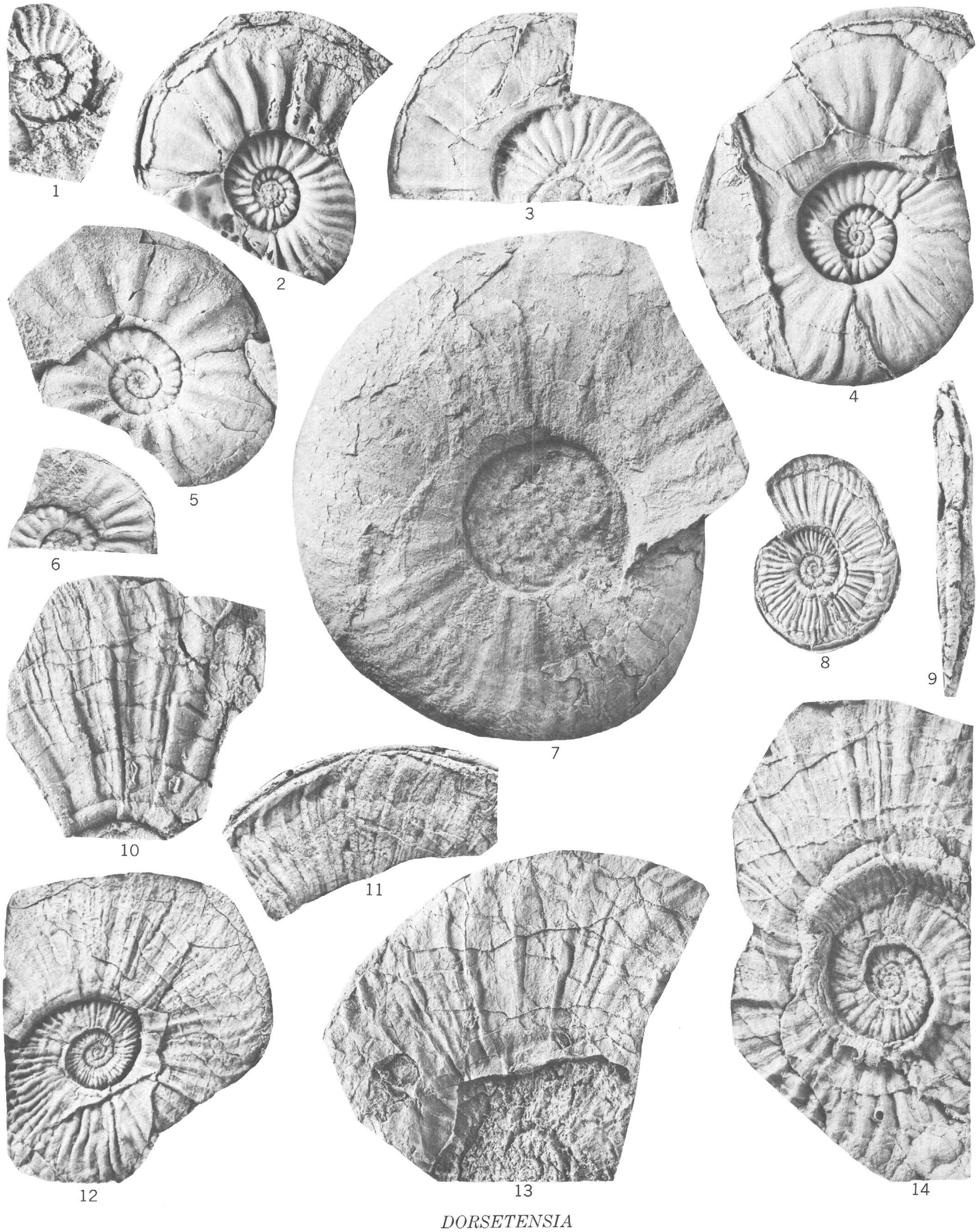
[All figures are natural size. Specimens shown in figs. 1–4 and 8–14 are from the lower exposed part of the Snowshoe Formation near Seneca. Those shown in figs. 5–7 are from the Warm Springs Member of the Snowshoe Formation]

FIGURES 1–4. *Dorsetensia oregonensis* Imlay, n. sp. (p. 72).
All specimens are from Lupher's loc. 272.
1. Paratype, CAS 13435.
2. Rubber imprint of external mold of paratype, CAS 13434.
3. Rubber imprint of external mold of paratype, CAS 13433.
4. Rubber imprint of external mold of holotype, CAS 13432.

5, 6. *Dorsetensia* cf. *D. complanata* Buckman (p. 72).
External molds, USNM 168537 a, b from USGS Mesozoic loc. 29396.

7. *Dorsetensia* cf. *D. subtexta* Buckman (p. 71).
Specimen, USNM 168536 from USGS Mesozoic loc. 29239. See other views on pl. 28, figs. 1, 2.

8–14. *Dorsetensia diversistriata* Imlay, n. sp. (p. 73).
All specimens are from Lupher's loc. 57.
8. Rubber imprint of external mold of paratype, CAS 13440.
9, 11. Rubber imprint of external mold of paratype, CAS 13438.
10. Paratype, CAS 13441.
12. Rubber imprint of external mold of paratype, CAS 13437.
13. Paratype, CAS 13439.
14. Rubber imprint of external mold of holotype, CAS 13436.



DORSETENSIA

PLATE 30

[All figures are natural size. Specimens shown in figs. 1–4, 7–9, and 11 are from near the top of the Warm Springs Member of the Snowshoe Formation in the Suplee area; in figs. 5 and 6 from 60 feet below the top of the middle member of the Snowshoe Formation in the Izee area; in figs. 10 and 12 from the lower 300 feet of the BaseyMember of the Snowshoe Formation in the Suplee area. Specimen shown in fig. 13 is described below]

FIGURES 1–4, 7, 8. *Dorsetensia* cf. *D. pulchra* Buckman (p. 71).

1–3, 7, 8. Laterally crushed specimens, USNM 168534a-e from USGS Mesozoic loc. 29241. Figures 1 and 3 are rubber imprints of external molds.

4. Rubber imprint of external mold, CAS 13429 from Lupher's loc. 109.

5, 6. *Dorsetensia* sp. undet. (p. 72).

Undeformed internal mold with some shell adhering. Specimen, CAS 13442 from Lupher's loc. 128.

9–12. *Dorsetensia* aff. *D. edouardiana* (d'Orbigny) (p. 72).

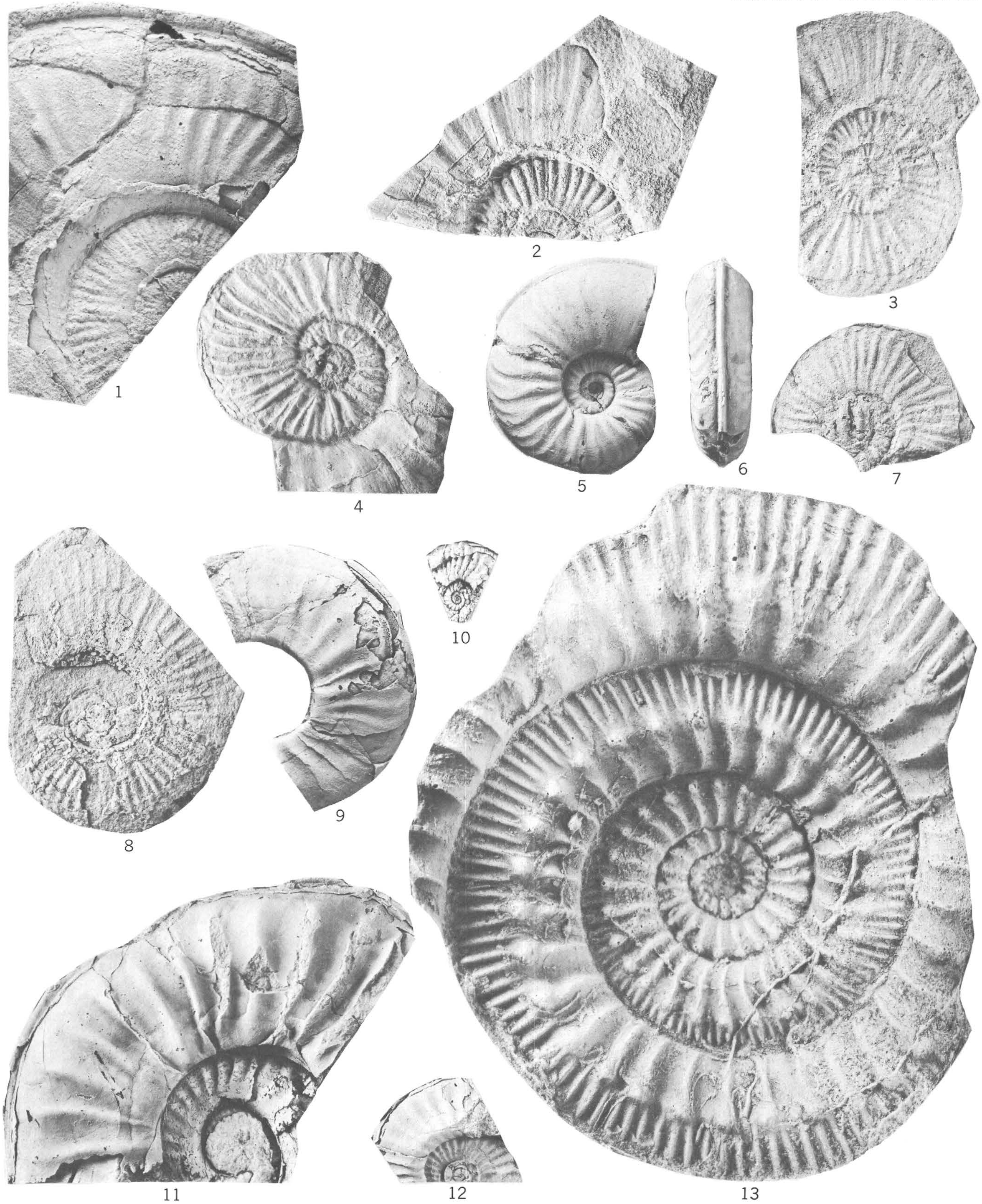
9. Internal mold, Stanford Univ. Mus. Paleontology 10025 from Dickinson's loc. 97.

10, 12. Small internal whorls, USNM 168538a,b from USGS Mesozoic loc. 29812.

11. Internal mold, Stanford Univ. Mus. Paleontology 10037 from Dickinson's loc. 97.

13. *Stephanoceras* (*Skirroceras*) *kirschneri* Imlay (p. 87).

Rubber imprint of hypotype, 168603 from USGS Mesozoic loc. 20017 in the Fitz Creek Siltstone, 1.08 miles N. 84.4° W. from mouth of Fitz Creek, Iniskin Peninsula, Alaska. Included for comparative purposes.



DORSETENSIA AND *STEPHANOCERAS (SKIRROCERAS)*

PLATE 31

[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation and represent a coarsely ribbed, tuberculate variant of the species]

FIGURES 1–12. *Witchellia (Latiwitchellia) evoluta* Imlay, n. sp. (p. 70).

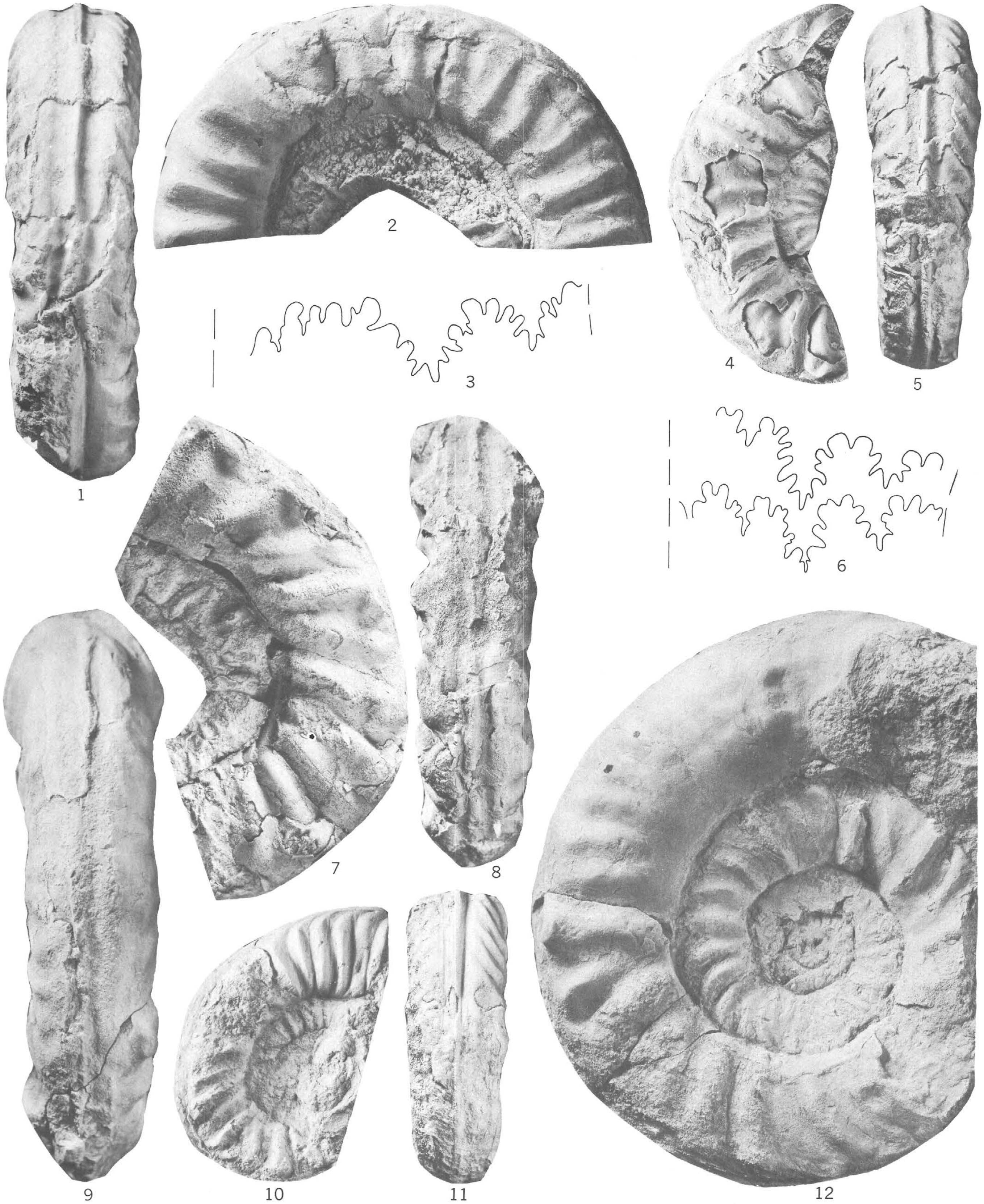
1–3. Ventral and lateral views and suture line of internal mold. Paratype, CAS 13419 from Lupher's loc. 228N. Suture line (X 2) drawn at whorl height of 21 mm near adapical end of specimen and of body chamber. Note ventral swellings on some ribs.

4, 5. Internal mold of paratype, CAS 13425 from Lupher's loc. 355. One spirally elongate tubercle present at adapical end.

6, 10, 11. Suture lines (× 2) and lateral and ventral views of septate whorls. Paratype, CAS 13426 from Lupher's loc. 361. Some ribs terminate in ventral swellings.

7, 8. Internal mold of paratype, CAS 13424 from Lupher's loc. 307. Note spirally elongate swelling near ventral ends of backwardly inclined ribs.

9, 12. Internal mold of adult. Paratype, CAS 13420 from Lupher's loc. 228N. Note that aperture is constricted on flanks and prolonged on the venter.



WITCHELLIA (LATIWITCHELLIA)

PLATE 32

[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation, bear ribbing of intermediate strength for the species, and do not bear tubercles]

FIGURES 1–11. *Witchellia (Latiwitchellia) evoluta* Imlay, n. sp. (p. 70).

1, 2, 5, 6. Ventral, lateral, and apertural views and suture line (× 2) of adult. Holotype, USNM 168530 from USGS Mesozoic loc. 29828. Holotype is mostly an internal mold but includes some shelly material. Suture line drawn from adapical end of body chamber which occupies about three-fifths of a whorl.

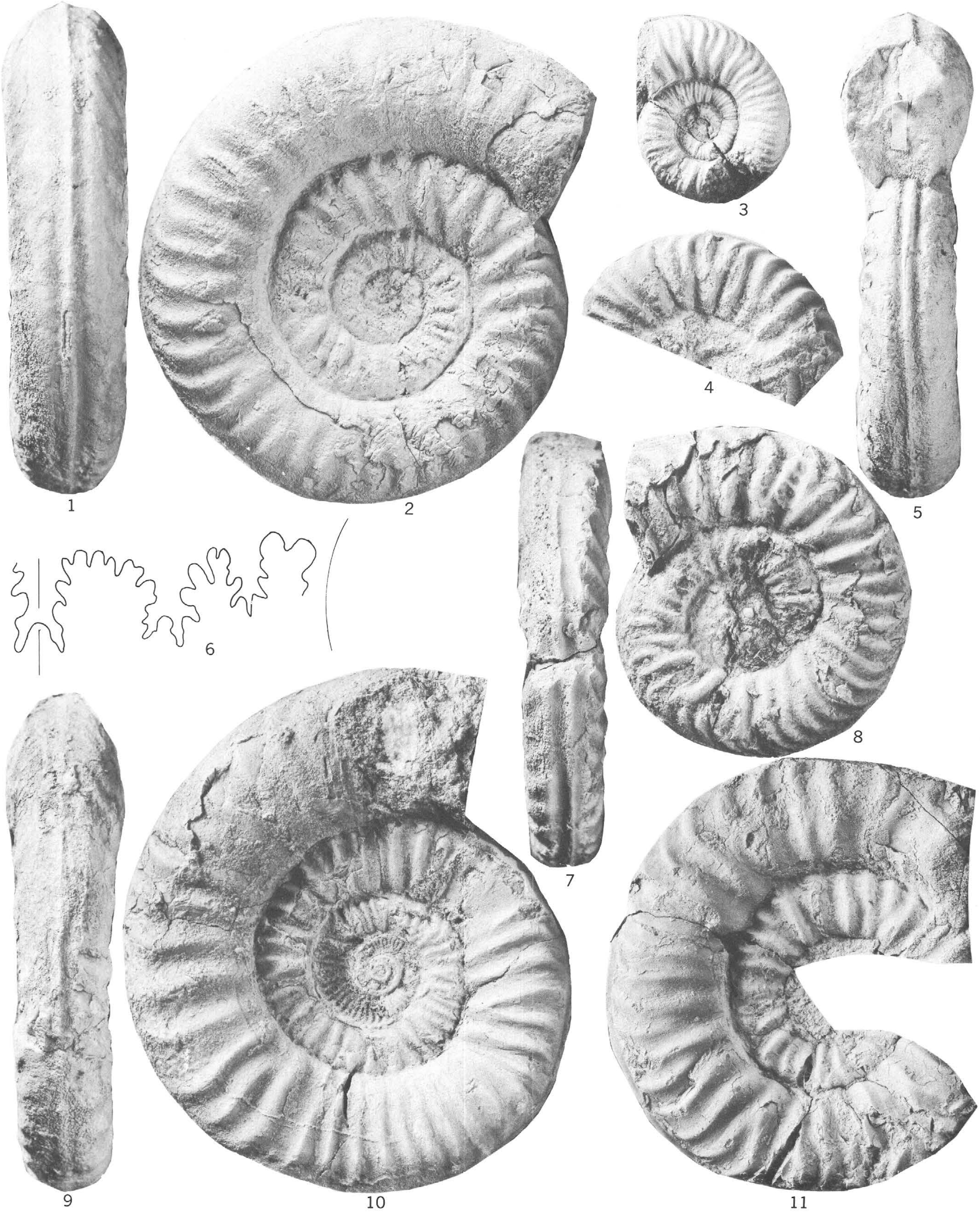
3. Small septate paratype, USNM 168531 from USGS Mesozoic loc. 29828.

4. Slightly larger septate paratype, CAS 13421 from Lupher's loc. 228N.

7, 11. Laterally compressed internal mold shows apertural constriction. Paratype, CAS 13427 from Lupher's loc. 563.

8. Internal mold of small septate specimen retaining some shell material. Paratype, CAS 13416 from Lupher's loc. 228.

9, 10. Internal mold of adult retaining some shell material. Note apertural prolongation on venter. Paratype, CAS 13423 from Lupher's loc. 228W.



WITCHELLIA (LATIWITCHELLIA)

PLATE 33

[All figures are natural size. All specimens are from the Weberg Member of the Snowshoe Formation and represent a finely ribbed variant of the species. The specimens shown in figs. 4, 5, 7, and 8 become coarser ribbed rather abruptly, whereas the other specimens become coarser ribbed more gradually]

FIGURES 1–12. *Witchellia (Latiwitchellia) evoluta* Imlay, n. sp. (p. 70).

1, 2. Immature internal mold retaining considerable shell material. Paratype, USNM 168533 from USGS Mesozoic loc. 26766.

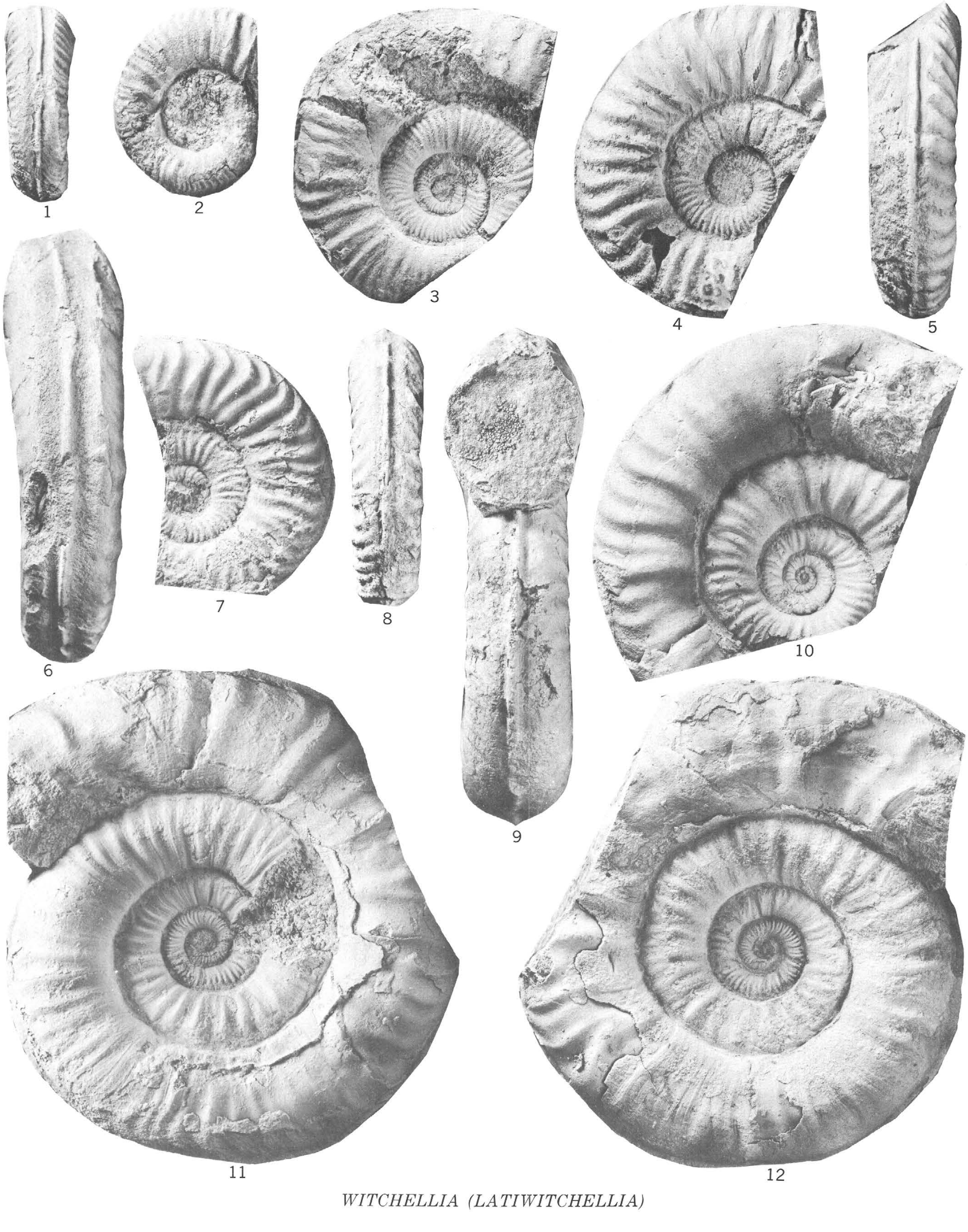
3. Internal mold retaining considerable shell material. Paratype, CAS 13417 from Lupher's loc. 228.

4, 5. Internal mold of paratype, CAS 13422 from Lupher's loc. 228N.

6, 10. Internal mold retaining considerable shell material. Paratype, CAS 13428 from Lupher's loc. 584. Note apertural constriction.

7, 8. Internal mold of paratype, CAS 13418 from Lupher's loc. 228.

9, 11, 12. Apertural and lateral views of adult internal mold retaining much shell material. Paratype, USNM 168532 from USGS Mesozoic loc. 29828.



WITCHELLIA (LATIWITCHELLIA)

PLATE 34

[All figures natural size unless otherwise indicated. Specimens shown in figs. 1–4, 10, 11, and 15–17 are from the Basey Member of the Snowshoe Formation; in figs. 5–9, 12, 14, and 18 from the lower exposed part of the Snowshoe Formation south of Seneca; in fig. 13 from the lower member of the Snowshoe Formation near Izee; and in figs. 19–34 from the Weberg Member of the Snowshoe Formation in the Suplee area]

FIGURES 1–4. *Pelekodites dobsonensis* Imlay, n. sp. (p. 74).

From USGS Mesozoic locality 29816.

1. Rubber imprint of compressed external mold of paratype, USNM 168552.
2. Rubber imprint of compressed external mold of paratype, USNM 168550.
3. Paratype, USNM 168551.
4. Rubber imprint of compressed external mold of holotype, UNSM 168549.

5–18. *Pelekodites silviesensis* Imlay, n. sp. (p. 74).

Specimens in figures 5–8 are from Lupher's loc. 272.

5. Holotype, CAS 13446. Note lateral lappet.
6. Rubber imprint of external mold of paratype, CAS 13450.
7. Rubber imprint of external mold of paratype, CAS 13448.
8. Paratype, CAS 13447. Note keel.
9. Paratype, CAS 13453 from Lupher's loc. 57.
10. Paratype, USNM 168547 from USGS Mesozoic loc. 29812.
11. Paratype, USNM 168548 from USGS Mesozoic loc. 29812.
12. Paratype, CAS 13452 from Lupher's loc. 57.
13. Paratype, USNM 168544 from USGS Mesozoic loc. 29230. Note lateral lappet.
14. Paratype, CAS 13451 from Lupher's loc. 57. Note lateral lappet.

15, 16. Rubber imprint of external mold showing lateral lappet and internal mold (fig. 16) of paratype, USNM 168545 from USGS Mesozoic loc. 29818.

17. Rubber imprint of external mold showing lateral lappet. Paratype, USNM 168546 from USGS Mesozoic loc. 29812.
18. Rubber imprint of external mold showing part of lateral lappet. Paratype, CAS 13449 from Lupher's loc. 272.

19–34. *Pelekodites webergi* Imlay, n. sp. (p. 73).

19. Paratype, Stanford Univ. Mus. Paleontology 10026 from Vigrass' loc. 205.
20. Paratype, USNM 168543 from USGS Mesozoic loc. 26766.

21, 30. Fragment of body chamber showing high, narrow keel. Paratype, USNM 168542 from USGS Mesozoic loc. 26766.

22, 23. Compressed internal mold bearing much shell material. Paratype, CAS 13444 from Lupher's loc. 370.

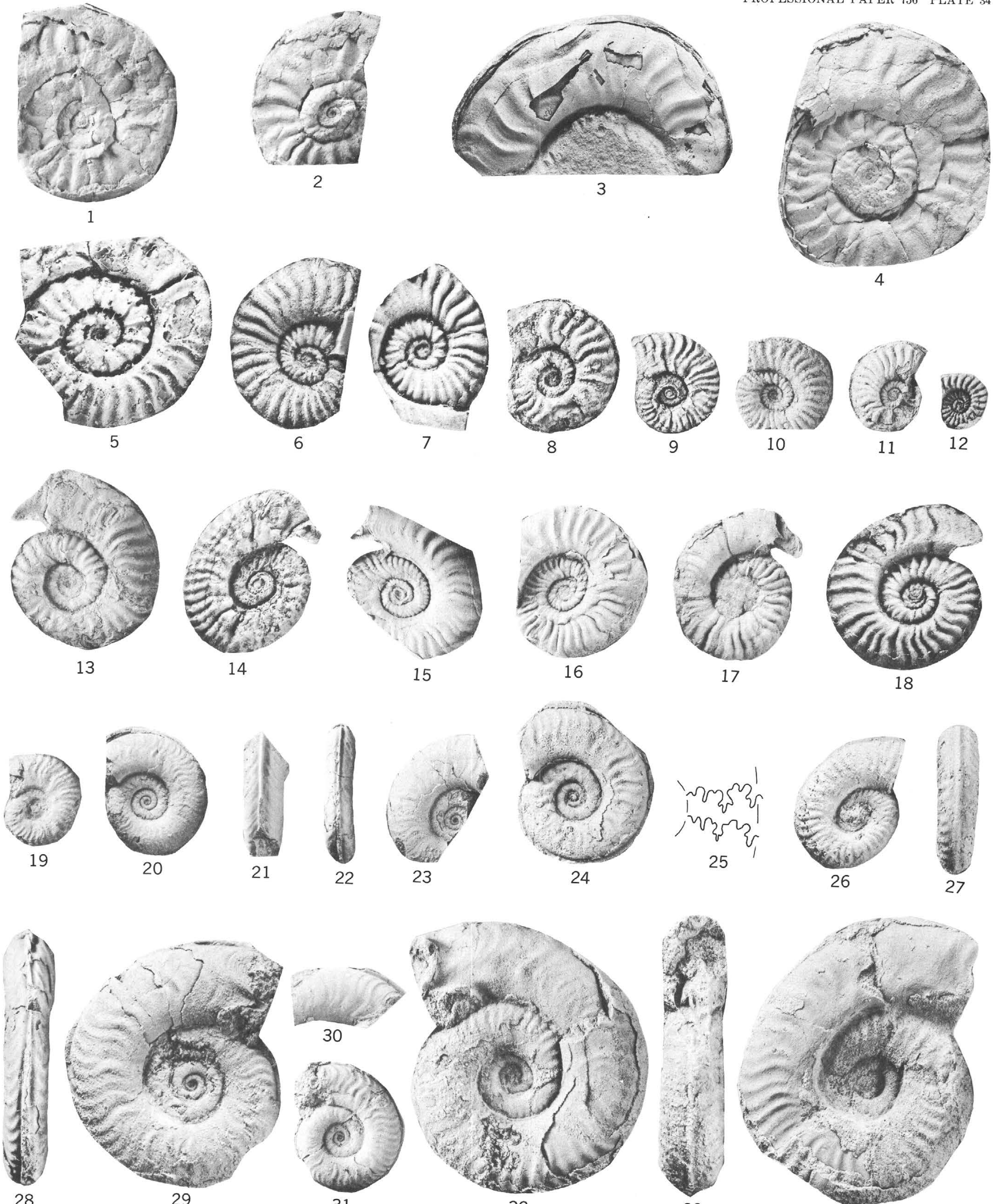
24. Internal mold (× 2) bearing some shell material. Paratype, USNM 168540 from USGS Mesozoic loc. 26766.

25–27. Suture line (× 2) from adoral end of internal mold shown on figures 26 and 27 (also × 2). Paratype, CAS 13445 from Lupher's loc. 474.

28, 29, 31. Ventral and lateral views (× 2 and × 1) of holotype, CAS 13443 from Lupher's loc. 370. Figure 29 shows distinct lateral lappet. Specimen retains much shell material.

32, 33. Internal mold (× 2) retaining much shell material except for body chamber. Paratype, USNM 168539 from USGS Mesozoic loc. 21612. Note lateral lappet.

34. Internal mold retaining some shell material and bears lateral lappet. Paratype, USNM 168541 from USGS Mesozoic loc. 26766.



PELEKODITES

PLATE 35

[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation]

FIGURES 1–9, 11–14. *Praestrigites* cf. *P. deltotus* (Buckman) (p. 75).

1, 2. Immature specimen (× 2) retaining much shell material, USNM 168555a from USGS Mesozoic loc. 21610.

3, 5–7. Suture line (× 2), ventral, lateral, and apertural views of septate internal mold, CAS 13469 from Lupher's loc. 228N. Suture line drawn from near adoral end at whorl height of 47 mm.

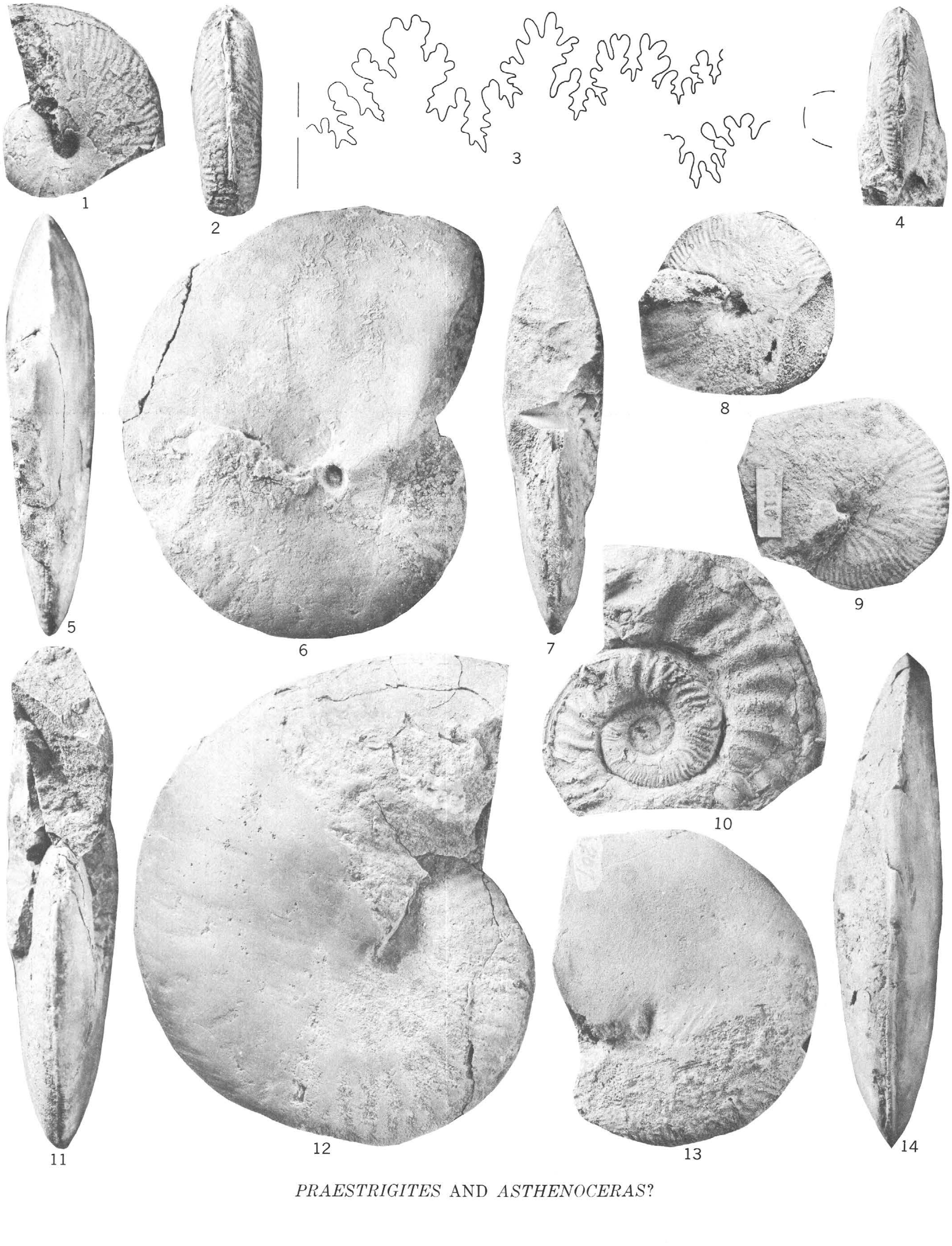
4, 8, 9. Fairly small specimen retaining much shell material, USNM 168555b from USGS Mesozoic loc. 21610. Shows characteristic ribbing where shell is present.

11, 12, 14. Apertural, lateral, and ventral views of mostly septate internal mold, CAS 13470 from Lupher's loc. 228N. Note broad, faint ribs that fade out adorally. Incomplete body chamber probably represented near crushed adoral end.

13. Small weathered internal mold, CAS 13468 from Lupher's loc. 207.

10. *Asthenoceras*? sp. (p. 56).

Specimen, USNM 168505 from USGS Mesozoic loc. 21611. Note lateral lappet and change from fine to coarse ribbing near beginning of body chamber.



PRAESTRIGITES AND *ASTHENOCERAS*?

PLATE 36

[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation]

FIGURES 1–4, 8–10. *Hebetoxyites* cf. *H. hebes* Buckman (p. 76).

1–4. Septate internal mold retaining some shell material, CAS 13474 from Lupher's loc. 475.

8–10. Suture line (× 2) and ventral and lateral views of internal mold, CAS 13473 from Lupher's loc. 225. In figure 9 the adoral end is pointed downward.

5–7, 11, 12. *Lissoceras?* sp. (p. 77).

Lateral, apertural, and ventral views and suture line (all views × 2) of specimen, USNM 168558 from USGS Mesozoic loc. 21610. About one-eighth of whorl is nonseptate. Suture line drawn at whorl height of 8.5 mm near adapical end of outer whorl.

13, 17–21. *Strigoceras* cf. *S. languidum* (Buckman) (p. 76).

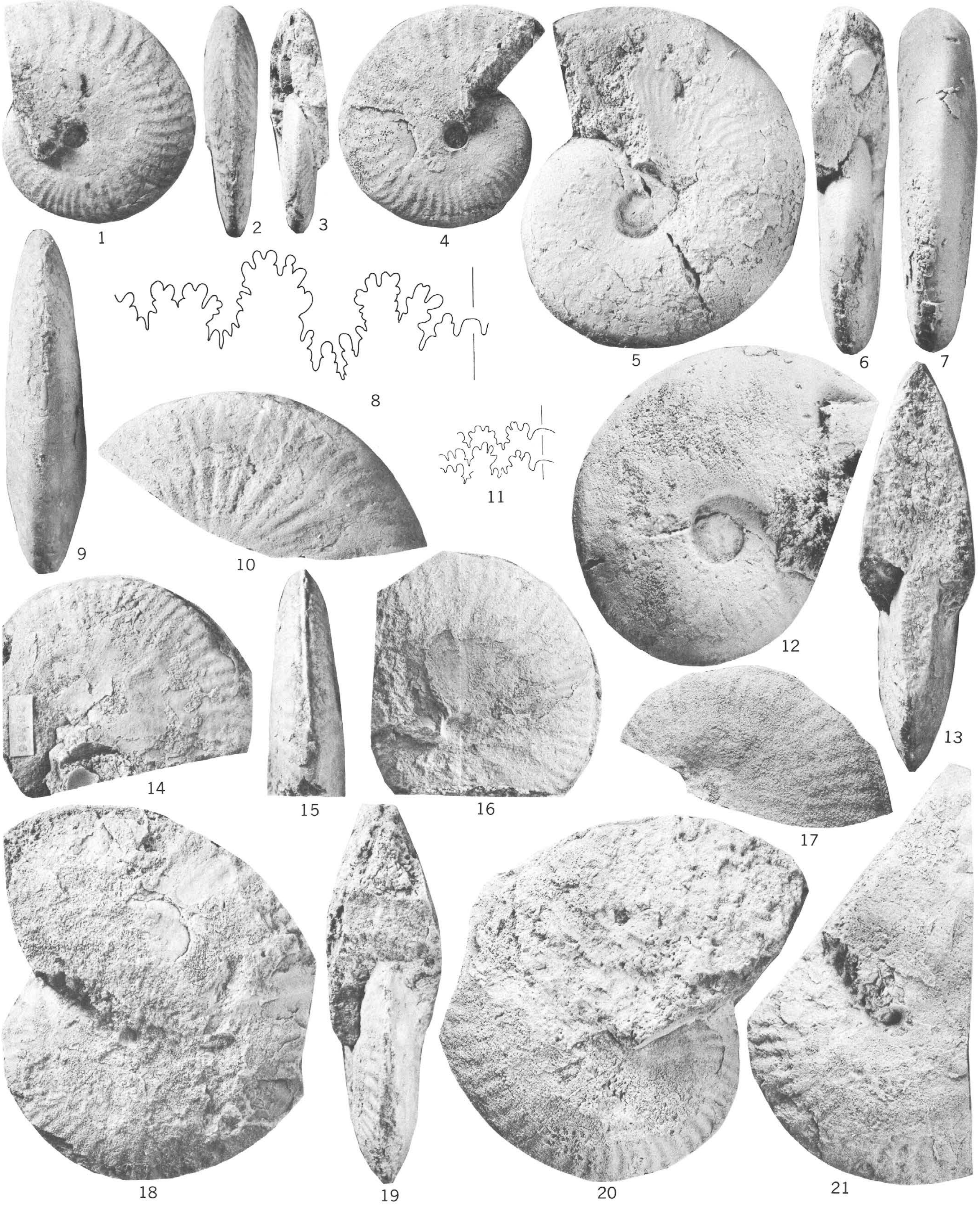
13, 21. Apertural and lateral views of internal mold, Stanford Univ. Mus. Paleontology 10027 from Vigrass' loc. 205.

17. Lateral view of fragment of internal mold, CAS 13471 from Lupher's loc. 371.

18–20. Lateral and apertural views of weathered internal mold, CAS 13472 from Lupher's loc. 460.

14–16. *Strigoceras* sp. undet. (p. 76).

Lateral and ventral views of internal mold, USNM 168556 from USGS Mesozoic loc. 26766. In figure 15 the adoral end is pointed downward.



HEBETOXYITES, *LISSOCERAS*?, AND *STRIGOCERAS*

PLATE 37

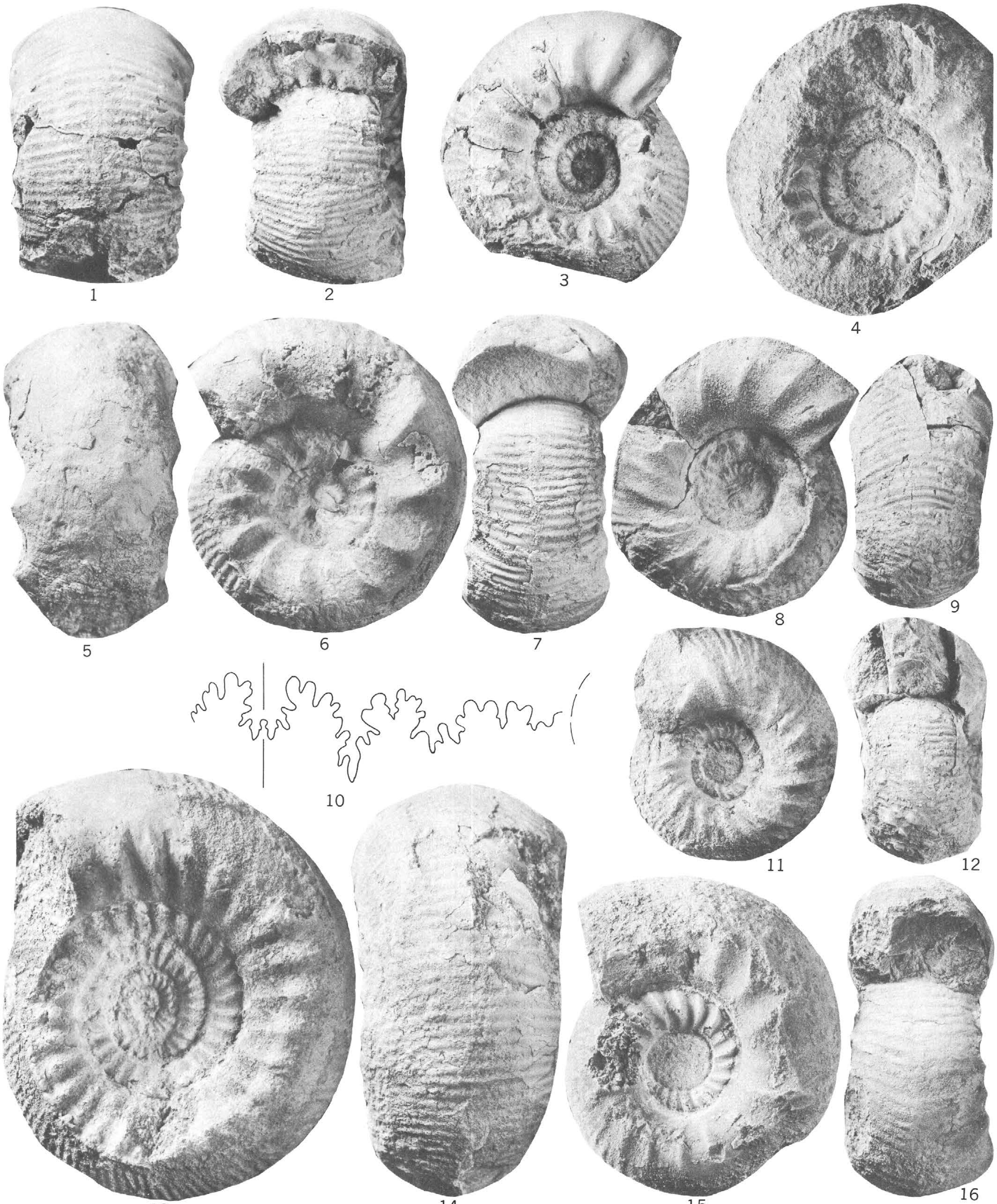
[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation]

FIGURES 1–3, 5–12, 15, 16. *Docidoceras sparsicostatum* Imlay, n. sp. (p. 79).

- 1–3. Septate internal mold. Paratype, CAS 13491 from Lupher's loc. 368.
- 5–7. Holotype, Stanford Univ. Mus. Paleontology 10028 from Vigrass' loc. 87. Body chamber represents only one-fourth of outer whorl shown in figure 6, but most of that chamber is fragmentary and is not illustrated.
- 8, 9, 11, 12. Paratype, USNM 168560 from USGS Mesozoic loc. 26760. Nearly half of the outer whorl shown in figure 8 is nonseptate.
- 10, 15, 16. Suture line (× 2) and lateral and ventral views of paratype, CAS 13490 from Lupher's loc. 212. Suture line drawn at whorl height of 16 mm about three-fourths whorl from adoral end of specimen.

4, 13, 14. *Docidoceras* cf. *D. liebi* Maubeuge (p. 79).

- 4. Specimen, CAS 13493 from Lupher's loc. 575. Shows fine ribbing on small septate whorl.
- 13, 14. Specimen, CAS 13492 from Lupher's loc. 575. Shows fairly fine ribbing and stoutness of outer septate whorl. The specimen also includes a fragment of the body whorl which is not illustrated.



DOCIDOCERAS

PLATE 38

[All figures natural size unless otherwise indicated. All specimens shown except figs. 10 and 11 are from the Weberg Member of the Snowshoe Formation]

FIGURES 1–7, 13. *Docidoceras warmspringsensis* Imlay, n. sp. (p. 78).

1–3, 13. Crushed adult internal mold. Paratype, CAS 13488 from Lupher's loc. 228N. Suture line (× 2) drawn near adapical end of outer whorl. Note apertural constriction.

4, 5. Partly crushed adult internal mold. Holotype, CAS 13487 from Lupher's loc. 228N. Note apertural constriction followed by swelling.

6, 7. Paratype, CAS 13489 from Lupher's loc. 352.

8, 9, 12, 14–17. *Docidoceras lupheri* Imlay, n. sp. (p. 78).

8, 12. Small septate paratype, CAS 13486 from Lupher's loc. 228.

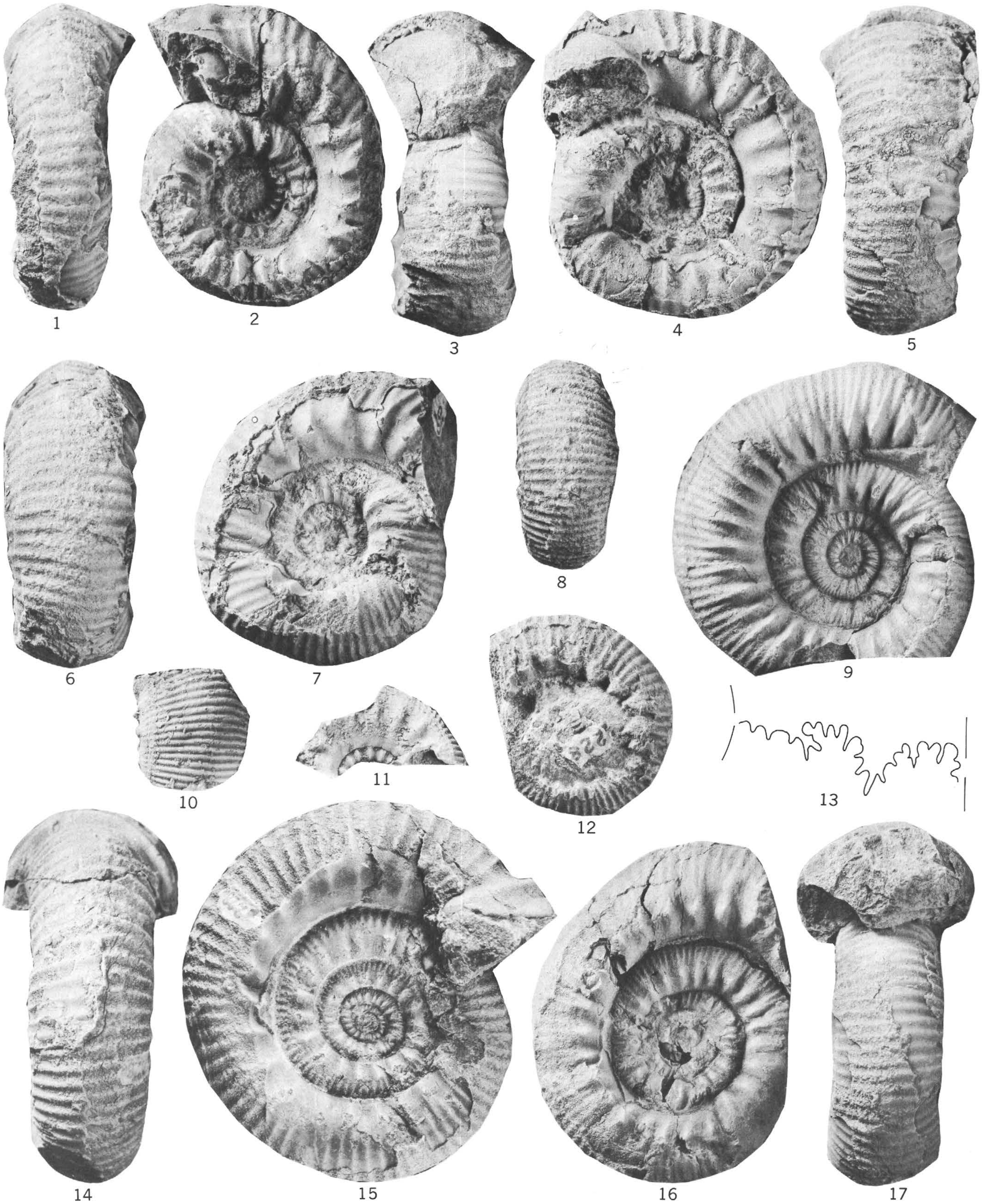
9. Paratype, USNM 168559 from USGS Mesozoic loc. 29828. Internal mold retains much shell material that shows details of ornamentation on inner whorl. About half of outer whorl is non-septate.

14, 15, 17. Holotype, CAS 13484 from Lupher's loc. 228N. Complete body chamber occupies almost an entire whorl.

16. Deformed paratype, CAS 13485 from Lupher's loc. 103.

10, 11. *Docidoceras*? cf. *D. paucinodosum* Westermann (p. 32).

Rubber imprint of external mold of specimen, USNM 168561 from USGS Mesozoic loc. 21293, 1200 feet below top of Red Glacier Formation and 1.35 miles N. 52° W. of mouth of Fitz Creek, Iniskin Peninsula, Alaska. Discussed under *Comparisons With Other Faunas*.



DOCIDOCERAS AND *DOCIDOCERAS*?

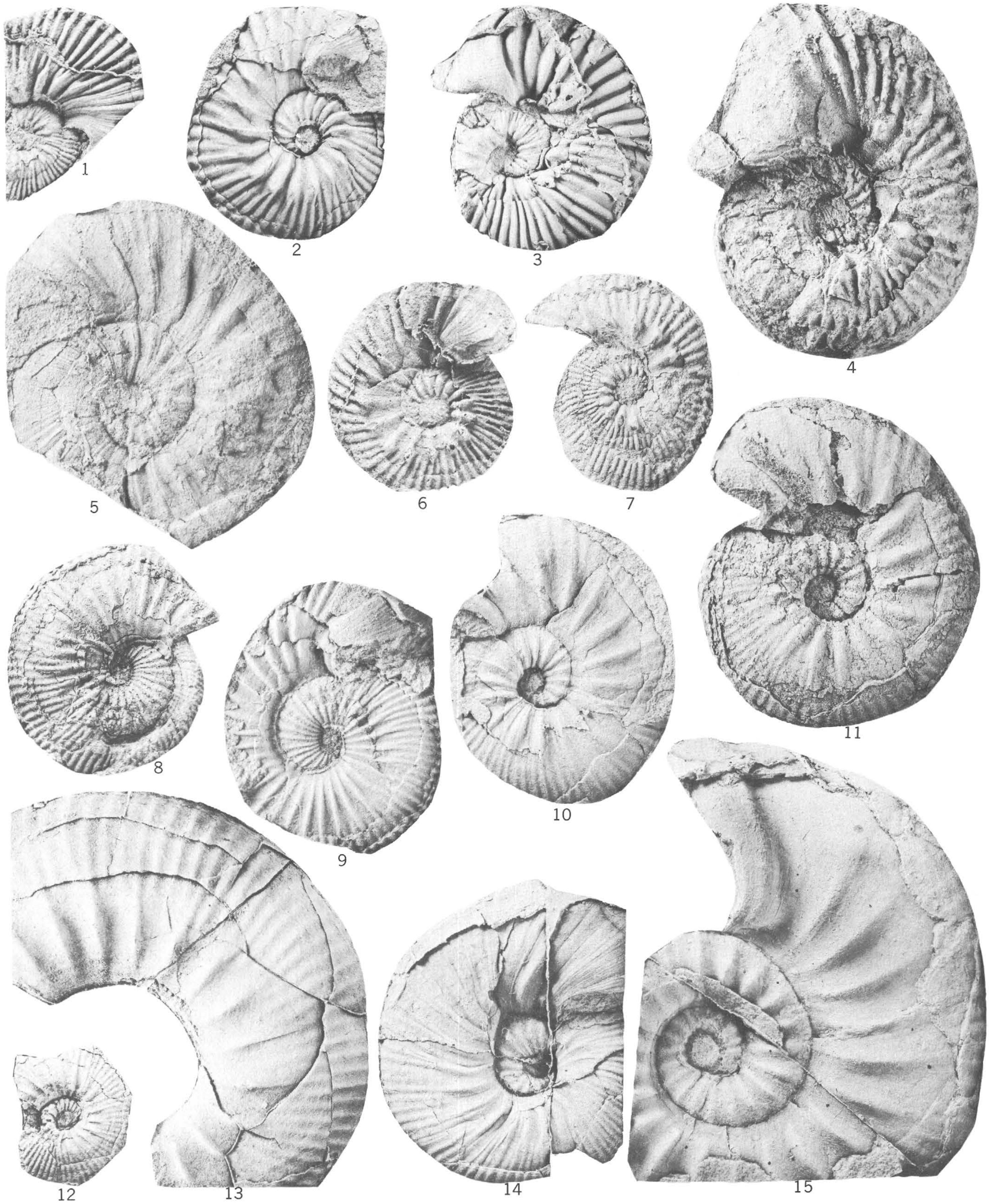
PLATE 39

[All figures are natural size. All specimens shown are from the Warm Spring Member of the Snowshoe Formation]

FIGURES 1–4, 6, 7. *Otoites contractus* (J. de C. Sowerby) (p. 81).
Specimens except those in figures 3 and 4 are from USGS Mesozoic loc. 29241.
1. Rubber imprint of external mold of hypotype, USNM 168570. Represents a finely ribbed variant.
2. Rubber imprint of external mold of hypotype, USNM 168569.
3. Rubber imprint of external mold of hypotype, USNM 168572 from USGS Mesozoic loc. 29395.
4. Hypotype, USNM 168571 from USGS Mesozoic loc. 29395.
6. Rubber imprint of external mold of hypotype, USNM 168568.
7. Hypotype, USNM 168567. Represents a finely ribbed variant.

5, 12, 14. *Emileia* sp. undet. (p. 80).
5. Rubber imprint of external mold of adult, USNM 168566a from USGS Mesozoic loc. 29241. Note apertural constriction.
12. Immature specimen, Stanford Univ. Mus. Paleontology 10029 from Dickinson's loc. 94.
14. Rubber imprint of external mold, USGS 168566b from USGS Mesozoic loc. 29241.

8–11, 13, 15. *Emileia buddenhageni* Imlay, n. sp. (p. 80).
Specimens shown are from USGS Mesozoic loc. 29241.
8–9. Internal mold and rubber imprint of external mold. Holotype, USNM 168562.
10, 11. Rubber imprint of internal mold and external mold (fig. 11) USNM 168563.
13. Paratype, USNM 168565
15. Rubber imprint of external mold of paratype, USNM 168564.



OTOITES AND *EMILEIA*

PLATE 40

[All figures natural size unless otherwise indicated. Specimens shown in figs. 1 and 2 are from the Warm Springs Member of Snowshoe Formation; in figs. 3, 24–33 from the lower part of the Snowshoe Formation south of Senaca; in figs. 4–10 from the top of the middle part of the Snowshoe Formation south of Senaca; in figs. 11, 14–16 from the Basey Member of the Snowshoe Formation; in fig. 12 from Snowshoe Formation near Emigrant Creek in beds equivalent to middle part of Snowshoe Formation of Senaca area; and in figs. 13, 17–23 from highest part of Snowshoe Formation near Senaca]

FIGURES 1, 2. *Normannites* (*Masckeites*?) cf. *N.* (*M.*?) *densus* (Buckman) (p. 85).
From USGS Mesozoic loc. 29241.
1. Rubber imprint of external mold, USNM 168593a. Outer whorl is nonseptate.
2. Rubber imprint of external mold of adoral part of body chamber. Specimen, USNM 168593b.

3. *Normannites*? *kialagvikensis* Imlay (p. 85).
Rubber imprint of external mold of hypotype, CAS 13507 from Lupher's loc. 57. Note lateral lappet.

4–7. *Megasphaeroceras rotundum* Imlay (p. 82).
From Lupher's loc. 28.
4. Lateral view of septate whorl, CAS 13501.
5. Lateral view of septate whorl, CAS 13499.
6. Rubber imprint of external mold, CAS 13500.
7. Ventral view of crushed internal mold, CAS 13498.

8–10. *Chondroceras* n. sp. undet. (p. 82).
From Lupher's loc. 28.
8. Adult specimen, CAS 13496.
9. Adult specimen, CAS 13494.
10. Crushed body chamber, CAS 13495.

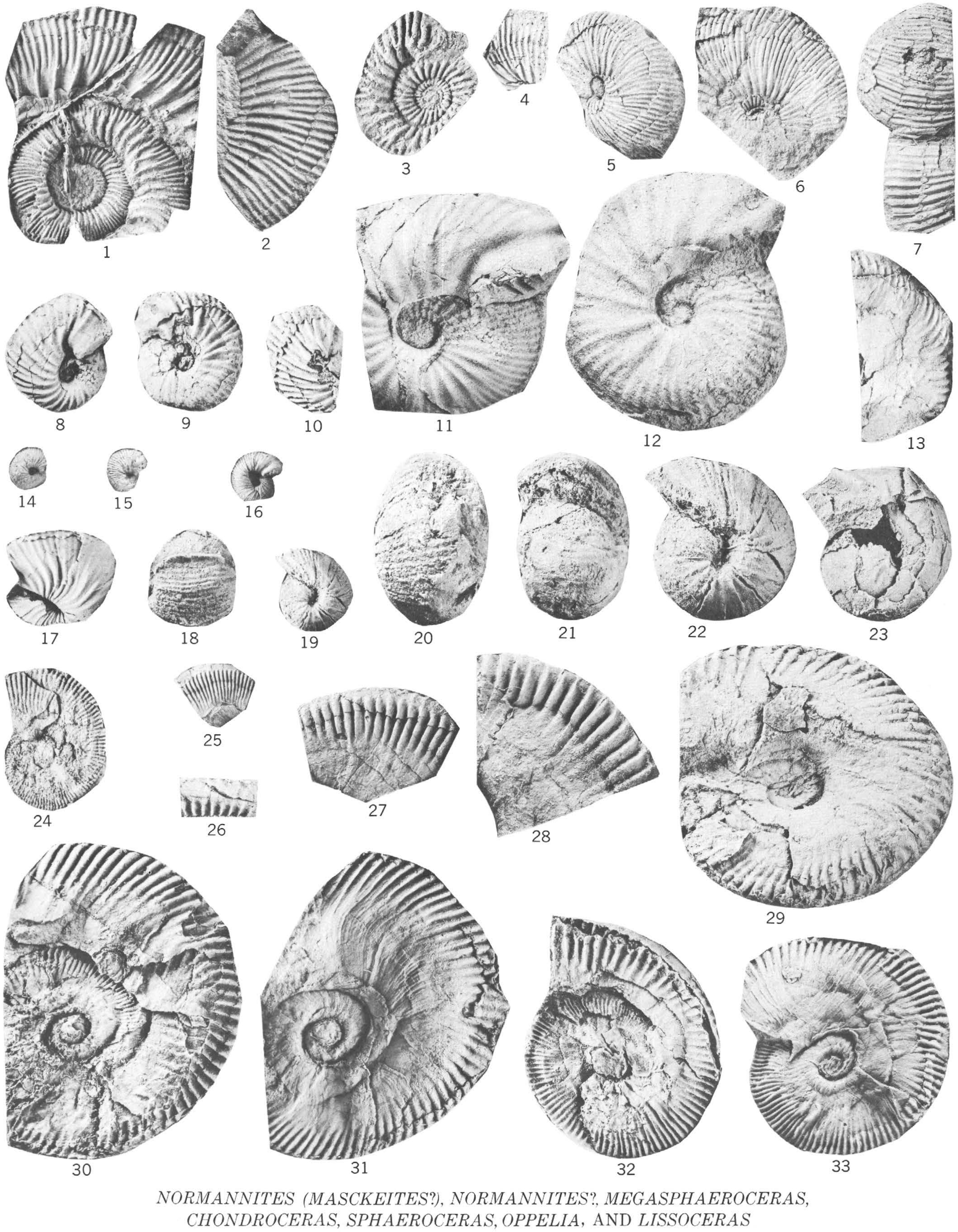
11, 12. *Chondroceras allani* (McLearn) (p. 81).
11. Adult hypotype, USNM 168574 from USGS Mesozoic loc. 28384.
12. Adult hypotype, USNM 168573 from USGS Mesozoic loc. 26770.

13. *Oppelia* cf. *O. subradiata* (J. de C. Sowerby) (p. 78).
Rubber imprint of external mold, CAS 13483 from Lupher's loc. 8.

14–16. *Sphaeroceras* sp. (p. 82).
14. Internal mold showing most of body chamber. Specimen, USNM 168579a from USGS Mesozoic loc. 29816.
15. Internal mold of adult, USNM 168579b from USGS Mesozoic loc. 29816. Note flared collar.
16. Internal mold of adult, USNM 168578 from USGS Mesozoic loc. 29813. Note flared collar.

17–23. *Sphaeroceras* cf. *S. brongniarti* (J. de C. Sowerby) (p. 81).
17. Rubber imprint of external mold showing most of body chamber. Specimen, USNM 168577 from USGS Mesozoic loc. 28017.
18. Ventral view of adoral part of body chamber. Specimen, USNM 168576 from USGS Mesozoic loc. 29236.
19–22. Lateral, ventral, and apertural views of undeformed internal mold of adult specimen, CAS 13497 from Lupher's loc. 8. Figures 20–22 (×2). Figure 22 shows same view as figure 19.
23. Lateral view of adult body chamber. Specimen, USNM 168575 from USGS Mesozoic loc. 28018.

24–33. *Lissoceras hydei* Imlay, n. sp. (p. 77).
Specimens shown, except in figure 29, are from Lupher's loc. 57.
24. Lateral view of small septate paratype, CAS 13478.
25. Lateral view of small fragment of internal mold showing smooth area along venter. Paratype, CAS 13481.
26. Ventral view of fragment showing smooth area along venter. Paratype, CAS 13482.
27. Lateral view showing smooth midventral area. Paratype, CAS 13480.
28. Lateral view of part of body whorl. Paratype, CAS 13479.
29. Internal mold retaining much shell material and representing most of adult body whorl. Paratype, USNM 168557 from USGS Mesozoic loc. 21617.
30, 31. Internal mold (fig. 30) and rubber imprint of external mold of adult body whorl. Holotype, CAS 13475.
32. Crushed internal and external molds of paratype, CAS 13476.
33. Rubber imprint of external mold of paratype, CAS 13477.



NORMANNITES (MASCKEITES?), NORMANNITES?, MEGASPHAEROCERAS, CHONDROCERAS, SPHAEROCERAS, OPPELIA, AND *LISSOCERAS*

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PLATE 41

[All figures are natural size. Specimens shown in figs. 1 and 18 are from the middle part of the Snowshoe Formation south of Seneca; in figs. 2–5, 9, 20, and 21 from equivalent beds near Emigrant Creek; in figs. 6–8, 17, and 19 from the lower part of the Snowshoe Formation south of Seneca; in fig. 10 from the Basey Member of the Snowshoe Formation; and in figs. 11–16 from the highest part of the Snowshoe Formation near Seneca]

FIGURE 1. *Normannites* (*Epalxites*) cf. *N.* (*E.*) *anceps* (Quenstedt) (p. 84).
Rubber imprint of external mold of specimen, USNM 168592 from USGS Mesozoic loc. 29413.

2–5. *Normannites* (*Itinsaites*) *crickmayi* (McLearn) (p. 83).
From USGS Mesozoic loc. 29410.
2. Rubber imprint of external mold of hypotype, USNM 168587.
3. Hypotype, USNM 168589. Note lateral lappet.
4. Hypotype, USNM 168588.
5. Hypotype, USNM 168586. Note lateral lappet.

6–8. *Normannites* (*Itinsaites*) aff. *N.* (*I.*) *itinsae* (McLearn) (p. 84).
From Lupher's loc. 272.
6. Specimen, CAS 13504. Note lateral lappet.
7. Specimen, CAS 13505. Outer half whorl is nonseptate.
8. Specimen, CAS 13506.

9, 10, 18, 20. *Normannites* (*Normannites*) *orbignyi* Buckman (p. 82).
9. Rubber imprint of external mold. Hypotype, USNM 168581 from USGS Mesozoic loc. 27579.
10. Hypotype, USNM 168583 from USGS Mesozoic loc. 29815.
18. Hypotype, USNM 168582 from USGS Mesozoic loc. 29415.
20. Hypotype, USNM 168580 from USGS Mesozoic loc. 26772.

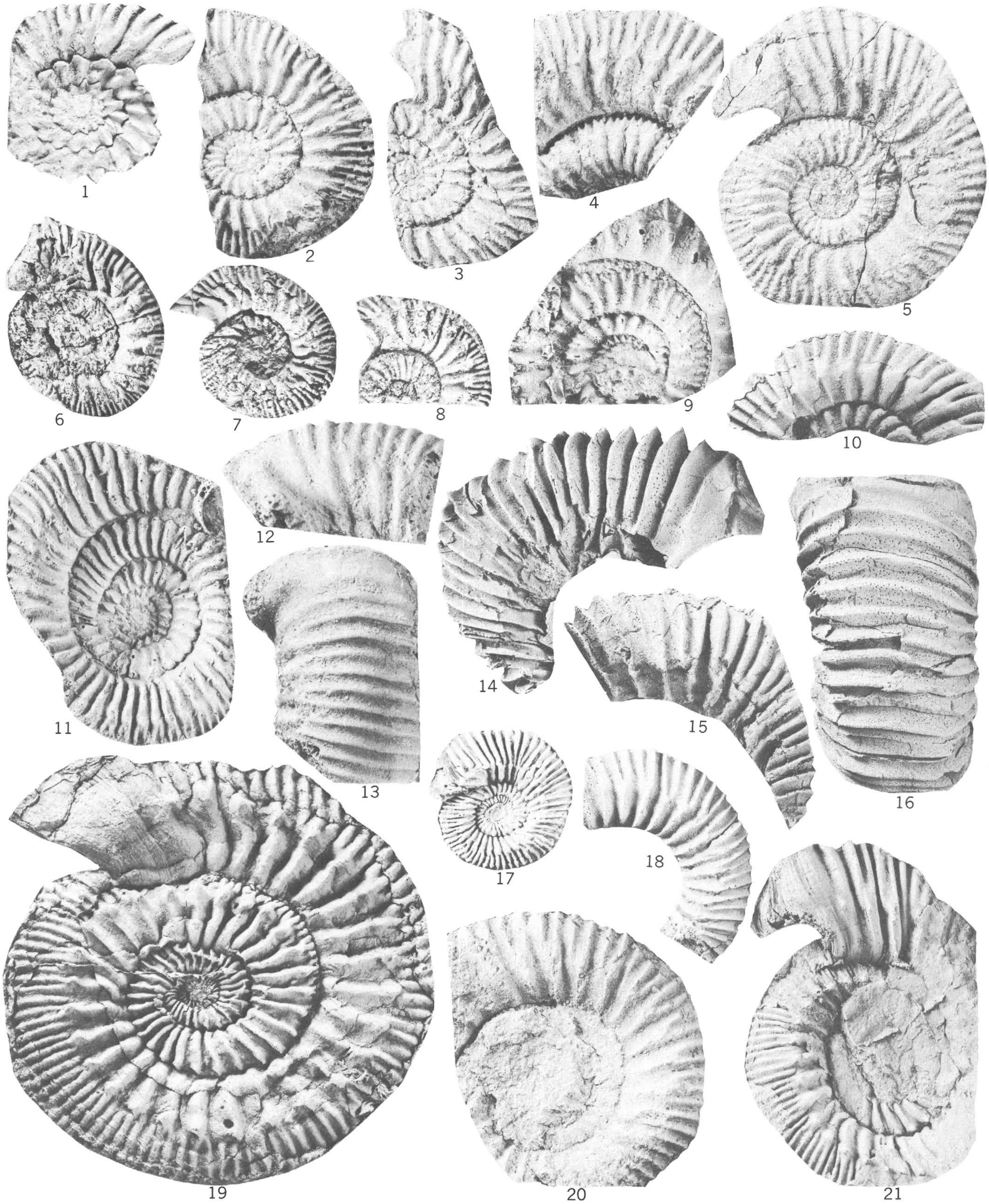
11–13. *Normannites* (*Normannites*) cf. *N.* (*N.*) *quenstedti* Roche (p. 83).
11. Rubber imprint of external mold. Specimen, CAS 13503 from Lupher's loc. 8.
12, 13. Lateral and ventral views of adoral end of specimen, CAS 13549 from Lupher's loc. 8.

14–16. *Normannites* (*Normannites*) n. sp. aff. *N.* (*N.*) *orbignyi* Buckman (p. 83).
14, 16. Lateral and ventral views of body whorl of specimen, USNM 168584 from USGS Mesozoic loc. 29232. Note lateral lappet.
15. Lateral view of specimen, USNM 168585 from USGS Mesozoic loc. 29231.

17. *Normannites* (*Normannites*) cf. *N.* (*N.*) *braikenridgii* (J. de C. Sowerby) (p. 83).
Rubber imprint of adult specimen, CAS 13502 from Lupher's loc. 57. Note lateral lappet.

19. *Normannites* (*Itinsaites*) *formosus* (Buckman) (p. 84).
Rubber imprint of external mold of adult. Hypotype, USNM 168590 from USGS Mesozoic loc. 21617.

21. *Normannites* (*Itinsaites*) cf. *N.* (*I.*) *gracilis* (Westermann) (p. 84).
Rubber imprint of external mold of adult specimen, USNM 168591 from USGS Mesozoic loc. 28029.



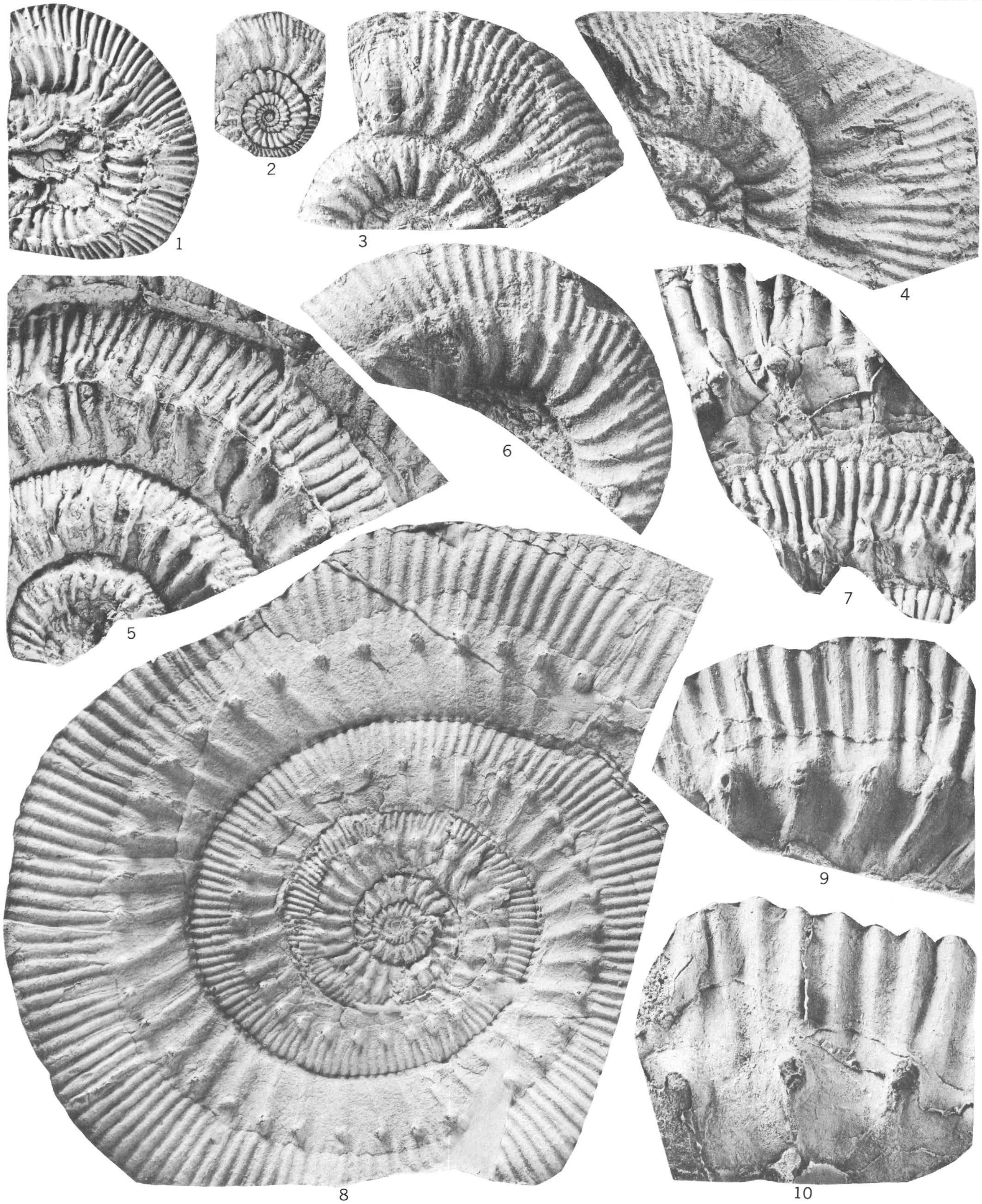
NORMANNITES (EPALXITES), N. (ITINSAITES), AND *N. (NORMANNITES)*

PLATE 42

[All figures are natural size. Specimens shown are all from Snowshoe Formation: in fig. 1 from middle part south of Seneca; in figs. 2 and 8 from the Basey Member; in figs. 3, 4, and 6 from equivalent beds in the Emigrant Creek area; and in figs. 5, 7, 9, and 10 from the lower part of the formation south of Seneca]

FIGURES 1–10. *Stephanoceras* (*Skirroceras*) *kirschneri* Imlay (p. 87).

1. Rubber imprint of small external mold. Hypotype, CAS 13510 from Lupher's loc. 55.
2. Small inner whorls. Hypotype, USNM 168604 from USGS Mesozoic loc. 29813.
3, 4. Parts of a single specimen. Hypotype, USNM 168605 from USGS Mesozoic loc. 26770.
5. Rubber imprint of external mold. Hypotype, CAS 13514 from Lupher's loc. 272.
6. Hypotype, USNM 168606 from USGS Mesozoic loc. 26772.
7. Rubber imprint of external mold. Hypotype, CAS 13513 from Lupher's loc. 272.
8. Rubber imprint of external mold. Hypotype. USNM 168607 from USGS Mesozoic loc. 29816. Compare with Alaskan specimen shown on pl. 30, fig. 13.
9. Rubber imprint of external mold of adult whorl. Hypotype, CAS 13512 from Lupher's loc. 272.
10. Rubber imprint of external mold of adult whorl. Hypotype, CAS 13511 from Lupher's loc. 272.



STEPHANOCERAS (SKIRROCERAS)

PLATE 43

[All figures are natural size. Specimens shown in figs. 1, 2, 4, 6, and 7 are from the lower part of the Snowshoe Formation south of Seneca; in fig. 3 from the top of the Weberg Member; in fig. 5 from the Warm Springs Member; in figs. 8 and 9 from the middle part of the formation south of Seneca; in fig. 14 from the upper part of the formation near Seneca; in figs. 10-13 from unnamed Jurassic beds on Juniper Mountain, Malheur County; in fig. 15 from lower member of Snowshoe Formation in Izee area]

FIGURES 1–7, 15. *Stephanoceras (Skirroceras) juhlei* Imlay (p.88).

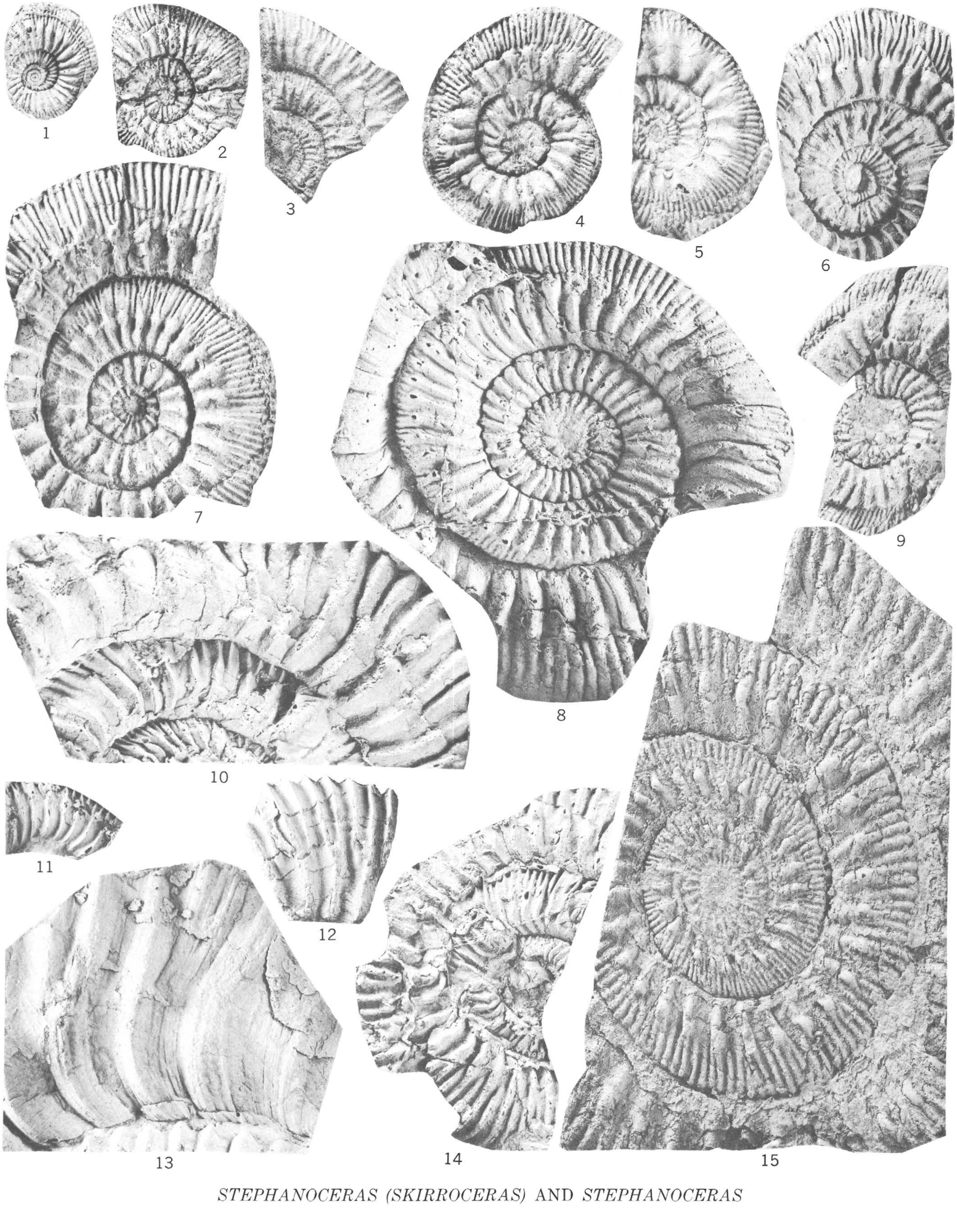
1. Rubber imprint of external mold. Hypotype, CAS 13519 from Lupher's loc. 272.
2. Hypotype, CAS 13517 from Lupher's loc. 272.
3. Hypotype, Stanford Univ. Mus. Paleontology 10031 from Vigrass' loc. 130.
4. Rubber imprint of external mold. Hypotype, CAS 13516 from Lupher's loc. 272.
5. Hypotype, CAS 13520 from Lupher's loc. 311.
6. Rubber imprint of external mold. Hypotype, CAS 13518 from Lupher's loc. 272.
7. Rubber imprint of external mold. Hypotype, CAS 13515 from Lupher's loc. 272.
15. Compressed hypotype, USNM 168608 from USGS Mesozoic loc. 28028.

8, 9. *Stephanoceras (Skirroceras)* aff. *S. (S.) juhlei* Imlay (p.88).

Rubber imprint of external mold and internal whorls of same specimen. USNM 168609 from USGS Mesozoic loc. 29413.

10–14. *Stephanoceras* sp. D (p. 86).

10. Rubber imprint of external mold, USNM 168599a from USGS Mesozoic loc. 28649.
11. Rubber imprint of external mold, USNM 168599b from USGS Mesozoic loc. 28649.
12. Specimen, USNM 168599c from USGS Mesozoic loc. 28649.
13. Rubber imprint of external mold, USNM 168599d from USGS Mesozoic loc. 28649.
14. Rubber imprint of external mold, USNM 168600 from USGS Mesozoic loc. 28020.



STEPHANOCERAS (SKIRROCERAS) AND *STEPHANOCERAS*

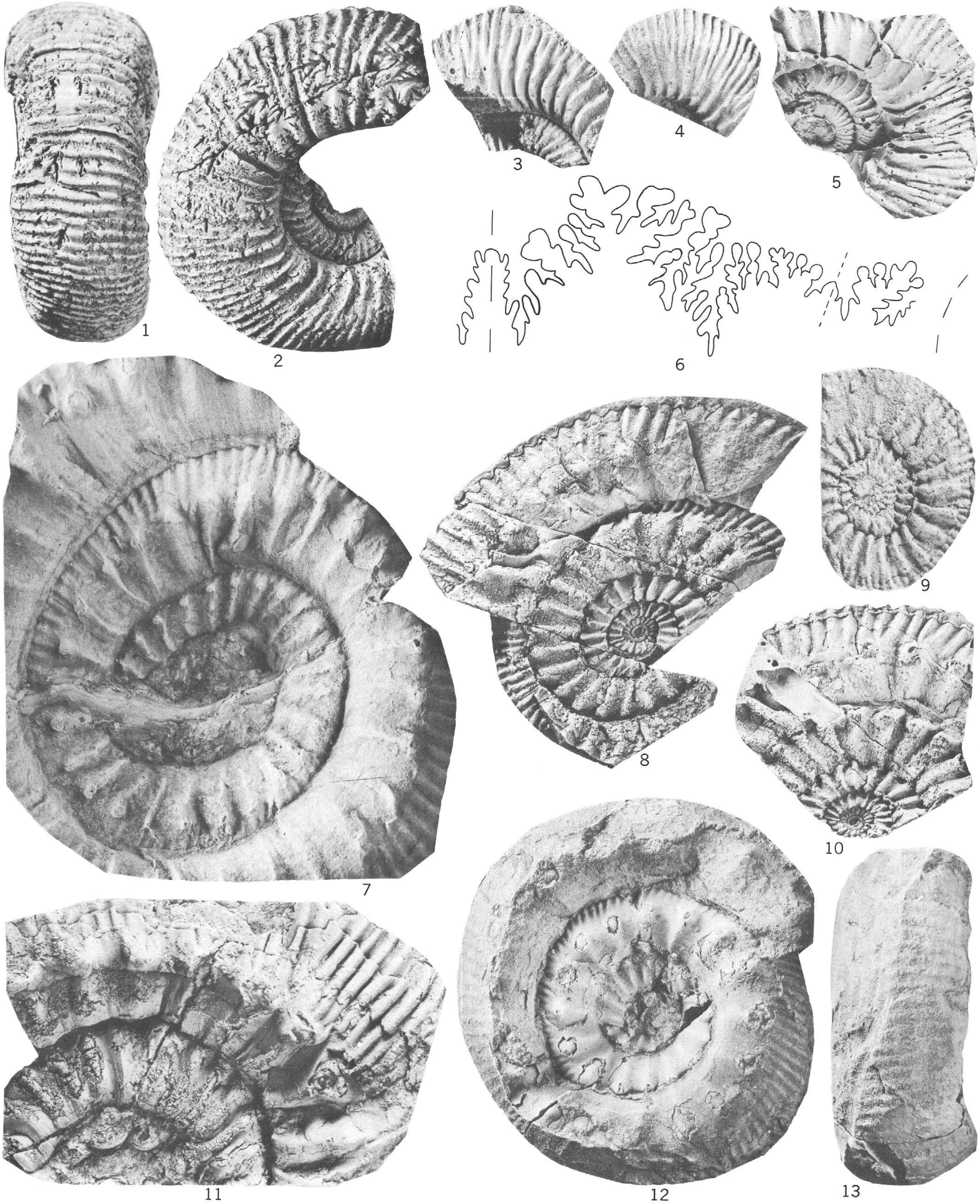
PLATE 44

[All figures natural size unless otherwise indicated. Specimens shown in figs. 1–6 are from the highest part of the Snowshoe Formation near Seneca; in fig. 9 from the Snowshoe Formation undifferentiated in the Seneca area; in fig. 7 from upper part of Basey Member of Snowshoe Formation; in figs. 8 and 10 from basal part of middle member of the Snowshoe Formation in the Izee area; on fig. 11 from near top of middle part of Snowshoe Formation south of Seneca; and in figs. 12 and 13 from upper part of Weberg Member of Snowshoe Formation]

FIGURES 1–6. *Stephanoceras* sp. C (p. 86).
From USGS Mesozoic loc. 29231.
1,2,5,6. Ventral and lateral views ($\times$ 1) and suture line ($\times$ 2) of specimen, USNM 168598a. Figure 5 is from a rubber imprint of an external mold.
3. Specimen, USNM 168598b.
4. Specimen, USNM 168598c.

7–11. *Stephanoceras* cf. *S. nodosum* (Quenstdet) (p. 87).
7. Rubber imprint of external mold of fairly large septate specimen, USNM 168602 from USGS Mesozoic loc. 28384.
8,10. Small whorls of specimen, USNM 168601 from USGS Mesozoic loc. 27363. Figure 10 is a rubber imprint of an external mold.
9. Rubber imprint of an external mold showing small whorls of specimen, CAS 13508 from Lupher's loc. 57.
11. Specimen, CAS 13509 from Lupher's loc. 28

12, 13. *Stephanoceras* aff. *S. nodosum* (Quenstedt) (p. 87).
Lateral and ventral views of specimen, Stanford Univ. Mus. Paleontology 10030 from Vigrass' loc. 162.



STEPHANOCERAS (SKIRROCERAS) AND *STEPHANOCERAS*

PLATE 45

[All figures are natural size. Specimens shown in figs. 1–7 are from the Warm Springs Member of the Snowshoe Formation; in figs. 8 and 11 from the Weberg Member; and in figs. 9 and 10 from the lower part of the Snowshoe Formation south of Seneca]

FIGURES 1–4. *Stephanoceras* (*Phaulostephanus*?) *oregonense* Imlay, n. sp. (p. 89).

1,2. Crushed internal mold and rubber imprint of external mold. Holotype, USNM 168611 from USGS Mesozoic loc. 29241. Figure 1 shows complete body chamber that occupies slightly more than one whorl. Figure 2 is oriented in same position as figure 1 and lacks about two-fifths of body chamber.

3. Rubber imprint of external mold of septate whorls. Paratype, USNM 168612 from USGS Mesozoic loc. 29395.

4. Rubber imprint of external mold. Paratype, USNM 168613 from USGS Mesozoic loc. 29395.

5–7. *Stephanoceras mowichense* Imlay, n. sp. (p. 85).

From USGS Mesozoic loc. 29395.

5. Rubber imprint of external mold. Paratype, USNM 168596.

6. Rubber imprint of external mold. Paratype, USNM 168595.

7. Rubber imprint of external mold. Holotype, USNM 168594.

8, 11. *Stephanoceras* (*Skirroceras*) cf. *S.* (*S.*) *dolichoecus* (Buckman) (p. 88).

8. Internal mold retaining some shell and showing inner whorls. Specimen, Stanford Univ. Mus. Paleontology 10033 from Vigrass' loc. 162.

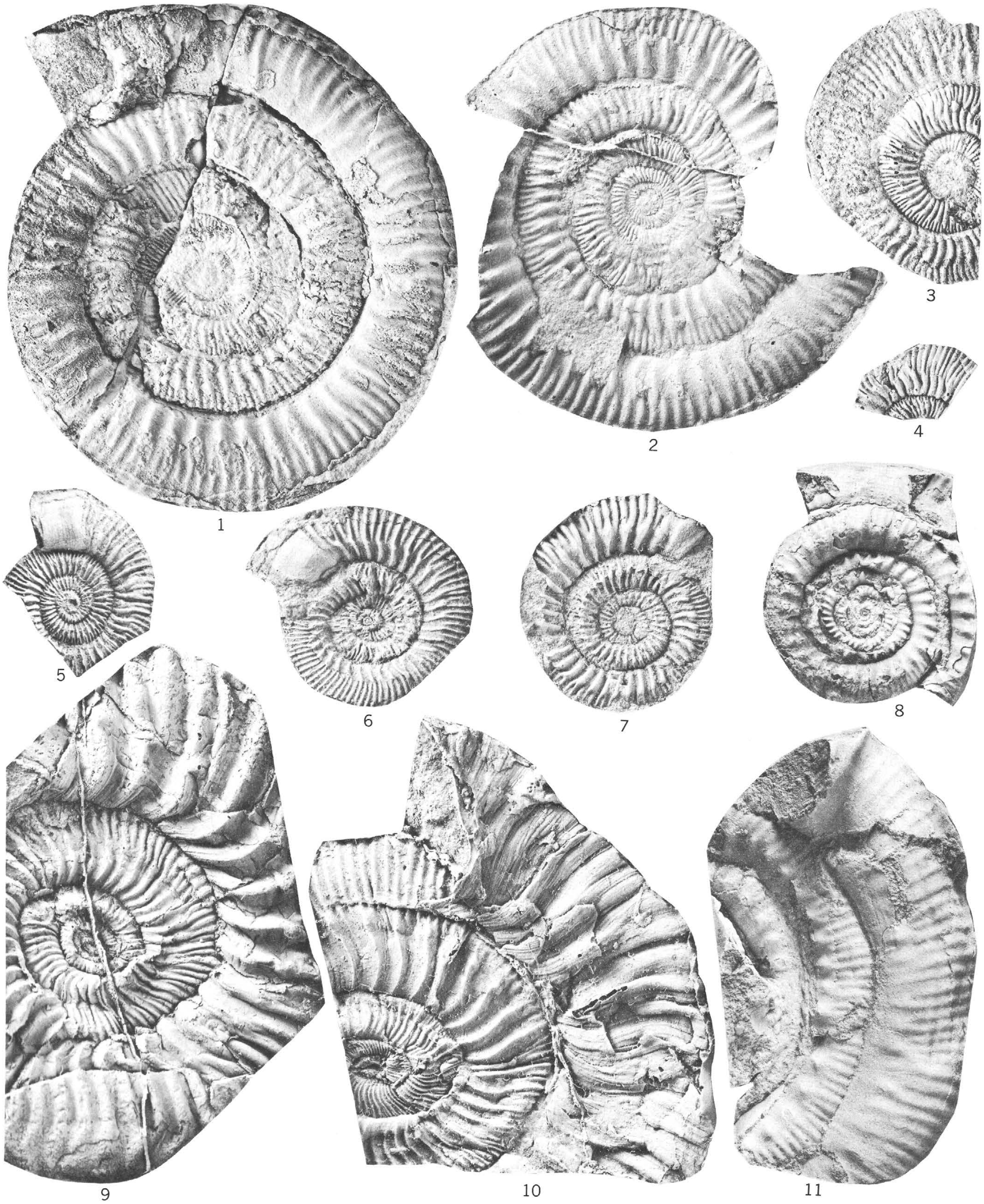
11. Internal mold showing adoral part of body chamber. Specimen, Stanford Univ. Mus. Paleontology 10032 from Vigrass' loc. 16.

9. *Stephanoceras* sp. B (p. 86).

Rubber imprint of external mold. Specimen, CAS 13548 from Lupher's loc. 57.

10. *Stephanoceras* sp. A (p. 86).

Rubber imprint of external mold. Specimen, USNM 168597 from USGS Mesozoic loc. 25818.



STEPHANOCERAS (PHAULOSTEPHANUS?), S. (SKIRROCERAS), AND *STEPHANOCERAS*

PLATE 46

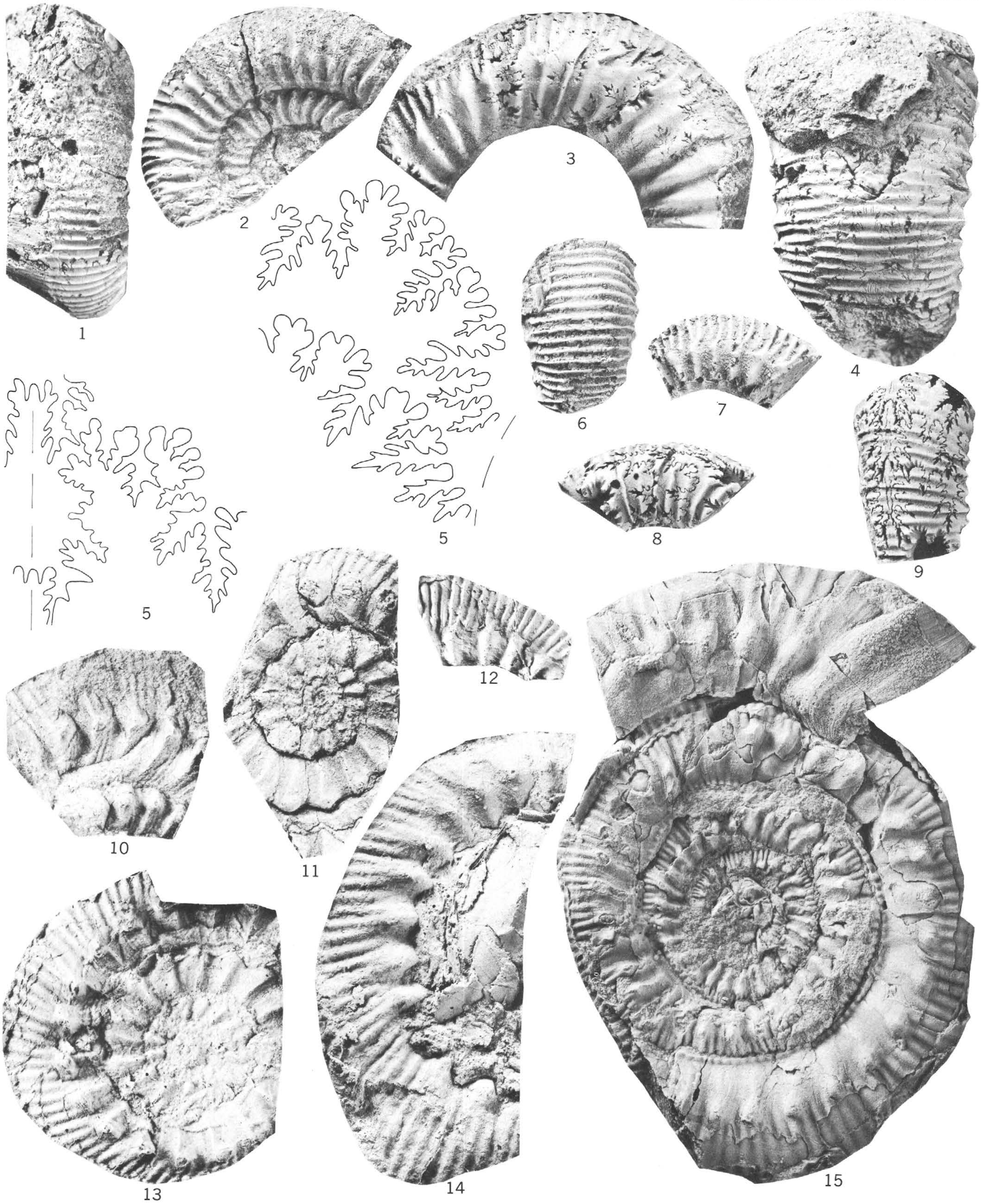
[All figures natural size unless otherwise indicated. Specimens shown in figs. 1–9 and 12 are from the upper part of the Snowshoe Formation near Seneca; in figs. 10, 11, 13, and 14 from the Snowshoe Formation near Emigrant Creek; and in fig. 15 from the Warm Springs Member cf the Snowshoe Formation in the Suplee area]

FIGURES 1–9. *Stemmatoceras* aff. *S. albertense* McLearn (p. 89).
From Lupher's loc. 8
1, 2. Specimen, CAS 13522.
3–5. Lateral and ventral views (×1) and suture line (×2) of largest available specimen. CAS 13521.
6, 7. Specimen, CAS 13524.
8, 9. Specimen, CAS 13523.

10, 11, 13. *Teloceras itinsae* McLearn (p.90).
10. Rubber imprint of external mold. Specimen, USNM 168614 from USGS Mesozoic loc. 29410.
11. Specimen, USNM 268616 from USGS Mesozoic loc. 26770.
13. Rubber imprint of external mold. Specimen, USNM 168615 from USGS Mesozoic loc. 26770.

12, 14. *Zemistephanus*? cf. *Z. richardsoni* (Whiteaves) (p. 90).
12. Rubber imprint of small whorl. Specimen, CAS 13255 from Lupher's loc. 30.
14. Rubber imprint of medium-sized whorl. Specimen, USNM 168617 from USGS Mesozoic loc. 29410. Note position of tuberles near umbilicus.

15. *Stephanoceras* (*Skirroceras*) cf. *S.* (*S.*) *leptogyrale* (Buckman) (p. 88).
Fairly complete internal mold, USNM 168610 from USGS Mesozoic loc. 29241.



STEMMATOCERAS, TELOCERAS, ZEMISTEPHANUS?, AND *STEPHANOCERAS (SKIRROCERAS)*

PLATE 47

[All figures natural size unless otherwise indicated. Specimens shown in figs. 1-9, 12-23, and 26-29 are from the highest part of the Snowshoe Formation near Seneca; in figs. 10 and 11 from near top of unnamed Jurassic sequence in the Huntington area; in fig. 24 from the base of the upper member in the Izee area; in fig. 25 from near the top of the middle part of the Snowshoe Formation near Seneca; in fig. 30 from unnamed Jurassic beds on Juniper Mountain, Malheur County; and in figs. 31-33, 35, and 36 from the Warm Springs Member of the Snowshoe Formation in the Suplee area. Specimens shown in figs. 1, 2, 6, 7, 9-11, 19, 25, 28-30, and 35 are rubber imprints of external molds]

FIGURES 1–20. *Lupherites senecaensis* Imlay, n. sp. (p. 90).

Specimens shown, except in figures 10 and 11, are from Lupher's loc. 30.

1. Paratype, CAS 13532.
2. Paratype, CAS 13531.
3. Paratype, CAS 13536.

4, 5. Lateral and ventral views of paratype, CAS 13535.

6. Paratype, CAS 13529.
7. Paratype, CAS 13540.
8. Paratype, CAS 13537. Note presence of weak swellings on ventral ends of primary ribs on nonseptate part of outer whorl.
9. Paratype, CAS 13527.
10. Paratype, USNM 168619 from USGS Mesozoic loc. 29111.
11. Paratype, USNM 168618 from USGS Mesozoic loc. 29111.

12, 13. Paratype, CAS 1350. Note change in ribbing from septate inner whorl to nonseptate outer whorl.

14. Holotype, CAS 13526. Note change in rib density from septate inner whorl to nonseptate outer whorl.
15. Suture line (X 2) drawn at whorl height of about 19 mm. Paratype, CAS 13528.

16, 20. Lateral and ventral views of nonseptate fragment. Paratype, CAS 13538.

17. Paratype, CAS 13533. Only right hand margin is septate.
18. Paratype, CAS 13539. Note lateral lappet.
19. Paratype, CAS 13534. Note lateral lappet.

21–23, 26, 27. *Leptosphinctes* cf. *L. evolutus* Imlay (p.91)

From Lupher's loc. 30.

21. Specimen, CAS 13543.

22, 23. Ventral and lateral views of specimen, CAS 13545.

26. Specimen, CAS 13542.
27. Specimen, CAS 13544.

24. *Leptosphinctes* sp. (p. 91).

Specimen, USNM 168620 from USGS Mesozoic loc. 26775.

25. *Leptosphinctes* cf. *L. leptus* Buckman (p. 91).

Specimen, CAS 13541 from Lupher's loc. 28.

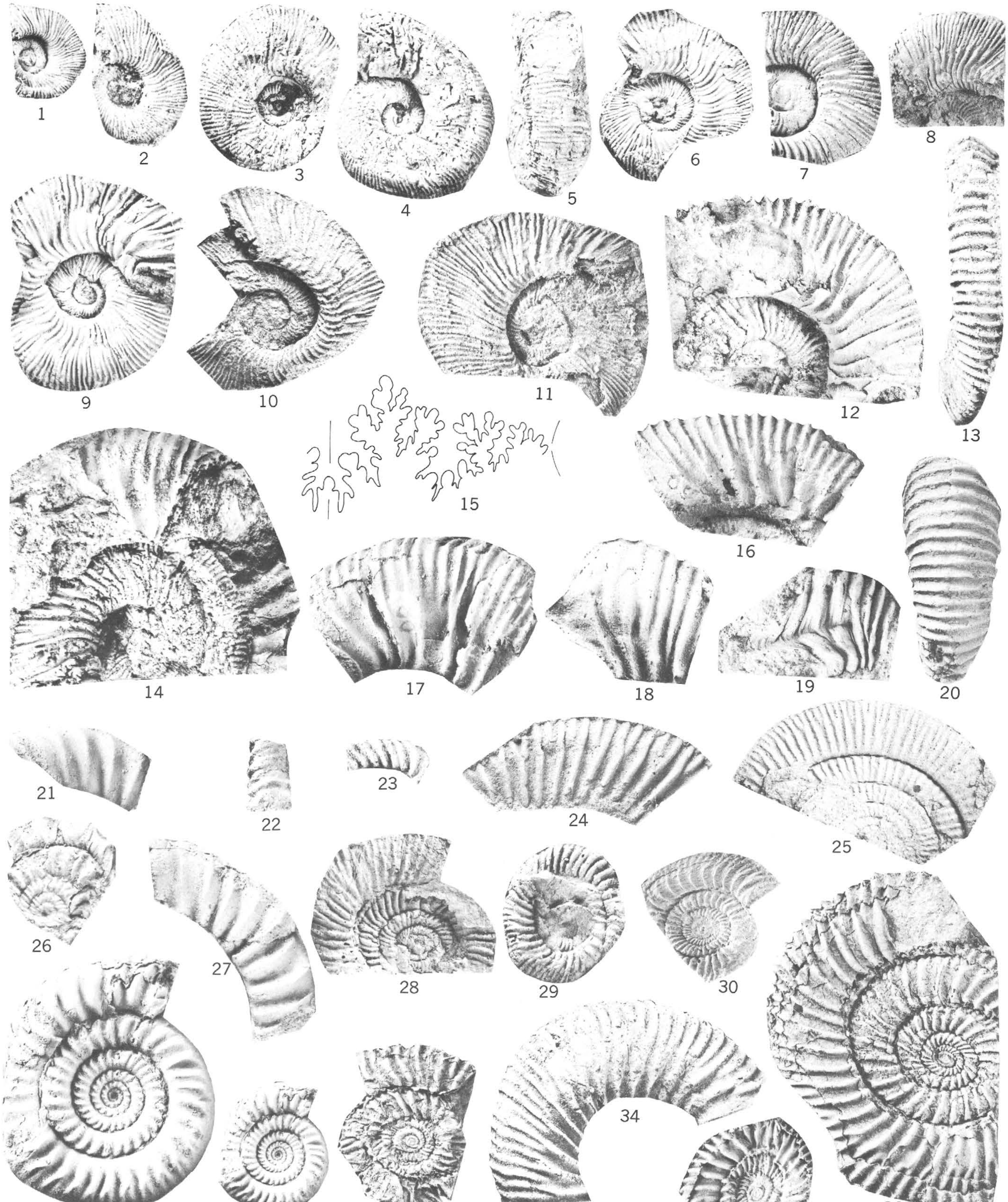
28–30. *Leptosphinctes* (*Prorsisphinctes?*) spp. juv. (p. 92).

28. Specimen, USNM 168622 from USGS Mesozoic loc. 28649.
29. Specimen, CAS 13546 from Lupher's loc. 30.
30. Specimen, USNM 168621 from USGS Mesozoic loc. 28650.

31–36. *Parabigotites crassicostatus* Imlay (p. 92).

31, 32. Lateral views (X 2 and X 1). Hypotype, CAS 13547 from Lupher's loc. 211.

33. Hypotype, Stanford Univ. Mus. Paleontology 10036 from Dickinson's loc 98.
34. Hypotype, USNM 168623 from USGS Mesozoic loc. 19773 from Kialagvik Formation on Alaska Peninsula.
35. Hypotype, Stanford Univ. Mus. Paleontology 10035 from Dickinson's loc. 96.
36. Hypotype, Stanford Univ. Mus. Paleontology 10034 from Dickinson's loc. 94.



LUPHERITES, *LEPTOSPHINCTES*, *L.* (*PRORSISPHINCTES?*), AND *PARABIGOTITES*