Lower Jurassic (Pliensbachian and Toarcian) Ammonites From Eastern Oregon and California

GEOLOGICAL SURVEY PROFESSIONAL PAPER 593-C

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By RALPH W. IMLAY

CONTRIBUTIONS TO PALEONTOLOGY

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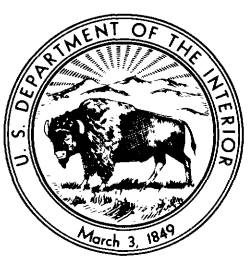
Ammonite faunas of Mediterranean affinities characterize the upper part of Lower Jurassic sequences in Oregon and California



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CONTRIBUTIONS TO PALEONTOLOGY

LOWER JURASSIC (PLIENSBACHIAN AND TOARCIAN) AMMONITES FROM EASTERN OREGON AND CALIFORNIA

By RALPH W. IMLAY

ABSTRACT

Early Jurassic ammonites of late Pliensbachian age occur in east-central Oregon throughout 200–300 feet of beds in the Nicely Shale of Lupher (1941) and in the upper third of his Suplee Formation. They occur in northeast Oregon throughout about 620 feet of beds exposed in the northern part of the Wallowa Mountains. They occur in east-central California throughout 50–100 feet, or more, of beds that lie about 2,000 feet above the base of the Sailor Canyon Formation. Ammonites of late Toarcian age occur in the basal 125 feet of the Snowshoe Formation of Lupher in east-central Oregon. Their presence shows that the underlying volcanic Hyde Formation of Lupher is of early Toarcian age. Toarcian ammonites have not been found elsewhere in Oregon or in California.

The beds of late Pliensbachian age contain the ammonites *Phylloceras, Partschiceras?, Holcophylloceras, Tragophylloceras, Lytoceras, Metacymbites?, Liparoceras (Becheiceras), Reynesoceras, Prodactylioceras, Dactylioceras, Leptaleoceras, Arieticeras, Canavaria, Fontanelliceras, Harpoceras, H. (Harpoceratoides), Paltarpites, Lioceratoides?, Protogrammoceras, Fuciniceras, Whitbyiceras?, and Fanninoceras.* These beds are characterized by an abundance of ammonites belonging to the families Hildoceratidae and Dactylioceratidae and by an absence of any ammonite of the family Amaltheidae. This association is similar to that which existed in the Mediterranean region during late Pliensbachian time. The absence of the Amaltheidae contrasts markedly with the abundance of that family in northwest Europe and in Alaska during that time.

The late Pliensbachian age is based on the presence of the ammonites *Leptaleoceras, Arietceras, Canavaria,* and *Fontanelliceras,* which in Europe are not known from younger or older beds. With these are associated such ammonites as *Tragophylloceras, Liparoceras (Becheiceras), Reynesoceras,* and *Prodactylioceras,* which in Europe occur also in beds of early Pliensbachian age but not in beds of Toarcian age. Other ammonites include *Paltarpites, Protogrammoceras,* and *Fuciniceras,* which in Europe are common in the Pliensbachian but occur also in beds of earliest Toarcian age.

The presence of densely ribbed spicies of *Dactylioceras* in the Sailor Canyon Formation and near the middle of the Nicely Shale is not evidence of an early Toarcian age, as is generally true in Europe, because these species are associated with, or occur below, genera not known above the Pliensbachian. Furthermore, in England and Portugal, similar densely ribbed species of *Dactylioceras* are recorded from the upper part of the Pliensbachian zone of *Pleuroceras spinatum.* These records in Europe suggest that at least the middle and upper parts of the Nicely Shale correlate with the zone of *Pleuroceras spinatum.*

The late Toarcian age of the basal part of the Snowshoe Formation is shown by the presence of *Haugia* about 75 feet above the base of the formation, *Catulloceras* from 100 to 125 feet above the base, and *Dumortieria?* from near the base. Of these ammonites, in Europe, *Haugia* occurs mainly in the zone of *Haugia variabilis* in the lower part of the upper Toarcian. *Catulloceras* and *Dumortieria* occur in the zone of *Dumortieria levesquei* at the top of the Toarcian. The presence of the early Bajocian ammonite *Tmetoceras* from 125 to 200 feet above the base of the Snowshoe Formation is evidence that only a small part of the formation is of late Toarcian age.

New species described herein include *Leptaleoceras dickinsoni* Imlay, *L.? morganense* Imlay, *Arieticeras lupheri* Imlay, and *Protogrammoceras? ochocoense* Imlay.

INTRODUCTION

The ammonites described herein have been studied in order to demonstrate the existence of marine sequences of late Early Jurassic age in eastern Oregon and California, to date some intervals of extensive volcanism in the Pacific coast region, and to show that the succession of ammonite faunas is similar to that in Europe. The fact that the ammonites of late Pliensbachian age have closer affinities with those in southern Europe than in northern Europe should interest geologists concerned with paleogeography and faunal differentiation.

The fossils from northeast Oregon were collected by Bruce Nolf in 1962 and 1963 and by Tracy Vallier, W. H. Taubeneck, and R. W. Imlay in 1963. The fossils from east-central Oregon were collected mostly by R. L. Lupher from 1926 to 1937 and by R. W. Imlay from 1956 to 1965. Some were collected by John Beeson in 1956 and 1957, C. E. Brown in 1958, H. J. Buddenhagen in 1965, J. A. Calkins in 1955, Reed Christner in 1958, W. R. Dickinson in 1956, 1957, and 1960, S. W. Muller in 1956 and 1957, W. O. Ross in 1965, L. W. Vigrass in 1956 and 1957, and R. E. Wallace in

1955. The fossils from east-central California were collected by Waldemar Lindgren in 1890, Cooper Curtice in 1891, and by L. D. Clark, N. J. Silberling, and R. W. Imlay in 1961.

The writer was aided in the field by R. L. Lupher, W. R. Dickinson, L. W. Vigrass, S. W. Muller, John Beeson, and H. J. Buddenhagen. Leo J. Hertlein and Dallas Hanna, of the California Academy of Sciences, granted permission to study the excellent collections made by Ralph Lupher. Especial thanks are due Lupher himself for the opportunity to study his collections and for supplying stratigraphic data.

BIOLOGIC ANALYSIS

The Oregon and California ammonites of late Early Jurassic (Pliensbachian and Toarcian) ages described herein number about 1,050 specimens. Their distribution by families, subfamilies, genera, and subgenera is shown in table 1. This table shows that the Hildoceratidae is the dominant family and includes about four-fifths of the specimens. The next most common family is the Dactylioceratidae which includes about one-eighth of the specimens. The Phylloceratidae, Juraphyllitidae, Lytoceratidae, Liparoceratidae, and Hammoceratidae are of minor importance. The most common genus by far is *Arieticeras*. Next most common are *Grammoceras*? *Protogrammoceras*, and *Fuciniceras* which are about equally abundant. Next in order of decreasing numbers are *Fanninoceras*, *Dactylioceras*, *Holcophylloceras*, *Polyplectus*, *Harpoceras*, *Leptaleoceras*, *Haugia*, and *Paltarpites*. The other genera are represented by only a few specimens. All the genera listed occur in Pliensbachian or Toarcian beds in Europe and in other parts of the world.

TABLE 1.—*Ammonite genera and subgenera from beds of late Early Jurassic age in eastern Oregon and California, showing biological relationships and relative numbers available for study*

Family	Subfamily	Genus and subgenus	Number of specimens
Phylloceratidae	Phylloceratinae	*Phylloceras*	1
		Partschiceras?	3
	Calliphylloceratinae	*Holcophylloceras*	31
Juraphyllitidae		*Tragophylloceras*	1
Lytoceratidae	Lytoceratinae	*Lytoceras*	3
Liparoceratidae		*Metacymbites*?	2
		Liparoceras (*Becheiceras*)	2
Dactylioceratidae		*Reynesoceras*	69
		Prodactylioceras	9
		Dactylioceras	49
Hildoceratidae	Arieticeratinae	*Leptaloceras*	24
		Leptaleoceras?	14
		Arieticeras	350
		Canavaria	5
		Fontanelliceras	1
	Harpoceratinae	*Harpoceras*	4
		Harpoceras (*Harpoceratoides*)	21
		Paltarpites	18
		Lioceratoides?	2
		Protogrammoceras	100
		Fuciniceras	80
		Whitbyiceras	1
		Fanninoceras	81
		Polyplectus	30
	Grammoceratinae	*Grammoceras*?	100
		Dumortieria?	12
		Catulloceras	15
Hammoceratidae	Phymatoceratinae	*Haugia*	22

On the generic level, most of the ammonites listed in this paper agree very well in most features with various genera as defined in the "Treatise on Invertebrate Paleontology" (Arkell and others, 1957). This statement applies in particular to the families Phylloceratidae, Juraphyllitidae, and Lytoceratidae. In the Liparoceratidae, *Liparoceras* (*Becheiceras*) is also represented by several typical specimens, but the assignment of one specimen to *Metacymbites* is questioned because its suture line is simpler and its sutured saddles are not constricted basally.

Among the genera of Dactylioceratidae listed in table 1, *Reynesoceras* is characterized by its highly evolute coiling, its nearly round whorl section, its simple nearly straight to slightly flexuous ribs, and by an absence of tubercles except on the innermost whorls of some species. *Prodactylioceras* resembles *Reynesoceras* in coiling, whorl section, and simple ribbing, but differs by having some forked and intercalated ribs, by the ribs inclining forward more strongly on the outer whorls, by having rather prominent sporadic ventrolateral tubercles, by bearing some fibulate, or looped ribs that terminate at

the lateral tubercles, and by attaining a larger size. *Dactylioceras* differs from *Prodactylioceras* by being generally less evolute, by having a more compressed whorl section, by its ribs being rectiradiate instead of inclined forward, by generally having many forked ribs on small and intermediate sized whorls, by the tubercles on its inner and intermediate-sized whorls being arranged regularly, and by an absence of tubercles on its outer whorls. The earliest known species of *Dactylioceras* occurred along with *Prodactylioceras* in the upper part of the zone of *Pleuroceras spinatum*.

These distinctions seem clear enough, but in practice some poorly preserved or fragmentary specimens are difficult to classify generically with certainty. This statement applies particularly to the distorted specimens of the Dactylioceratidae from the Sailor Canyon Formation. Furthermore, most of the earliest species of *Dactylioceras* in the zones of *Pleuroceras spinatum* and *Dactylioceras tenuicostatum* are much more finely and densely ribbed than later species and are not very different than some of the species of *Prodactylioceras* with which they may be associated in beds of latest Pliensbachian age. It seems probable, therefore, that *Dactylioceras* arose from *Prodactylioceras* and that some species show characteristics of both genera.

Among the genera of Hildoceratidae listed in table 1 are representatives of the subfamilies Arieticeratinae, Harpoceratinae, and Grammoceratinae as defined in Arkell and others (1957, p. L254–L262). Among the Arieticeratinae, all the genera listed are small and highly evolute and have a low umbilical wall that rounds evenly into the flanks, and they have nearly straight to gently flexuous ribs that incline or curve forward slightly on the venter. All have a single low keel except *Fontanelliceras* which has one high keel and two low keels, or ridges, that are separated by deep furrows. *Arieticeras* is characterized by a fairly stout whorl section and by strong fairly widely spaced simple ribs. It resembles the Toarcian genus *Orthildaites* but differs by bearing a single instead of a triple keel. *Canavaria* is characterized by having some ribs that arise in pairs from the umbilical margin and by bearing one or two rows of tubercles on the flanks. *Fontanelliceras* is characterized by a round whorl section, a tricarinate venter, and by high narrow very widely spaced simple ribs. *Leptaleoceras* differs from the other genera by having much weaker and more closely spaced ribs that fade out on the adult body whorl.

Among the Harpoceratinae listed in table 1, *Harpoceras*, *H.* (*Harpoceratoides*), *Paltarpites*, and *Polyplectus* are all of moderate size and have similar ribbing. *Harpoceras* is characterized by an elliptical compressed whorl section, flattened flanks, a moderately wide umbilicus, a single keel, a sharp undercut umbilical edge, and falcate ribs that are strongest on the outer half of the flanks and that project strongly forward on the venter. *H.* (*Harpoceratoides*) differs from *Harpoceras* by having a wider umbilicus, a beveled umbilical edge, and gently falciform fasciculate ribbing. *Paltarpites* differs from *Harpoceras* by having a much wider umbilicus, a rounded umbilical edge, and gently falcoid ribbing that becomes flat topped on its outer whorls and may change to striae on the adult body whorl. *Polyplectus* has a very small umbilicus, a discoidal shell, a knife-edge venter, a sharp umbilical edge, and falcate ribbing. It differs from *Harpoceras* by having a much smaller umbilicus and a sharper venter.

The other genera of the Harpoceratinae listed in table 1 differ considerably in ribbing from those just described and from each other. *Lioceratoides* is fairly small. It has an ovate compressed whorl section, a moderately wide umbilicus, a single keel, a gently inclined umbilical wall, a rounded umbilical edge, and blunt falcate widely spaced ribs that are variably weak and that fade on the adult body whorl. The presence of *Lioceratoides* in Oregon is questioned because the only specimens available are small and presumably immature and their ribs project forward more strongly on the ventral margin than is typical.

Fuciniceras and *Protogrammoceras* resemble each other considerably. Both are medium to small in size and elliptical to subquadrate in whorl section. Both have flattened flanks, a moderate to fairly wide umbilicut, a single keel, a low vertical umbilical wall, and an evenly to abruptly rounded umbilical edge. *Fuciniceras* is characterized by gently flexuous to nearly straight ribs that trend radially or slightly backward on the flanks. *Protogrammoceras* is characterized by gently falciform ribs that project forward on the ventral margin.

The specimens from Oregon and California herein assigned to *Fuciniceras* and *Protogrammoceras* appear to represent a gradational highly variable series. Some can be assigned definitely to one genus or to the other, but many specimens have a rib pattern showing intermediate characteristics. In some specimens the ribbing is less falciform than in *Protogrammoceras* but more projected forward than in *Fuciniceras*. In other specimens the ribbing is nearly straight and radial on most whorls but becomes falciform on the outer body whorl. The presence of such specimens suggest that only one genus is represented, and that the name *Protogrammoceras* should either be abandoned or used as a subgenus.

It seems probable that *Fuciniceras* and *Protogrammoceras* are the ancestors of many other genera of the Hildoceratidae. This is suggested by their earlier

appearance than the others in the lower Pliensbachian zone of *Prodactylioceras davoei*, by their resemblance to other genera such as *Arieticeras* and *Hildaites*, and by their abundance in many parts of the world during late Pliensbachian time.

Whitbyiceras is questionably represented in Oregon by one specimen that differs from the type species of the genus by lacking ventral furrows bordering the keel and by having an evenly rounded instead of a sharp umbilical edge. It may be an immature representative of *Whitbyiceras* but more probably represents a new genus.

The genus *Fanninoceras* is fairly small. It has a very small umbilicus, a narrowly rounded or sharpened venter, a low nearly vertical to undercut umbilical wall, an abruptly rounded umbilical edge, and feeble flexuous widely spaced ribs that project gently forward on the venter and fade on the adult body whorl. In shape, ribbing, and sutures, it resembles the Oxynoticeratidae considerably.

Among the genera of Grammoceratinae listed in table 1, the genus *Grammoceras* is questionably represented by some ammonite fragments. The fragments indicate the presence of ammonites that are widely umbilicate and unicarinate and that bear gently flexuous simple ribs. Associated with the fragments are specimens of *Dumortieria* and *Catulloceras*, whose identification seems reasonably certain. Of these genera, *Dumortieria* is characterized by a subquadrate whorl section, flattened flanks, a moderate to wide umbilicus, a single low keel, an evenly rounded umbilical wall, and strong nearly straight fairly widely spaced ribs that curve abruptly forward near the keel. Its overall appearance resembles that of *Arnioceras* of Sinemurian age, but it is less evolute, its whorl section is less subquadrate, its ribs are generally closer spaced, and its nucleus changes from smooth to ribbed at a smaller size. The genus *Catulloceras* greatly resembles *Dumortieria* and is considered by Donovan (1958, p. 53) to be a synonym. It differs, however, by having periodic constrictons, by its ribs being a little sharper and more wiry, and by the ventral ends of the ribs not curving abruptly forward near the keel.

A distinct ammonite faunal province did not exist in the Pacific coast region of North America during late Early Jurassic time. Only one genus, *Fanninoceras*, appears to be restricted to that area. All the other ammonite genera listed in table 1 have been found in many parts of the world. The ammonites as a whole have a Tethyan or Mediterranean aspect, however, as shown by the dominance of the Hildoceratidae and the Dactylioceratidae. For the ammonites of Pliensbachian age, in particular, a faunal connection with the Tethyan Realm is shown also by the absence of the family Amaltheidae. That family was dominant in the seas of late Pliensbachian time throughout most of northwest Europe but was uncommon south of France (Howarth, 1958, p. xxiv–xxvi). In North America it was fairly common in seas of late Pliensbachian time in Alaska (Imlay, 1955, p. 87) and in various parts of western Canada as far south as northwestern British Columbia (Frebold, 1964a, p. 9; 1964b, p. 5). It appears, therefore, that the Amaltheidae disappear southward in North America as they do in Europe and that the Pliensbachian seas in Oregon and California were south of the southern range of the family.

STRATIGRAPHIC SUMMARY

EAST-CENTRAL OREGON

In east-central Oregon near Izee and Seneca (figs. 1, 2), Pliensbachian ammonites have been obtained from the upper half of the Suplee Formation of Lupher (1941) and from all parts of his Nicely Shale. In the same area, late Toarcian ammonites have been obtained from the basal 125 feet of the Snowshoe Formation of Lupher (1941) which is separated from the Nicely Shale by Lupher's Hyde Formation.

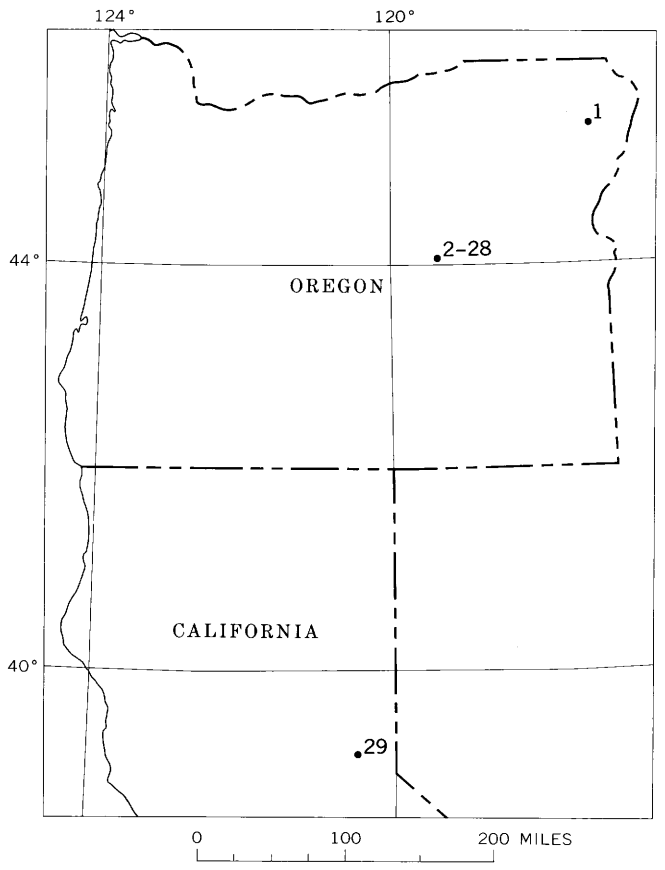

FIGURE 1.—Index map showing general positions of upper Lower Jurassic fossil localities in Oregon and California. (Numbers on map refer to numbers in first column of tabulation. Pages C22–C25 give detailed geographic descriptions.)

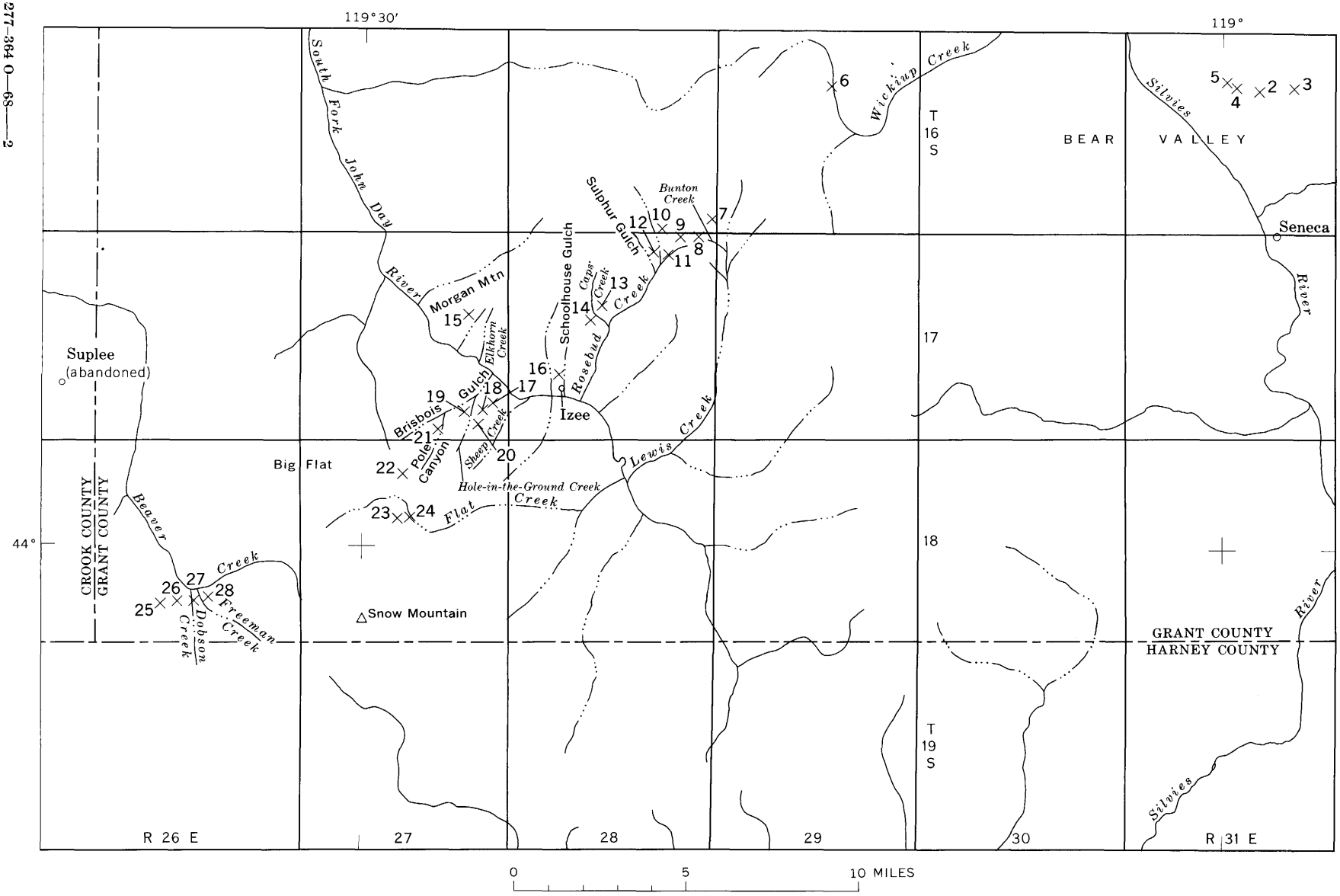

FIGURE 2.—Index map of upper Lower Jurassic fossil localities near Izee and Seneca in east-central Oregon.

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The lithologic features of these formations have been described by Lupher (1941, p. 227, 239–245, 255–261) and Dickinson and Vigrass (1965, p. 36, 37) and are summarized herein.

The Suplee Formation of Lupher (1941) consists of gray granular limestone and calcareous sandstone, weathers light brown, ranges from 30 to 150 feet in thickness (table 2), and grades into the adjoining formations or locally rests unconformably on Upper Triassic or basal Jurassic (Hettangian) beds (Dickinson and Vigrass, 1964, p. 1040–1041; 1965, p. 31). The Suplee Formation near the type section south of the South Fork of Beaver Creek and along the north side of Bear Valley north of Seneca rests conformably on the Robertson Formation of Lupher (1941, p. 239) whose upper part is marked by limestone beds containing the pelecypod *Plicatostylus* and the gastropod *Nerinea*. The Suplee Formation rests abruptly on dark shaly beds containing upper Sinemurian ammonites in an area north of the headwaters of Rosebud Creek. It rests on beds of earliest Jurassic (Hettangian) age northeast of Morgan Mountain in the north-central part of sec. 12, T. 17 S., R. 27 E. Elsewhere in the South Fork drainage the Suplee Formation rests on Upper Triassic beds.

TABLE 2.—*Thicknesses, in feet, of Suplee and Nicely Formations, of Lupher (1941) in the Izee area, eastern Oregon*

[Data furnished by W. R. Dickinson, written commun., Feb. 8, 1966]

Locality	Suplee Formation	Nicely Shale
Robertson Ranch near Dobson Creek, SE¼ sec. 28, T. 18 S., R. 26 E	35	75
Near Flat Creek on east side of Big Flat, SE¼ sec. 9, T. 18 S., R. 27 E	50	150
Pole Canyon to Hole-in-the-Ground, SE¼ sec. 34 to NE¼ sec. 35, T. 17 S., R. 27 E.	50	300
On high hill southwest of South Fork bridge, SE¼ sec. 25, T. 17 S., R. 28 E.	65–70(?)	225
Area between South Fork bridge and Poison Creek, SW¼ to NE¼ sec. 30, T. 17 S., R. 28 E	70	180
Caps Creek, SE¼NW¼ sec. 16, T. 17 S., R. 28 E	50	120
Head of Rosebud Creek, NE¼ sec. 1, T. 17 S., R. 28 E., and SW¼ sec. 36, T. 16 S., R. 28 E	30	250
Southeast slope of Morgan Mountain, NE¼ sec. 14, T. 17 S., R. 27 E	150	200+

The Suplee Formation contains many pelecypods and brachiopods, a few corals and gastropods, and its upper third locally contains many ammonites. The pelecypods include such genera as *Parallelodon*, *Modiolus*, *Pinna*, *Meleagrinella*, *Gervillia*, *Camptonectes*, *Weyla*, *Ostrea*, *Gryphaea*, *Trigonia*, *Astarte*, *Coelastarte*, *Lucina*, *Pleuromya*, *Goniomya*, and *Homomya*. In addition, the rudistid-like pelecypod *Plicatostylus* occurs rarely in calcareous beds in the lower part of the formation. The most common gastropod is *Nerinea*. The most common ammonites are *Protogrammoceras*, *Fuciniceras*, and *Fanninoceras*. Less common ammonites include *Arieticeras*, *Canavaria*, *Reynesoceras*, *Partschiceras*?, and *Lytoceras*.

The Nicely Shale of Lupher (1941) consists mostly of dark-grey to black highly fossiliferous calcareous siltstone and claystone that weather brownish gray. Minor constitutents include thin beds of fine-grained sandstone and hard black concretions ranging in diameter from a few inches to as much as 3½ feet. A lava flow has been mapped by W. R. Dickinson (written commun., 1966) near the middle of the formation in the area extending from Big Flat northward to Hole-in-the-Ground. The formation is 75–300 feet thick (table 2) and grades into or intertongues with the adjoining formations.

Intertonguing of the dark shaly units typical of the Nicely Shale with units of volcanic sandstone typical of Lupher's Hyde Formation makes selection of the exact boundary difficult in some sections. For example, Lupher (1941, p. 240) states that the Nicely Shale on Dobson Creek near the Robertson Ranchhouse is 134 feet thick, but Dickinson (written commun., Feb. 1966) assigns only 75–80 feet to the formation at that locality. Presumably Lupher measured the Nicely Shale up to the top of the highest black siltstone unit in a sequence consisting of black siltstone units alternating with thicker volcanic sandstone. Dickinson notes, however, that the Nicely Formation, as mapped by him, is much thicker from Big Flat northward than it is between the Robertson Ranch and Snow Mountain, and he suspects that this difference in thickness reflects lateral gradation of the lower part of the Hyde Formation into the upper part of the Nicely Formation. In other words, the entire 80 feet that he assigns to the Nicely Formation near the Robertson Ranchhouse may be equivalent only to the lower part of the Nicely near Big Flat.

Ammonites and the monotid pelecypod *Lupherella boechiformis* (Hyatt) are by far the most common megafossils in the Nicely Shale. Rhynchonellid brachiopods are fairly common, also, in certain sandy or silty beds in the lower part of the formation. Other fossils that are uncommon to rare include ichthyosaur vertebrae, fish remains, ammonite aptychii, belemnite guards, small gastropods, small oysters attached to concretions, and the pelecypods *Entolium*, *Camptonectes*, *Oxytoma*, *Modiolus*, and *Pinna*. Most of these fossils occur both in concretions in all parts of the formation and along bedding planes. The fossils in the concretions are generally

well preserved and commonly are not crushed. Most of the ammonites and pelecypods occurring in the bedding planes are flattened, crumble easily, and generally are not preserved on weathered surfaces.

The Hyde Formation of Lupher (1941, p. 255, 256), as mapped by Dickinson (1962a, p. 483–486), and Dickinson and Vigrass (1965, p. 31, 32, 41, 43), consists of a 1,000–1,500 feet of thick-bedded to massive andesitic marine tuff and volcanic graywacke that form prominent ridges in the area of drainage of the South Fork of the John Day River. Minor constituents include dark volcanic siltstone and mudstone that are poorly fossiliferous. The top of the formation is marked by a thin unit of calcareous volcanic sandstone that grades fairly abruptly into the Snowshoe Formation of Lupher, 1941 (Dickinson, written commun., Feb. 1966).

The Snowshoe Formation of Lupher (1941), is about 3,000–3,500 feet thick and consists mostly of dark-gray to black thin-bedded volcanic mudstone, siltstone, and sandstone. These pass laterally in part into andesitic marine tuff and volcanic graywacke (Dickinson, 1962a, p. 483; Dickinson and Vigrass, 1965, p. 44–46, 58–60). The basal 125 feet contains ammonites of late Toarcian age and are remarkably similar lithologically to the Nicely Shale. This similarity includes the presence of black limestone concretions that weather light gray.

The megafossils found in the basal part of the Snowshoe Formation consist mostly of ammonites and the pelecypod *Bositra buchi* (Roemer). With the ammonites in some concretions have been found some small nondescript oysters. Otherwise, bottom-dwelling pelecypods are absent.

NORTHEASTERN OREGON

A lower Jurassic sequence about 980 feet thick is exposed in a small gulch that drains northward from Sheep Ridge along the northeast side of the Wallowa Mountains, about 5½ miles S. 54° W. of the center of Enterprise, Oreg. (fig. 1, No. 1). The sequence is cut by intrusive rocks, its upper limit is covered by volcanic rocks, and its lower limit is concealed by debris. The beds consist of dark-gray to black hard claystone and siltstone that are very fossiliferous and weather brownish red. Lithologically they resemble the siltstone and claystone beds of the Nicely Shale of east-central Oregon, but differ by being much harder. The greater hardness, however, appears to be a result of metamorphism induced by heat from nearby intrusive rocks. The beds have been compacted but in most places are not sheared, as is shown by the presence of many flattened but otherwise undeformed ammonites. The ammonites indicate that the lower 300 feet of the Lower Jurassic sequence is of late Sinemurian age. The next overlying 50 feet is either of latest Sinemurian or earliest Pliensbachian age. The highest 620 feet is of late Pliensbachian age. Megafossils other than ammonites are uncommon but include belemnites and the pelecypods *Entolium*, *Eopecten*, and *Lupherella*. Mud-dwelling organisms are not present.

The Lower Jurassic (Sinemurian to Pliensbachian) sequence on Sheep Ridge is considered by Bruce Nolf (unpub. Ph. D. thesis, Princeton University, 1966) to belong in the upper part of the Hurwal Formation of Smith and Allen (1941, p. 6, 13, 14). Similar argillaceous beds of Sinemurian age occur elsewhere in the Enterprise quadrangle and locally grade downward into beds of Late Triassic age (Bruce Nolf, written commun., May 18, 1966).

EAST-CENTRAL CALIFORNIA

The Sailor Canyon Formation is exposed along the North Fork of the American River in the northern Sierra Nevada, Calif. (Clark and others, 1962, fig. 1). It is at least 10,000 feet thick and consists mostly of hard gray graywacke, tuff, and dark-gray siltstone. Most beds weather brownish gray to reddish gray. A few units or beds consist of black siltstone that weathers black. Partial metamorphism of the beds is demonstrated by the stretched and distorted shapes of many of the fossils. The formation locally rests disconformably on as much as 400 feet of Upper Triassic (?) limestone and conglomerate, which in turn unconformably overlies Paleozoic strata.

Ammonites of Early Jurassic and early Middle Jurassic age have been obtained from the Sailor Canyon Formation at widely separated stratigraphic positions. The genus *Crucilobiceras* of late Sinemurian age was found about 1,000 feet above the base of the formation (USGS Mesozoic locs. 28403, 28404). Two genera, *Arieticeras* and *Reynesoceras*, of late Pliensbachian age and three genera of Pliensbachian to early Toarcian age were found associated throughout 50–100 feet of beds that lies about 2,000 feet above the base of the formation (USGS Mesozoic locs. 574, 2464, 28392, 28395, 28396). The genus *Tmetoceras* of early Bajocian age was found from 9,000 to 10,000 feet above the base (USGS Mesozoic locs. 2467, 24388, 24389). The age of the highest parts of the formation is unknown.

Megafossils other than ammonites are uncommon in the Sailor Canyon Formation. They include the pelecypods *Entolium? semiplicatum* (Hyatt) in beds of late Sinemurian age, *Lupherella boechiformis* (Hyatt) and *Hemientolium?* in beds of late Pliensbachian age, and *Bositra buchi* (Roemer) (Jeffries and Minton, 1965, p. 156), formerly called *Posidonia ornati* Quenstedt, in beds of early Bajocian age. The only bottom-dwelling pelecypod is *Gryphaea* which occurs in a brownish-

black calcareous siltstone and was found about half a mile from and a little above the main beds bearing late Pliensbachian ammonites (Hyatt, 1894, p. 417).

AGES AND CORRELATIONS

SUPLEE FORMATION OF LUPHER (1941) IN EAST-CENTRAL OREGON

Ammonites have been found rarely in the lower two-thirds of the Suplee Formation of Lupher. By contrast the upper third has furnished some ammonites at many localities (table 3, and figs. 3–5), although only at USGS Mesozoic locality 26732 have ammonites been found in moderate abundance. Many of the ammonites are poorly preserved and deformed, and hence are difficult to identify. The genera present include *Partschiceras?*, *Lytoceras*, *Reynesoceras*, *Arieticeras*, *Canavaria*, *Protogrammoceras*, *Fuciniceras*, and *Fanninoceras*. Most of the specimens present belong to the last three genera mentioned.

The exact age of the lower two-thirds of the Suplee Formation is unknown. An age not older than Pliensbachian is indicated, however, by the presence of a species of *Gryphaea* resembling *G. cymbium* Lamarck. Also, the Suplee Formation locally north of Rosebud Creek rests on shaly beds that near their top have furnished the ammonites *Crucilobiceras* and *Gleviceras* (Mesozoic loc. 28367) whose association indicates a late Sinemurian age. Another bit of evidence consists of a fragment of the flank of an ammonite found as float on the Suplee Formation near Dickinson's locality F55 in the SE¼SW¼ sec. 20, T. 17 S., R. 28 E., Grant County. This fragment was referred to *Subcollina* in preliminary reports, but it also resembles *Crucilobiceras* of late Sinemurian age, or the inner whorls of *Uptonia* of early Pliensbachian age.

The age of the upper third of the Suplee Formation is definitely late Pliensbachian as shown by the presence of the ammonites *Arieticeras* and *Canavaria* (fig. 6) and by its stratigraphic position below the Nicely Shale which contains many ammonite genera of middle to late Pliensbachian age. The presence of *Protogrammoceras* and *Fuciniceras* in fair abundance is also suggestive of a late Pliensbachian age, although both genera range from the upper part of the lower Pliensbachian (zone of *Prodactylioceras davoei*) into the basal part of the Toarcian (Dubar and Mouterde, 1961, p. 239; Dubar, 1961a, p. 246–253; Mouterde, 1955, p. 18–26). The presence of *Reynesoceras* at one locality is additional evidence for a Pliensbachian age not older than the zone of *Prodactylioceras davoei*.

NICELY SHALE OF LUPHER (1941) IN EAST-CENTRAL OREGON

The entire Nicely Shale of Lupher is of late Pliensbachian age. This is shown by comparing the stratigraphic ranges of the ammonite genera (fig. 5) within the Nicely Shale with their European ranges (fig. 6). Thus *Reynesoceras* and *Arieticeras*, which range from the base to near the top of the Nicely Shale, are unknown in Europe above the Pliensbachian, and in Europe, *Arieticeras* is known only from the upper Pliensbachian. Similarly, *Leptaleoceras* ranges through the middle and upper parts of the Nicely Shale and is recorded in Europe only from the upper Pliensbachian. Likewise, *Tragophylloceras* obtained near the middle of the upper half of the Nicely Shale has been found in Europe throughout the Pliensbachian as high as the zone of *Amaltheus margaritatus* (Howarth and Donovan, 1964, p. 293).

Other evidence of a late Pliensbachian age for the Nicely Shale consists of the presence of the ammonites *Prodactylioceras* throughout the lower half and *Liparoceras* (*Becheiceras*) from near the middle of the formation. The association of *Becheiceras* with *Dactylioceras* (Mesozoic loc. 26739) and with *Arieticeras* and *Paltarpites* (Mesozoic loc. 29222) indicates a slightly higher stratigraphic position for the genus than is known in Europe.

Additional age evidence is furnished by the ammonites *Fontanelliceras* and *Metacymbites?*, obtained from unknown stratigraphic positions within the Nicely Shale. Of these genera, *Fontanelliceras* is typical of the late Pliensbachian, and *Metacymbites* is not known above the zone of *Amaltheus margaritatus* in Europe. The specimen from Oregon that is questionably assigned to *Metacymbites?* was obtained from the same concretion as *Arieticeras* and *Paltarpites*. In Europe these genera occur higher in the Pliensbachian than *Metacymbites*.

The Nicely Shale also contains the ammonites *Paltarpites*, *Harpoceras?*, and *Dactylioceras*, which in Europe range from the upper Pliensbachian into the Toarcian. Of these, *Paltarpites* is recorded from the middle third of the formation and in Europe ranges through most of the upper Pliensbachian into the basal Toarcian (Buckman, 1922, pl. 362; 1923, pl. 363; 1927, pl. 698; Dubar and Mouterde, 1961, p. 240). *Harpoceras* in northwest Europe ranges through the entire lower Toarcian (Dean and others, 1961, p. 476–480; Donovan, 1958, p. 43) but has been recorded, also, from

the upper Pliensbachian in Portugal (Mouterde, 1955, p. 23) and in Austria (Fischer, 1966, p. 12, 13). *Dactylioceras*, found in the middle third of the Nicely Shale, is most common in Europe from the base of the Toarcian into the zone of *Haugia variabilis* (Dean and others, 1962, p. 476–481, 484), but it occurs in the highest part of the Pliensbachian in Portugal (Mouterde, 1955, p. 24) and in England (Howarth, 1957, p. 193, 197–200). In Portugal it is associated with *Canavaria*, *Paltarpites*, *Harpoceras*, and *Protogrammoceras*. In England it is associated with *Pleuroceras* and *Paltarpites*.

In summation, the Nicely Shale contains three genera, *Leptaleoceras*, *Arieticeras*, and *Fontanelliceras*, that in Europe have been found only in upper Pliensbachian beds. It contains four genera, *Tragophylloceras*, *Liparoceras* (*Becheiceras*), *Reynesoceras*, *Prodactylioceras*, and possibly also *Metacymbites*, that in Europe range from the lower into the upper Pliensbachian but no higher. The Nicely Shale contains three genera, *Paltarpites*, *Protogrammoceras*, and *Fuciniceras*, that in Europe range from the Pliensbachian into the basal Toarcian. It contains one genus, *Dactylioceras*, that in Europe ranges from the highest Pliensbachian (upper part of *Pleuroceras spinatum* zone) into the basal part of the upper Toarcian. The ranges and associations of these genera within the Nicely Shale are excellent evidence, therefore, that the entire formation is of late Pliensbachian age. The presence of *Dactylioceras* in the middle third of the Nicely Shale indicates that at least the upper two-thirds of that formation is as young as the *Pleuroceras spinatum* zone at the top of the Pliensbachian.

During preliminary faunal studies, the writer considered the Nicely Shale to be of early Toarcian rather than of late Pliensbachian age (Dickinson, 1962a, p. 483; Hallam, 1965, p. 1489; Dickinson and Vigrass, 1965, p. 37, 41) because it contained some specimens of finely ribbed *Dactylioceras* and did not contain any genera of the Amaltheidae such as characterize beds of late Pliensbachian age in northwest Europe, the Arctic region, and western Canada. This evidence was substantiated by the presence in the Sailor Canyon Formation in California of many specimens of *Dactylioceras* along with other ammonites of which most were identical specifically with ammonites in the Nicely Shale. Such numbers of finely ribbed *Dactylioceras* by comparison with the European faunal succession was considered good evidence for an early Toarcian age.

With the age of the Nicely Shale thus reasonably established as early Toarcian, the ammonites described herein were referred to genera of Toarcian age in preliminary reports. For example, *Fuciniceras* and *Protogrammoceras* were referred to *Hildaites*, *Arieticeras* to *Orthildaites*, *Prodactylioceras* to *Zugodactylites*, and *Peronoceras* and *Paltarpites* to *Harpoceras*.

Later, while describing the ammonites the writer found one ammonite similar to *Metacymbites*, two fragments belonging to *Becheiceras*, and some fairly well preserved specimens of *Leptaleoceras* and *Reynesoceras*. As these genera are definitely of Pliensbachian age, on the basis of their European ranges, all previous generic and age determinations became suspect. Consequently, all fossil collections were reexamined and reevaluated.

At first the evidence for a Pliensbachian age furnished by these ammonites was discounted because the ranges of some rather uncommon genera, such as *Tragophylloceras* and *Metacymbites*, have probably not yet been well established in Europe, and the ranges of other genera, such as *Harpoceras* and *Polyplectus*, are reported to be much longer in the Mediterranean region than in northwest Europe (Donovan, 1958, p. 42). As studies continued, however, evidence favoring a late Pliensbachian age for the entire Nicely Shale gradually became overwhelming. This conclusion is based primarily on the stratigraphic distribution of *Arieticeras* and *Leptaleoceras* throughout most of the Nicely Shale (fig. 3), on the presence of *Tragophylloceras* high in the formation, on the identity or close similarity of some species in the Nicely Shale to species of *Arieticeras*, *Leptaleoceras*, and *Prodactylioceras* from upper Pliensbachian beds in British Columbia (Frebold, 1964a, p. 2, 3, 8–10, 13–15), and on finding records of *Dactylioceras* near the top of the Pliensbachian in England (Howarth, 1957, p. 193, 197–200) and Portugal (Mouterde, 1955, p. 24).

These records show that in England, *Dactylioceras* is associated with the ammonites *Pleuroceras* and *Paltarpites* (Howarth, 1957, p. 193, pl. 17, figs. 5, 6) and in Portugal is associated with *Canavaria*, *Paltarpites*, *Harpoceras* (*Ovaticeras*), *Eleganticeras*, and *Protogrammoceras*. Such associations are similar to those occurring in the Nicely Shale in Oregon and in the Sailor Canyon Formation in California. Evidently the presence of densely and finely ribbed species of *Dactylioceras* by themselves is not positive evidence of an early Toarcian age.

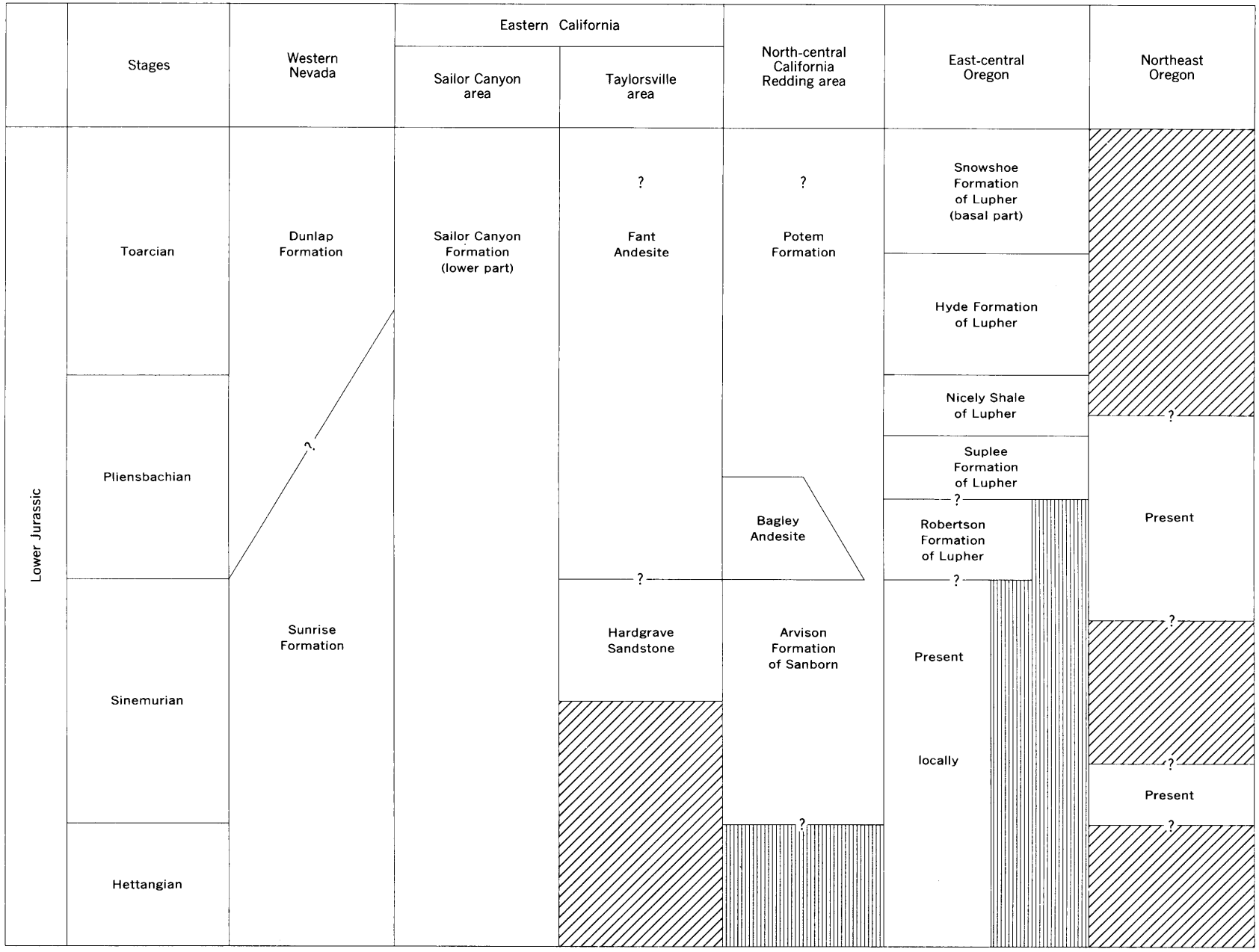

FIGURE 3.—Correlation of some Lower Jurassic formations in Oregon, California, and Nevada.

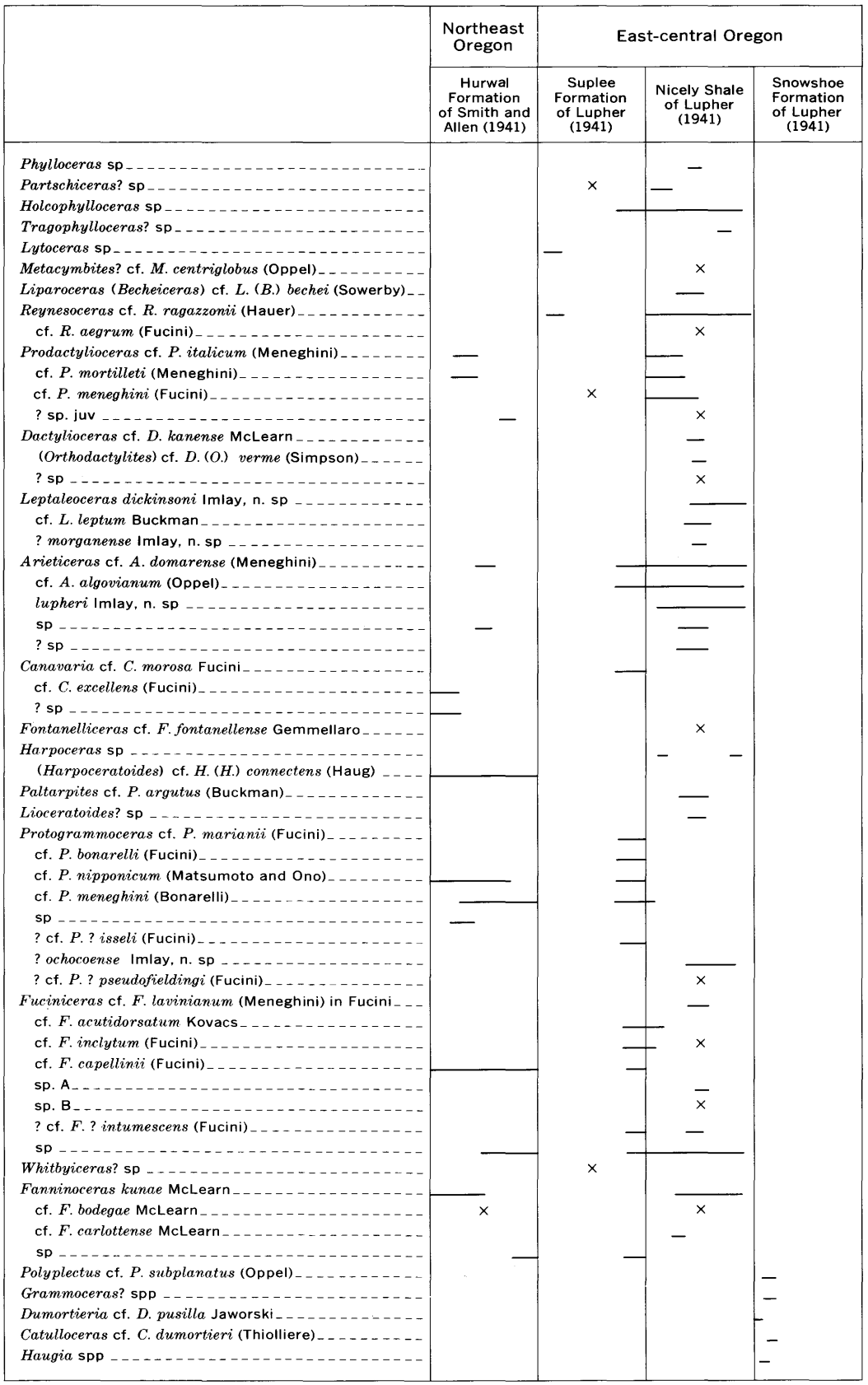

FIGURE 4.—Stratigraphic distribution of some upper Lower Jurassic ammonite species in eastern Oregon (× indicates that stratigraphic position within formation is unknown).

TABLE 3.—*Geographic distribution of ammonites of late Early*

[Nos. 1-29 refer to numbers in figs. 1 and 2. Most of the larger numbers refer to Mesozoic collections in the U.S. Geol.

	Oregon																																							
	Wallowa County					Grant County																																			
	Enterprise quadrangle					Seneca quadrangle					Logdell quadrangle				Izee quadrangle																											
	Hurwol formation of Smith and Allen 1941					Nicely Shale [1]		Suplee Formation [1]			Snowshoe Formation [1]				Nicely Shale [1]		Suplee Formation [1]				Nicely Shale [1]					Suplee Formation [1]				Nicely Shale [1]					Suplee Formation [1]					
	1					2		3	4	5	6				7	8				9								10	11	12	13	14									
	28807	28808	28809	28810	28820	Lupher 35	Lupher 47	Lupher 37	27388	Lupher 45	25823	28030	29216	29217	25819	Dickinson F84	26732	26733	26734	28372	26740	26742	29213	29214	29219	29220	29224	29226	28366	25689	27359	27358	Dickinson F82	Dickinson F81	27360	27361	28033			
Phylloceras sp																															X									
Partschiceras? sp																							X			X														
Holcophylloceras sp																	X														X	X			X	X			
Tragophylloceras sp																																								
Lytoceras sp								X	X																															
Crucilobiceras? sp																																								
Metacymbites? cf. *M. centriglobus* (Oppel)																																								
Liparoceras (*Becheiceras*) cf. *L.* (*B.*) *bechei* (Sowerby)																															X									
Reynesoceras cf. *R. ragazzonii* (Hauer)									X						X																			X					
cf. *R. aegrum* (Fucini)																																								
Prodactylioceras cf. *P. italicum* (Meneghini)			X																					X															
cf. *P. mortilleti* (Meneghini)			X																					X															
cf. *P. meneghini* (Fucini)										X											X																		
? sp. juv				X																	X																		
Dactylioceras cf. *D. acanthus* Buckman (non d'Orbigny)																																							
cf. *D. kanense* McLearn																																								
(*Orthodactylites*) cf. *D.* (*O.*) *tenuicostatum* (Young and Bird)																																								
cf. *D.* (*O.*) *verme* (Simpson)																																								
? sp																					X																		
Leptaleoceras dickinsoni Imlay, n. sp																															X				X					
cf. *L. leptum* Buckman																					X																		
? *morganense* Imlay, n. sp																																								
Arieticeras cf. *A. domarense* (Meneghini)			X				X										X	X				X																	
cf. *A. algovianum* (*Oppel*)						X	X										X	X				X					X												
lupheri Imlay, n. sp																																			X	X				
sp			X																										X										
? sp																																								
Canavaria cf. *C. morosa* Fucini																	X																							
cf. *C. excellens* (Fucini)				X																																			
? sp				X																																			
Fontanelliceras cf. *F. fontanellanse* (Gemmellaro)							X																																	
Harpoceras sp																																								
(*Harpoceratoides*) cf. *H.* (*H.*) *contectens* (Haug)	X	X		X	X																																		
Paltarpites cf. *P. argutus* (Buckman)							X														X																		
Lioceratoides? sp																																								
Protogrammoceras cf. *P. marianii* (Fucini)																	X																							
cf. *P. bonarelli* (Fucini)																	X																							
cf. *P. nipponicum* (Matsumoto and Ono)		X		X													X										X			X	X								
cf. *P. meneghini* (Bonarelli)	X		X		X												X																						X
sp			X															X	X													X							
? cf. *P.* ? *isseli* (Fucini)																	X																						
? *ochocoense* Imlay, n. sp																																								
? cf. *P.* ? *pseudofieldingi* (Fucini)																																								

[1] Of Lupher (1941).

Jurassic age in eastern Oregon and California

Survey. Collections referred to Dickinson are at Leland Stanford Univ. Collections referred to Lupher are at the Calif. Acad. Sci.]

Oregon—Continued																																		California				
Grant County—Continued																																		Placer County				
Izee quadrangle—Continued																																		Royal Gorge and Duncan Park quadrangles				
Nicely Shale [1]													Suplee formation [1]		Nicely Shale [1]		Snowshoe Formation [1]		Nicely Shale [1]	Suplee Formation [1]		Snowshoe Formation [1]	Nicely Shale [1]					Suplee Formation [1]	Nicely shale [1]							Sailor Canyon Formation				
15													16	17		18	19	20			21		22	23	24		25						26	27				28			29				
26739	26743	26745	26746	27378	27379	27380	27381	27392	Lupher 71	Lupher 72	Lupher 125	Dickinson F80	Dickinson F55	Lupher 77	29212	Dickinson F79	26741	25690	26751	Lupher 76	Dickinson F76	29223	Dickinson F39	29228	26750	Lupher 127	Dickinson F75	26747	29222	Lupher 119	Lupher 144	Lupher 300 sh	Lupher 300 ss	Dickinson F30	29218	Lupher 404	Lupher 552	Lupher 553	29326	29327	Lupher 121	574	2464	28391	28395	28396

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TABLE 3.—*Geographic distribution of ammonites of late Early*

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	Oregon																																					
	Wallowa County					Grant County																																	
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	Hurwol formation of Smith and Allen 1941					Nicely Shale [1]		Suplee Formation [1]			Snowshoe Formation [1]				Nicely Shale [1]		Suplee Formation [1]			Nicely Shale [1]				Suplee Formation [1]						Nicely Shale [1]				Suplee Formation [1]				
	1					2		3	4	5	6				7	8			9							10	11	12	13	14									
	28807	28808	28809	28810	28820	Lupher 35	Lupher 47	Lupher 37	27388	Lupher 45	25823	28030	29216	29217	25819	Dickinson F84	26732	26733	26734	28372	26740	26742	29213	29214	29219	29220	29224	29226	28366	25689	27359	27358	Dickinson F82	Dickinson F81	27360	27361	28033
*Fucinicera*s cf. *F. lavinianum* (Meneghini) in Fucini.																																						
cf. *F. acutidorsatum* Kovacs																	×			×								×									
cf. *F. inclytum* (Fucini)																	×																				
cf. *F. capellinii* (Fucini)	×			×	×												×	×																			
sp. A																																					
sp. B							×																														
? cf. *F. ? intumescens* (Fucini)																	×																				
sp	×	×			×					×						×					×		×	×		×					×	×	×		×		
Whitbyiceras? sp										×																											
Fanninoceras kunae McLearn			×	×	×																×														×		
cf. *F. bodegae* McLearn					×										×						×																
cf. *F. carlottense* McLearn																																					
sp	×																																				
Polyplectus cf. *subplanatus* (Oppel)																																					
Gramoceras? spp																																					
Dumortieria? cf. *D. pusilla* Jaworski											×	×	×	×																							
Catulloceras cf. *C. dumortieri* (Thiolliere)																																					
Haugia spp																																					

[1] Of Lupher (1941).

SNOWSHOE FORMATION OF LUPHER (1941) IN EAST-CENTRAL OREGON

The basal 4–5 percent of the Snowshoe Formation of Lupher in the Izee area has furnished ammonites (table 3) of late Toarcian age at three places. In the bed of Flat Creek, just east of Big Flat, about 75 feet above the base of the formation, have been obtained *Haugia* spp., *Polyplectus* cf. *P. subplanatus* (Oppel), and *Grammoceras*? spp. (USGS Mesozoic loc. 26750 and Lupher's loc. 127). In a roadcut on the divide between Sheep Creek and Hole-in-the-Ground, about 100–125 feet above the base of the Snowshoe Formation, have been obtained *Polyplectus* cf. *P. subplanatus* (Oppel), *Catulloceras* cr. *C. dumortieria* (Thoiolliere), and *Grammoceras*? sp. (Mesozoic locs. 26751, 25690, and Lupher's loc. 76). From the west bank of Wickiup Creek near the base of the Snowshoe Formation have been obtained *Dumortieria*? cf. *D. pusilla* Jaworski and fragments of other ammonites suggestive of *Catulloceras* and *Hammatoceras* (Mesozoic locs. 25823, 28030, 29216, 29217). The collections in Flat Creek were made 50 feet below the lowest occurrences of the early Bajocian ammonite *Tmetoceras*.

The collections from Flat Creek that contain *Haugia* are correlated with the European zone of *Haugia variabilis* because of the presence of the genus *Haugia*, which in Europe ranges from the upper part of the *Hildoceras bifrons* zone through the *Haugia variabilis* zone (fig. 6). The presence of many fragments resembling *Grammoceras* suggests an age not older than the *Haugia variabilis* zone. The collections that contain *Catulloceras* and *Dumortieria*? are correlated with the European zone of *Dumortieria levesquei* inasmuch as those genera are characteristic of that zone and have not been found lower.

HURWAL FORMATION OF SMITH AND ALLEN (1941) IN NORTHEASTERN OREGON

Ammonites of late Early Jurassic age have been collected stratigraphically (table 3) from the upper 620

Jurassic age in eastern Oregon and California—Continued

Survey. Collections referred to Dickinson are at Leland Stanford Univ. Collections referred to Lupher are at the Calif. Acad. Sci.]

Oregon—Continued																																		California					
Grant County—Continued																																		Placer County					
Izee quadrangle—Continued																												Delintment Lake quadrangle										Royal Gorge and Duncan Park quadrangles					
Nicely Shale [1]												Suplee formation [1]		Nicely Shale [1]		Snowshoe Formation [1]		Nicely Shale [1]	Suplee Formation [1]			Snowshoe Formation [1]		Nicely Shale [1]								Suplee Formation [1]		Nicely Shale [1]				Sailor Canyon Formation					
15												16		17		18	19	20			21		22	23	24		25							26	27			28		29					
26739	26743	26745	26746	27378	27379	27380	27381	27392	Lupher 71	Lupher 72	Lupher 125	Dickinson F80	Dickinson F55	Lupher 77	29212	Dickinson F79	26741	25690	26751	Lupher 76	Dickinson F76	29223	Dickinson F39	29228	26750	Lupher 127	Dickinson F75	26747	29222	Lupher 119	Lupher 144	Lupher 300 sh	Lupher 300 ss	Dickinson F30	29218	Lupher 404	Lupher 552	Lupher 553	29326	29327	Lupher 121	574	2464	28391	28395	28396
								×									×																												
	×		×						×	×	×											×	×										×				×							×
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feet of a sequence, assigned to the Hurwal Formation of Smith and Allen, exposed on Sheep Ridge southwest of Enterprise, Oreg. The fossil collection (Mesozoic loc. 28810) from the lowest 160 feet of the 620 feet of beds contains the ammonite *Canavaria*, which in Europe is characteristic of the upper Pliensbachian (fig. 6), in association with the subgenus *Harpoceras* (*Harpoceratoides*) which in Europe is not known below the highest Pliensbachian. The fossil collection (Mesozoic loc. 28809) from the next higher 190 feet of beds is correlated also with the highest Pliensbachian of Europe on the basis of the association of *Arieticeras*, *Harpoceras* (*Harpoceratoides*), and *Prodactylioceras*. Of these, *Arieticeras* and *Prodactylioceras* have not been reported above the Pliensbachian. The fossil collections (Mesozoic locs. 28807 and 28808) from the upper 270 feet of the 620 feet of beds contain an association of ammonite genera that could be either latest Pliensbachian or earliest Toarcian in age. The presence of *Protogrammoceras* and *Fuciniceras* shows, however, that the fossil collections are not younger than the basal Toarcian zone of *Dactylioceras tenuicostatum*.

The entire upper 620 feet of Hurwal Formation in northeastern Oregon is correlated on the basis of identical species of *Prodactylioceras*, *Arieticeras*, *Protogrammoceras*, *Fuciniceras*, and *Fannioceras* with the upper third of Lupher's Suplee Formation and at least the lower third of his Nicely Shale (fig. 4). Correlation of the upper 460 feet with the Nicely Shale is indicated, also, by the presence of the pelecypod *Lupherella boechiformis* (Hyatt). Faunally the upper 620 feet of the Hurwal Formation differs from the Suplee and Nicely Formations by the presence of the ammonite *Harpoceratoides* and by the absence of the ammonites *Reynesoceras*, *Paltarpites*, and *Dactylioceras*. The absence of the last two genera may mean that the highest part of the Hurwal Formation is not as young as the middle and upper parts of the Nicely Shale. Such a possibility needs confirmation by additional collecting.

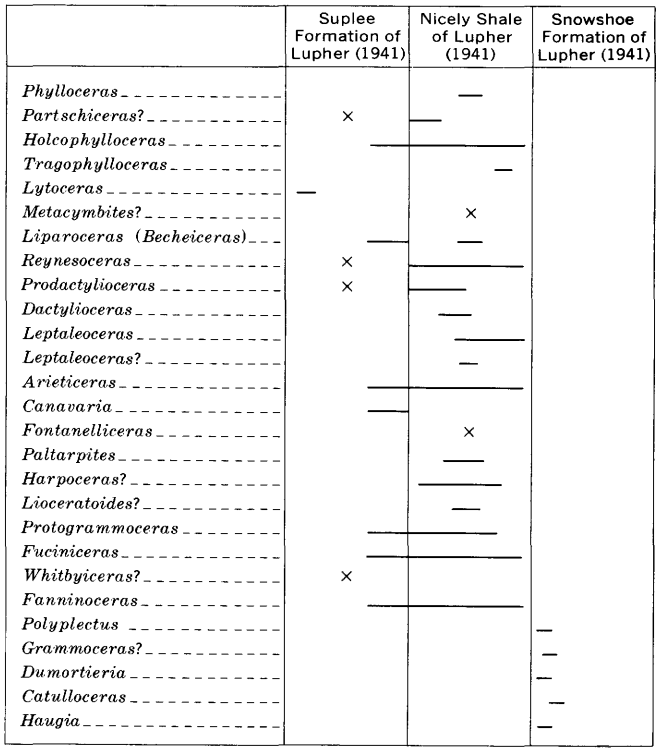

FIGURE 5.—Stratigraphic distribution of upper Lower Jurassic ammonite genera near Izee in east-central Oregon (× indicates that stratigraphic position within formation is unknown).

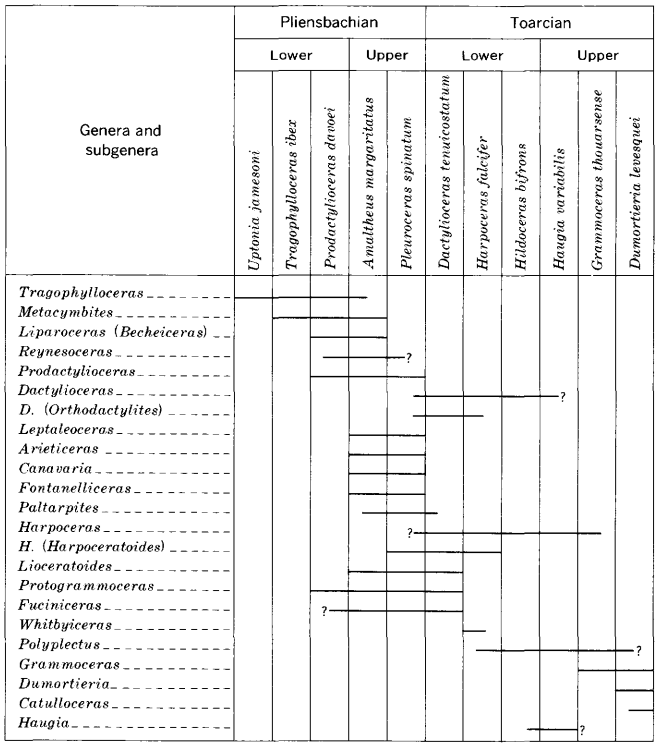

FIGURE 6.—European ranges of certain Pliensbachian and Toarcian ammonite genera that are present or possibly present in eastern Oregon and California.

SAILOR CANYON FORMATION IN EAST-CENTRAL CALIFORNIA

Most of the fossils of late Early Jurassic age that have been obtained from the Sailor Canyon Formation are from Sailor Canyon near and west of the Trinidad mine (abandoned) in the Royal Gorge quadrangle. The horizontal distance involved is about 1,000–1,200 feet, and the thickness of beds involved is perhaps 800–1,000 feet. The largest collection, USGS Mesozoic locality 28396, was obtained from about 50 to 100 feet of dark gray siltstone exposed on the trail almost due west of the mine and about 1,000 feet west of the bottom of the canyon. Apparently all the fossils at USGS Mesozoic locality 574 and part of those at USGS Mesozoic locality 2464 were obtained at about the same locality and stratigraphic position as Mesozoic locality 28396 because they contain many identical species that are preserved in lithologically identical matrix. Some generically indeterminable ammonites at Mesozoic locality 2464, however, are preserved in a softer black siltstone which, according to an accompanying note by the collector, Cooper Curtice, are "supposed to be below No. 574, but very little." In addition, one large generically indeterminable ammonite from Mesozoic locality 2464 is preserved in black siltstone obtained from "nearly opposite a little falls on the east side of the main canyon." It appears, therefore, that all the generically determinable ammonites were obtained at about the same place and stratigraphic position and represent a single faunal assemblage.

The ammonites of late Early Jurassic age that are preserved in a dark gray siltstone in the Sailor Canyon Formation include the following:

Reynesoceras cf. *R. raggazzoni* (Hauer) (Mesozoic locs. 574, 2464, 28396).
Dactylioceras cf. *D. acanthus* (Buckman) (non d'Orbigny) (Mesozoic locs. 28391, 28395, 28396).
cf. *D. tenuicostatum* (Young and Bird) (Mesozoic locs. 574, 2464, 28396).
cf. *D. verme* (Simpson) (Mesozoic loc. 28396).
Arieticeras cf. *A. domarense* (Meneghini) (Mesozoic locs. 2464, 28396).
Harpoceras (*Harpoceratoides*)? sp. (Mesozoic loc. 574).
Protogrammoceras cf. *P. meneghini* (Bonarelli) (Mesozoic locs. 2464, 28396).
sp. (Mesozoic locs. 574, 28395).
Fuciniceras sp. (Mesozoic loc. 28396).

In addition, some ammonites preserved in a black siltstone matrix (Mesozoic loc. 2464) include two small fairly smooth specimens resembling *Leptaleoceras*, five fragments of a large evolute harpoceratid resembling *Paltarpites*, and two fragments that were labeled *Peronoceras*? by Alpheus Hyatt but which also resemble specimens of *Prodactylioceras* from Oregon.

This ammonite assemblage is nearly identical with that in the Nicely Shale in Oregon. It differs mainly by being less well preserved, much less varied, and by containing many more specimens of densely ribbed *Dactylioceras*. The presence of *Dactylioceras* in fair abundance has been the basis in the past for assigning an early Toarcian age to the assemblage in the Sailor Canyon Formation (Clark and others, 1962, p. B19). The presence of *Reynesoceras* and *Arieticeras*, however, in equal or greater abundance than *Dactylioceras* is much better evidence for a late Pliensbachian age. The possibility that the three genera are associated as a consequence of extremely slow deposition seems unlikely considering the great thickness of the formation. The possibility that *Dactylioceras* actually occurs at a slightly higher level than the other genera was not apparent to the writer and his associates while collecting the fossils at USGS Mesozoic locality 28396. Furthermore, *Dactylioceras* is now known to occur in beds of late Pliensbachian age in England, Portugal, and eastern Oregon, as discussed in detail herein. Therefore, its association with *Reynesoceras* and *Arieticeras* as in the Sailor Canyon Formation has precedents elsewhere.

COMPARISONS WITH OTHER FAUNAS

SOUTHERN MEXICO

The lower Pliensbachian ammonite *Uptonia* has been identified by Burckhardt (1930, p. 15, 20, 21) and Erben (1956, p. 16, 126, 365, pl. 41, figs. 14, 15; 1957, p. 44) on the basis of two small fragments obtained from the upper part of the Totolapa Formation in northern Puebla. These fragments have not been described and are not identifiable generically from their illustrations. Their assignment to *Uptonia* is questioned because they are associated with *Plesechioceras* and *Euechioceras* (Erben, 1956, p. 126, 332, 334; pl. 40, figs. 6, 7; pl. 41, figs. 4–7), which are synonyms of *Paltechioceras* (Arkell and others, 1957, p. L244) and are characteristic of the upper Sinemurian (Hallam, 1965, p. 1493). The upper Pliensbachian ammonite *Arieticeras* has been described by Erben (1954, p. 5–12, pl. 1, figs. 4, 5; text fig. 2 on p. 21) on the basis of one fairly well preserved specimen from Guerrero. The Toarcian Stage has not yet been identified faunally in Mexico.

NEVADA

Pliensbachian ammonites have been recorded from several localities in western Nevada (figs. 7 and 8) (Muller and Ferguson, 1939, p. 1621, 1622; Silberling, 1959, p. 26–29; Hallam, 1965, p. 1485–1488). An ammonite assemblage from near the top of the Sunrise Formation in New York Canyon in the Gabbs Valley Range has been correlated with the lower Pliensbachian (Muller and Ferguson, 1939, p. 1612). The presence of *Eoderoceras*, however, if correctly identified, is evidence for correlation with the upper Sinemurian (Arkell and others, 1957, p. L247). The lower Pliensbachian is possibly represented by an ammonite tentatively referred to *Uptonia* that was found in the Union district in the Shoshone Mountains (Silberling, 1959, p. 27, 29). The upper Pliensbachian is represented by a well-preserved specimen of *Arieticeras* from the Westgate area, about 60 miles east of Fallon.

Both lower and upper Toarcian ammonites have been found near Westgate, Nevada (Hallam, 1965, p. 1485–1488; Corvalan, 1962). *Nodicoeloceras*, obtained a few feet above *Arieticeras*, is indicative of the European lower Toarcian zones of *Dactylioceras tenuicostatum* and *Harpoceras falcifer* (Howarth, 1962, p. 408, 410; Fischer, 1966, p. 13, 35). *Dactylioceras*, obtained about 130 feet above *Arieticeras*, ranges from the highest Pliensbachian into the lower part of the upper Toarcian (Howarth, 1957, p. 197, 200; Dean and others, 1961, p. 481). *Catacoeloceras*, obtained a few feet above *Dactylioceras*, occurs in Europe in the zones of *Hildoceras bifrons* and *Haugia variabilis* (Howarth, 1962, p. 408). Nearly 300 feet above *Arieticeras* were found the ammonites *Grammoceras* and *Pseudolioceras*. Of these, *Grammoceras* in Europe occurs in the upper Toarcian zones of *Grammoceras thouarsense* and *Dumorteria levesquei* (Dean and others, 1961, p. 486; Fischer, 1966, table facing page 70), and *Pseudolioceras* ranges from the zone of *Harpoceras falcifer* into the Bajocian (Dean and others, 1961, p. 480; Frebold, 1960, p. 21, 28).

The presence of upper Pliensbachian beds in the Westgate area has been questioned by Hallam (1965, p. 1488, 1493) because the full range of *Arieticeras* has not been firmly established in the Mediterranean region, where the genus is very common, and because in the Westgate area an insufficient thickness of beds exists between the basal Toarcian and the highest beds containing upper Sinemurian ammonites to account for the Pliensbachian Stage.

These arguments against the presence of upper Pliensbachian beds in Nevada are not convincing for several reasons. First, the ammonite *Arieticeras* has been found in many parts of the world in upper Pliensbachian beds but has never been found in higher or lower beds. Second, in Portugal, *Arieticeras* occurs in upper Pliensbachian beds but does not range into the Toarcian zone of *Dactylioceras tenuicostatum* (Mouterde, 1955, p. 22–26), which is represented by many ammonites. Third, the section near Westgate, as published by Hallam (1965, p. 1487), shows nearly 200 feet of beds between the basal Toarcian and the highest occurrence of the upper Sinemurian ammonite *Xiphero-*

	Stages	Northwest European Ammonite zones (After Dean and others, 1961)	Western Nevada (Muller and Ferguson, 1939; Hallam, 1965)	East-central Oregon	Western and Interior of British Columbia (Frebold, 1964a)	Wrangel Mountains, south side, southern Alaska	Cook Inlet region and Alaska Peninsula, southern Alaska
Lower Jurassic	Toarcian	*Dumortieria levesquei*	*Grammoceras*	*Catulloceras* and *Dumortieria*	*Catulloceras?*		
		Grammoceras thouarsense			*Grammoceras* cf. *G. fallaciosum*		*Grammoceras*
		Haugia variabilis	*Catacoeloceras* and *Dactylioceras*	*Haugia* and *Polyplectus*			*Haugia* and *Phymatoceras*
		Hildoceras bifrons	?	?	*Peronoceras* and *Dactylioceras*		*Dactylioceras* cf. *D. commune*
		Harpoceras falcifer	*Nodicoeloceras*		*Harpoceras* cf. *H. exaratum*		?
		Dactylioceras tenuicostatum		?	?		
	Pliensbachian	*Pleuroceras spinatum*	*Arieticeras*	*Arieticeras, Reynesoceras, Paltarpites, Prodactylioceras*, and *Leptaleoceras*	?	*Arieticeras*	*Pleuroceras, Amaltheus*, and *Paltarpites*
		Amaltheus margaritatus			*Arieticeras, Amaltheus*, and *Leptaleoceras*		
		Prodactylioceras davoei		?	*Prodactylioceras* and *Becheiceras*	?	
		Tragophylloceras ibex					
		Uptonia jamesoni	*Uptonia?*	?	*Uptonia*	*Uptonia*	*Uptonia, Apoderoceras*, and *Acanthopleuroceras*
	Sinemurian	*Echioceras raricostatum*	*Eoderoceras* and *Crucilobiceras*	*Crucilobiceras* and *Eoderoceras*		*Crucilobiceras* and *Eoderoceras*	*Crucilobiceras*
		Oxynoticeras oxynotum	*Oxynoticeras*	?	?		
		Asteroceras obtusum	?		*Asteroceras*		
		Caenisites turneri				*Microderoceras*	
		Arnioceras semicostatum	?	?	?	?	?
		Arietites bucklandi	*Arnioceras, Arietites, Coroniceras*, and *Megarietites*	*Arnioceras*	*Arnioceras* and *Paracoroniceras*	*Arnioceras*	*Arnioceras*
				?	*Coroniceras*	?	?
							Coroniceras
	Hettangian	*Schlotheimia angulata*	*Schlotheimia* and *Alsatites*	*Schlotheimia* and *Alsatites*	*Schlotheimia*		*Schlotheimia*
		Alsatites liasicus	?	?	?		*Waehneroceras*
		Psiloceras planorbis	*Waehneroceras* and *Psiloceras*	*Waehneroceras* and *Psiloceras*	*Psiloceras*		

FIGURE 7.—Correlation of Lower Jurassic ammonite faunas in the Pacific coast region.

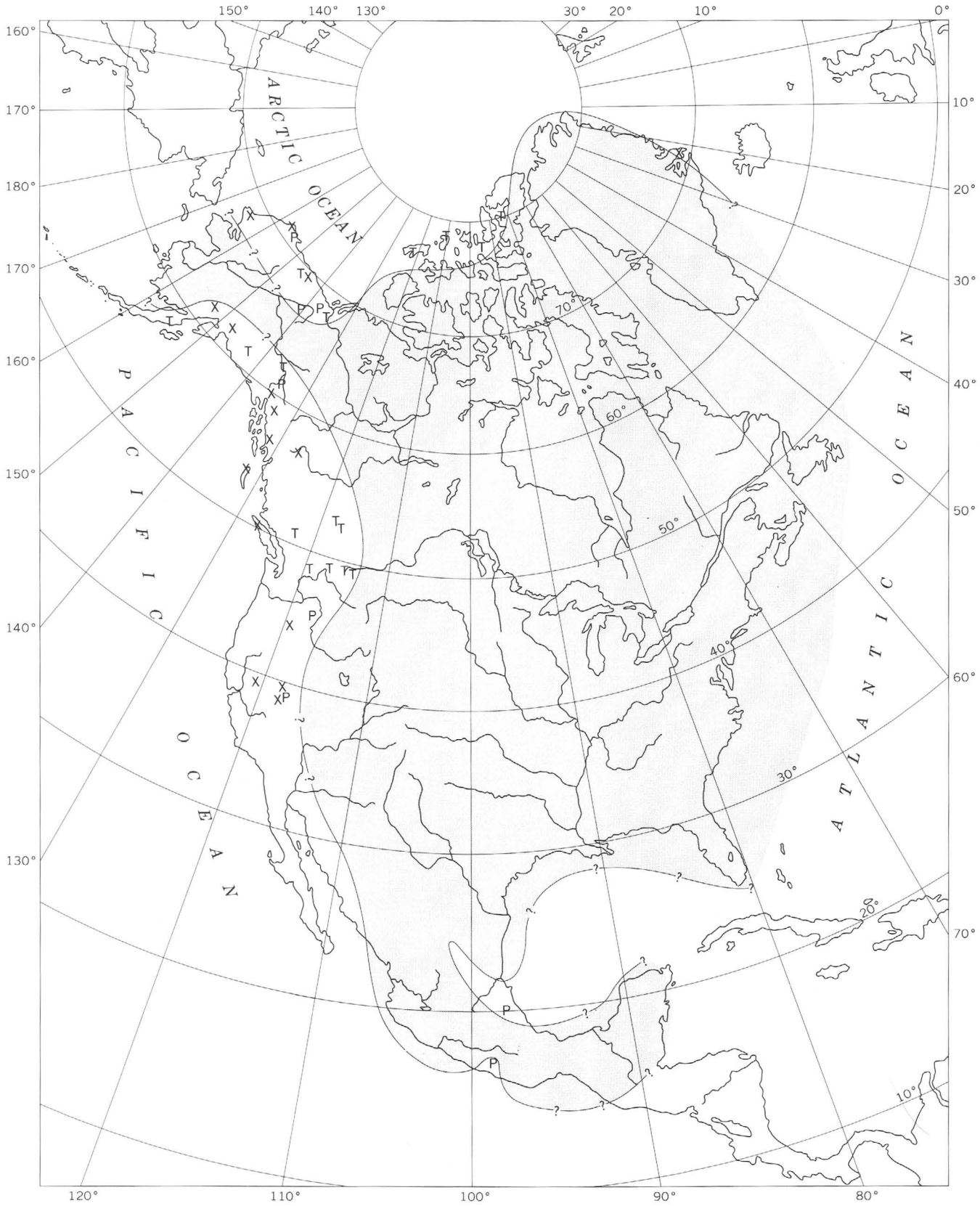

FIGURE 8.—Regional distribution of upper Lower Jurassic marine rocks in North America (x=Pliensbachian and Toarcian; P=Pliensbachian only; T=Toarcian only).

ceras. This thickness appears to be adequate to account for the Pliensbachian, especially by comparison with the thickness of beds in the same sequence actually occupied by ammonites of Hettangian, Sinemurian, and Toarcian age.

BRITISH COLUMBIA AND SOUTHERN YUKON

The various European zones of the Pliensbachian and Toarcian Stages are much better represented in British Columbia than in Oregon (fig. 7). In most places, however, the relative stratigraphic succession of faunas is unknown and, therefore, correlation with Europe is based on the assumption that the faunal succession is the same, or similar, to that in Europe.

All the European Pliensbachian ammonite zones except the zones of *Tragophylloceras ibex* and *Pleuroceras spinatum* have been identified in British Columbia. The zone of *Amaltheus margaritatus* is present also in the southern Yukon (Frebold, 1964a, p. 24–25, table 1). Ammonites characteristic of the basal Pliensbachian zone of *Uptonia jamesoni* have not been described but, as indicated by Frebold (1964b, p. 5), are represented by characteristic genera, such as *Uptonia*, in the Queen Charlotte Islands (USGS Mesozoic locs. 28723 and 28726). The zone of *Prodactylioceras davoei* is represented by *P. davoei* (Sowerby) and *Liparoceras* (*Becheiceras*) cf. *L.* (*B.*) *bechei* (Sowerby) in northwestern British Columbia (Frebold, 1964a, p. 2–5). The next higher zone of *Amaltheus margaritatus* is represented in both northwestern British Columbia and the southern Yukon by *Arieticeras algovianum* (Oppel), *Leptaleoceras pseudoradians* (Reynes), and *Amaltheus stokesi* (Sowerby). In addition, the late Pliensbachian is represented on the south shore of Maude Island at locality M3 of McLearn (1949, p. 6, fig. 2) by species of *Fanninoceras* (McLearn, 1932, p. 70–78) and *Arieticeras*.

Most of the European Toarcian ammonite zones are represented in British Columbia, and the highest two zones are probably represented also in the southern Yukon (McLearn, 1932, p. 59–70, Frehold, 1957, p. 46, 47; 1959, p. 7, 8; 1964a, p. 2–5, 16, 25, 26, table 1). The lowermost Toarcian zone of *Dactylioceras tenuicostatum* has not been identified. The next higher zone of *Harpoceras falcifer* is probably represented by *H.* cf. *H. exaratum* (Young and Bird) in association with *Dactylioceras* but not with *Peronoceras*. The overlying zone of *Hildoceras bifrons* is probably represented by *Peronoceras* in association with *Dactylioceras*, although both genera in Europe range into the zone of *Haugia variabilis* (Fischer, 1966, p. 67, table facing p. 70; Dean and others, 1961, p. 481). The zone of *Grammoceras thouarsense* is probably represented by certain species of *Grammoceras* (Frebold, 1964a, p. 17, 18) although the genus in Europe ranges above that zone. The highest Toarcian zone of *Dumortieria levesquei* may be represented by some poorly preserved ammonites referred questionably to *Catulloceras*. These ammonites (Frebold, 1964a, p. 16, pl. 7, figs. 5–9) are almost identical in appearance with specimens of *Catulloceras* from Oregon whose stratigraphic position near the top of the Toarcian is established.

Of these ammonites from British Columbia and the southern Yukon, those of late Pliensbachian age are closely comparable or identical with ammonites in the Suplee and Nicely Formations of Lupher in Oregon, and those of late Toarcian age closely resemble ammonites in the basal part of Lupher's Snowshoe Formation. The ammonite assemblages of the late Pliensbachian age in western Canada are particularly valuable in making correlations with Europe because of the presence of *Amaltheus*, which has not yet been found in the United States. Its association with other ammonites that are common in the Suplee and Nicely Formations suggests that those formations in part may be correlated with the *Amaltheus margaritatus* zone in Europe.

SOUTHERN ALASKA

Many of the European ammonite zones of the Pliensbachian and Toarcian Stages are represented in the Alaska Peninsula, the Cook Inlet region, and the Wrangel Mountains in southern Alaska (figs. 7 and 8). As in western Canada, the relative stratigraphic succession of most of the ammonite assemblages is unknown and correlation with Europe is based on the assumption that the ammonite faunal succession is similar. The assumption seems to be justified by the fact that most of the species are either closely similar, or identical with species in Europe. Likewise, many of the species are identical with described species from western Canada.

On the basis of similarities with Europe, the basal Pliensbachian in southern Alaska is represented by *Uptonia* and *Acanthopleuroceras*, the highest Pliensbachian by *Pleuroceras*, *Amaltheus*, *Paltarpites*, and *Arieticeras*, the lower Toarcian by *Dactylioceras* and *Harpoceras*, and the upper Toarcian by *Haugia*, *Phymatoceras*, and *Grammoceras*. Ammonite evidence is lacking for the presence of the European zones of *Tragophylloceras ibex*, *Prodactylioceras davoei*, and *Amaltheus margaritatus*. Similarities with the ammonite succession in eastern Oregon include the presence of *Grammoceras* and *Haugia* in upper Toarcian beds and *Paltarpites* and *Arieticeras* in upper Pliensbachian beds. Differences with Oregon include the presence of *Amaltheus* and *Pleuroceras* in upper Pliensbachian beds and the absence of *Catulloceras* in the uppermost Toar-

cian beds. Failure to find evidence for certain European ammonite zones may have stratigraphic significance but may merely reflect insufficient collecting.

NORTHERN ALASKA

Several of the European ammonite zones of the Pliensbachian and Toarcian stages have been identified in a sequence of cores obtained from the South Barrow test well 3 near Point Barrow, Alaska (Imlay, 1955, p. 82, 87–88, pl. 10, figs. 1–6, 9–16). Some of the identifications have been revised by Howarth (1958, p. xxvi) without changes in age determinations. The succession of fossils, from top to bottom, as revised, is as follows:

	Depth in well (feet)
Dactylioceras cf. *D. commune* (Sowerby)	1,772
cf. *D. crassiusculosum* (Simpson)	1,772
cf. *D. delicatum* (Simpson)	1,772
cf. *D. kanense* McLearn	2,016
cf. *D. semicelatum* (Simpson)	2,017, 2,018
Nodicoeloceras sp	2,063
Amaltheus sp. indet	2,074
(*Pseudoamaltheus*) cf. *A.* (*P.*) *engelhardti* (d'Orbigny)	2,090
margaritatus de Montfort	2,111
cf. *A. stokesi* (J. Sowerby)	2,186
stokesi (J. Sowerby)	2,198

In the above faunal succession, the upper Pliensbachian ammonite *Amaltheus* is represented in cores from 2,198 to 2,074 feet. Of the species present *A. stokesi* in Europe occurs in the basal part of the *Amaltheus margaritatus* zone (Howarth, 1958, p. 6). *A. margaritatus* ranges from the middle of that zone into the lower part of the *Pleuroceras spinatum* zone (Howarth, 1958, p. 17). *A.* (*Pseudoamaltheus*) ranges from the uppermost part of the *A. margaritatus* zone to the end of the *Pleuroceras spinatum* zone. The genus *Amaltheus* is not known above that zone.

The remainder of the faunal succession is of early Toarcian age. *Nodicoeloceras* ranges through the zones of *Dactylioceras tenuicostatum* and *Harpoceras falcifer*. Finely ribbed species of *Dactylioceras*, such as *D. kanense* and *D. semicelatum*, are characteristic of the zones of *D. tenuicostatum* and *Harpoceras falcifer*. Coarsely ribbed species, such as *D. commune*, are characteristic of the zone of *Hildoceras bifrons*.

From outcrops in northern Alaska have been obtained the late Pliensbachian ammonite *Amaltheus* (Mesozoic locs. 29164 and 29165), the early Toarcian ammonite *Harpoceras* cf. *H. exaratum* (Young and Bird) (Mesozoic locs. 29159–29161), and Toarcian(?) species of *Pseudolioceras* similar to *P. compactile* (Simpson). The genus *Pseudolioceras* itself ranges from early Toarcian (zone of *Harpoceras falcifer*) to early middle Bajocian and is not very useful as a guide fossil.

Overall, the ammonites of Pliensbachian and Toarcian age in northern Alaska are remarkably similar to those of the same age in Northwest Europe. The succession appears to be the same, and some of the species are identical.

EUROPE

During late Pliensbachian time, marked faunal differentiation from north to south occurred in Europe. The ammonite family Amaltheidae dominated over all other ammonite families in northwest Europe (Howarth, 1955, p. 149), the families Dactylioceratidae and Hildoceratidae dominated over the Amaltheidae in the Mediterranean region, and all three families intermingled in southeast France (Arkell, 1956, p. 152, 242, 279; Howarth, 1958, p. xxiv; Mouterde, 1955, p. 18–24). Southward from France such amaltheid genera as *Amaltheus* and *Pleuroceras* became uncommon to rare. Northward from Italy such common Mediterranean genera as *Arieticeras*, *Canavaria*, *Protogrammoceras*, *Fuciniceras*, and *Reynesoceras* became uncommon. At the end of Pliensbachian time, the Amaltheidae disappeared from northwest Europe and were succeeded during Toarcian time by many genera of the Dactylioceratidae and Hildoceratinae which were not differentiated geographically.

In comparison with Europe, the ammonite assemblage of late Pliensbachian age in Oregon and California closely resembles the assemblage of that age in the Mediterranean region, such as in Italy. This is shown by an abundance of genera and species of the families Dactylioceratidae and Hildoceratidae and by the absence of the Amaltheidae. The assemblage of late Pliensbachian age from northwestern British Columbia is also mainly Mediterranean in affinities, although it includes a few representatives of *Amaltheus*. In contrast, the assemblages of late Pliensbachian age in Alaska contain *Amaltheus* and *Pleuroceras* and appear to be closely related to those in northwest Europe.

The extinction of the Amaltheidae in Britain at the end of the Pliensbachian is ascribed by Howarth (1958, p. xxxiii) to epeirogenic movement, which resulted in elimination of local basins characterized by marked sedimentary differences, and probably also to competition with *Dactylioceras* which arrived in late Pliensbachian time. Similarly the disappearance of the Amaltheidae is correlated by Hallam (1961, p. 153) with a sudden deepening of the sea in early Toarcian time after widespread shallowing in late Pliensbachian time. This deepening presumably allowed genera from the Mediterranean region to spread northward. Furthermore, the sudden deepening of the sea may have been eustatic, or worldwide, according to Hallam (1961, p. 154, 1965, p. 1499), which might explain the abrupt disappearance of

277-364 O—68——4

the Amaltheidae throughout the world at about the same time.

These observations by Howarth and Hallam imply that the differentiation of ammonites in Europe during late Pliensbachian time was due primarily to northwest Europe being covered by very shallow seas, containing many local basins, into which ammonites from deeper water in the Mediterranean region seldom penetrated. As soon as the sea covering northwest Europe deepened in early Toarcian time, the ammonites from the Mediterranean region spread northward and ammonite differentiation ceased. If the changes in sea level were worldwide, as Hallam suggests, then the same explanation for ammonite differentiation ought to apply to western North America during late Pliensbachian time. It seems unlikely, however, that eustatic changes in sea level could be the sole cause of ammonite differentiation, or would control the distribution of ammonites in exactly the same manner on different continents. Other factors probably also influenced ammonite differentiation, such as occurred many times during Middle and Late Jurassic and Cretaceous time (Imlay, 1965, p. 1036).

GEOGRAPHIC DISTRIBUTION

The geographic occurrences of the ammonites described herein are shown in figures 1 and 2 and table 3. Detailed descriptions of the occurrences are given in the following unnumbered table.

Some upper Lower Jurassic fossil localities in eastern Oregon and California

Locality No. (figs. 1 and 2)	Geological Survey Mesozoic locality	Collector's field No.	Collector, year of collection, description of locality, and stratigraphic assignment
1	28807	W–10–143	Bruce Nolf, Tracy Vallier, W. H. Taubeneck, and R. W. Imlay, 1963. Northeast side of Sheep Ridge, about 5½ miles S. 54° W. of center of Enterprise, near center of N¼NW¼ sec. 19 (unsurveyed), T. 2 S., R. 44 E., Enterprise quad., Wallowa County, Oreg. Unnamed beds from 820 to 1,030 ft stratigraphically above base of exposures. Highest elev 6,960 ft.
1	28808	W–10–144	Same data as Mesozoic loc. 28807, but from 760 to 820 ft above base of exposures. Overlies 50 ft of gabbro.
1	28809	W–10–145	Same data as Mesozoic loc. 28807, but from 520 to 710 ft above base of exposures.
1	28810	W–10–146	Same data as Mesozoic loc. 28807, but from 360 to 520 ft above base of exposures.
1	28820	W–10–134	Bruce Nolf, 1962. Same geographic data as Mesozoic loc. 28807, but probably from entire 360 to 1,030 ft above base of exposures.
2	----------	L35	R. L. Lupher, 1927. Black shale in depression between main gully and first spring about 100 ft north of Pine Tree Triangle, SE¼SE¼ sec. 10, T. 16 S., R. 31 E., Seneca quad., Grand County, Oreg. Nicely Shale.
2	----------	L47	R. L. Lupher, 1931. Same as locality L35. From about 60 ft of black shale that apparently underlies Robertson Formation. Nicely(?) Shale.
3	----------	L37	R. L. Lupher, 1927. On west side of siliceous limestone ridge, SE¼ sec. 11, T. 16 S., R. 31 E., Seneca quad., Grant County, Oreg. Suplee Formation.
4	27388	I58–8–18	R. W. Imlay and C. E. Brown, 1958. On north side of Bear Valley 4½ miles north of Seneca, near center of NW¼SW¼ sec. 10, T. 16 S., R. 31 E., Seneca quad., Grant County, Oreg. Suplee Formation, from 20–30 ft above base.
5	----------	L45	R. L. Lupher, 1927. North side of Bear Valley near fence, north of abandoned Roe Stratton house, NE¼SE¼ sec. 9, T. 16 S., R. 31 E., Seneca quad., Grant County, Oreg. Suplee Formation.
6	25823	REW55–F34	R. E. Wallace and J. A. Calkins, 1955. West bank of Wickiup Creek on hill slope, south-central part of NE¼SW¼ sec. 10, T. 16 S., R. 29 E., Logdell quad., Grant County, Oreg. Snowshoe Formation, basal part.
6	28030	WRD39	W. R. Dickinson, 1960. From a concretionary ledge of white-weathering laminated black limestone in a sequence of gray-weathering black platy siltstone exposed on bare slope on west bank of Wickiup Creek at same spot as Mesozoic locs. 25823 and 29217. Snowshoe Formation, basal part.
6	29216	I65–7–7E	W. O. Ross and R. W. Imlay, 1965. From bank on west side of Wickiup Creek about 100 ft south of Mesozoic loc. 28030. Snowshoe Formation, basal part.
6	29217	I65–7–7D	W. O. Ross and R. W. Imlay, 1965. From same spot as Mesozoic locs. 25823, 27355, and 28030. Snowshoe Formation, basal part.
7	25819	REW55–F24	R. E. Wallace and J. A. Calkins, 1955. Interbedded shale and dark limestone beneath Hyde Formation. NE¼SE¼ sec. 36, T. 16 S., R. 28 E., Izee quad., Grant County, Oreg. Nicely Shale.
8	----------	F84(3–6–5)	W. R. Dickinson, 1957. Near top of knoll on divide between Rosebud Creek and Bunton Creek, NW¼NE¼ sec. 1, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Nicely Shale, slightly above middle.
8	26732	F67(3–6–9)	R. W. Imlay and W. R. Dickinson, 1957. On slope north of headwaters of Rosebud Creek just above road shown on 1961 edition of Izee quad. in NE¼NW¼NW¼ sec. 1, T. 17 S., R. 28 E., Grant County, Oreg. Suplee Formation, upper 10 ft.
8	26733	F68(3–6–10)	R. W. Imlay and W. R. Dickinson, 1957. On west side of small draw east of loc. 26732 in NE. cor. NW¼NW¼ sec. 1, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Suplee Formation, near top.

Some upper Lower Jurassic fossil localities in eastern Oregon and California—Continued

Locality No. (figs. 1 and 2)	Geological Survey Mesozoic locality	Collector's field No.	Collector, year of collection, description of locality, and stratigraphic assignment
8	26734	F69(3-6-4)	W. R. Dickinson and R. W. Imlay, 1957. On crest of divide between headwaters of Rosebud Creek and east fork of Bunton Hollow, SE. cor. SE¼SW¼ sec. 36, T. 16 S., R. 28 E., Izee quad., Grant County, Oreg. Suplee Formation, upper 10 ft.
9	28372	I61-7-23A	R. W. Imlay, 1961. On logging road in NE. cor. sec. 2, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Suplee Formation, 15–25 ft below top.
9	26740	F83(3-6-8)	W. R. Dickinson and R. W. Imlay, 1957. On an open south slope traversed by two abandoned logging roads north of the headwaters of Rosebud Creek, SW¼ sec. 36, T. 16 S., R. 28 E., and NW¼ sec. 1, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Nicely Shale, from concretions in roadcuts and on surface of ground.
9	26742	I57-7-28	R. W. Imlay, 1957. Head of main fork of Rosebud Creek, SW. cor. SW¼ sec. 36, T. 16 S., R. 28 E., Izee quad., Grant County, Oreg. Nicely Shale, from, 10–25 ft below top.
9	29213	I65-7-10C	W. O. Ross and R. W. Imlay, 1965. East side of logging road near north section line in north-central part of NE¼NE¼ sec. 2, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Nicely Shale, from 50 to 60 ft above base.
9	29214	I65-7-10F	W. O. Ross and R. W. Imlay, 1965. In roadcut on northward curve in logging road just east of junction with a southward-trending logging road in NW. cor. sec. 1, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Nicely Shale.
9	29219	I65-7-10G	W. O. Ross, 1965. Same geographic data as Mesozoic loc. 29214. Nicely Shale, 70–80 ft above base.
9	29220	I65-7-10B	W. O. Ross, 1965. Same geographic data as Mesozoic loc. 29213. Nicely Shale, about 20 ft above base.
9	29224	I65-7-10A	R. W. Imlay and W. O. Ross, 1965. In roadcut at point where road bends sharply northward on crest of southward trending spur north of main fork of Rosebud Creek, north-central part of NE¼NE¼ sec. 2, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Suplee Formation.
9	29226	I65-7-10D	R. W. Imlay, 1965. In fault sliver just west of southward bend in road in NE. cor. sec. 2, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Suplee Formation.
10	28366	F12	R. W. Imlay and C. E. Brown, 1961. Near northernmost bend in road in south-central part of SE¼SW¼ sec. 35, T. 16 S., R. 28 E., Izee quad., Grant County, Oreg. Suplee Formation.
11	25689	REW55-F7	J. A. Calkins, 1955. From calcareous fine-grained graywacke at head of Rosebud Creek, 0.1 mile southwest of NE. cor. SW¼ sec. 2, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Suplee Formation.
12	27359	I58-8-25B	R. W. Imlay and Reed Christner, 1958. On west side of Rosebud Creek in north-central part of SW¼ sec. 2, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Suplee Formation, upper 30 ft.
12	27358	I58-8-25A	R. W. Imlay and Reed Christner, 1958. West side of west fork at head of Rosebud Creek, north-central part of SW¼ sec. 2, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Nicely Shale, about 100 ft above base.
13	----------	F82(3-49-20)	W. R. Dickinson, 1957. Near top of slope east of Caps Creek, NE¼NW¼NE¼ sec. 16, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Nicely Shale, probably middle third.
14	----------	F81(1-48-4)	W. R. Dickinson, 1957. Black limestone bed on west slope of spur south of Caps Creek, SE¼NW¼ sec. 16, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Nicely Shale, upper third, 20 ft below top.
14	27360	I58-8-26A	R. W. Imlay, 1958. On bridge south of Caps Creek, SE¼NW¼ sec. 16, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Location probably same as Dickinson loc. F81(1-48-4). Nicely Shale about 20 ft below top.
14	27361	I58-8-26B	R W. Imlay and Reed Christner, 1958. On crest of spur south of Caps Creek, SE¼NW¼ sec. 16, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Suplee Formation, upper 10 ft.
14	28033	F57(1-48-5)	W. R. Dickinson, 1957 and 1960. On top of spur on west side of Caps Creek, SE¼NW¼ sec. 16, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Near Mesozoic loc. 27361. Suplee Formation, near top.
15	26739	I57-7-26E	R. W. Imlay, 1957. At head of east fork of first small creek west of Elkhorn Creek on steep southeast slope of Morgan Mountain, SW¼NE¼NE¼ sec. 14, T. 17 S., R. 27 E., Izee quad., Grant County, Oreg. Nicely Shale, about 100 ft above base.
15	26743	F85(56-73)	R. W. Imlay, S. W. Muller, W. R. Dickinson, and L. W. Vigrass, 1957. From black concretions lying in gullies on the south slope of Morgan Mountain, near center of NE¼ sec. 14, T. 17 S., R. 27 E., Izee quad., Grant County, Oreg. Nicely Shale.
15	26745	I57-7-26A	R. W. Imlay, 1957. At head of west fork of Elkhorn Creek, NE¼NE¼ sec. 14, T. 17 S., R. 27 E., Izee quad., Grant County, Oreg. Nicely Shale, basal 5 ft.
15	26746	I57-7-26D	R. W. Imlay, 1957. Head of east fork of first small creek west of Elkhorn Creek, SW¼NE¼NE¼ sec. 14, T. 17 S., R. 27 E., Izee quad., Grant County, Oreg. Nicely Shale, about 50 ft above base.

Some upper Lower Jurassic fossil localities in eastern Oregon and California—Continued

Locality No. (figs. 1 and 2)	Geological Survey Mesozoic locality	Collector's field No.	Collector, year of collection, description of locality, and stratigraphic assignment
15	27378	I58–9–9A	R. W. Imlay, 1958. Steep southeast slope of Morgan Mountain at head of first small creek west of Elkhorn Creek, SW¼NE¼NE¼ sec. 14, T. 17 S., R. 27 E., Izee quad., Grant County, Oreg. Nicely Shale, about 120 ft above base.
15	27379	I58–9–9B	R. W. Imlay, 1958. At head of first small creek west of Elkhorn Creek on steep southeast slope of Morgan Mountain, SW¼NE¼NE¼ sec. 14, T. 17 S., R. 27 E., Izee quad., Grant County, Oreg. Nicely Shale, about 100 ft above base.
15	27380	I58–9–9C	R. W. Imlay, 1958. Same geographic data as Mesozoic loc. 27379. Nicely Shale, 70 ft above base.
15	27381	I58–9–9D	R. W. Imlay, 1958. Same geographic data as Mesozoic loc. 27379. Nicely Shale, about 100 ft above base.
15	27392	I58–9–11	R. W. Imlay, 1958. Same geographic and stratigraphic data as Mesozoic loc. 27379.
15		L71	R. L. Lupher, 1927. Southeast side of Morgan Mountain, NE¼ sec. 14, T. 17 S., R. 27 E., Izee quad., Grant County, Oreg. Nicely Shale, 6 in. of shale containing many brachiopods from 15 to 20 ft above base of formation.
15		L72	R. L. Lupher, 1927. Same place as L71. From about 50 ft of dark shale overlying basal 15–20 ft of Nicely Shale.
15		L125	R. L. Lupher, 1937. Same geographic data as L71 but mostly from farther west on southeast slope of Morgan Mountain. Nicely Shale.
16		F80(1–46–13)	W. R. Dickinson, 1957. On west slope of Schoolhouse Gulch, SE¼SW¼ sec. 20, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Nicely Shale, probably middle third.
16		F55(1–46–15)	W. R. Dickinson, 1957. On a small nose just south of a sharp draw on lower part of the west slope of Schoolhouse Gulch, SE. cor. SW¼ sec. 20, T. 17 S., R. 28 E., Izee quad., Grant County, Oreg. Suplee Formation, float probably from lower part.
17		L77	R. L. Lupher, 1927. On high hill southwest of South Fork bridge about on extension of line of secs. 30 and 31, T. 17 S., R. 28 E. Probably from south-central part of sec. 25, T. 17 S., R. 27 E., Izee quad., Grant County, Oreg. Suplee Formation.
17	29212	I65–7–7A	W. O. Ross, 1965. On west side of ridge, about 200 ft below crest, SE¼SE¼SW¼ sec. 25, T. 17 S., R. 27 E., Izee quad., Grant County, Oreg. Nicely Shale, from 50–70 ft below top in upper fourth of formation.
18		F79(56–41)	W. R. Dickinson, 1956. Concretions near crest of ridge between Brisbois Gulch and Sheep Creek, SE¼SW¼ sec. 25, T. 17 S., R. 27 E., Izee quad., Grant County., Oreg. Nicely shale, upper fifth, about 50 ft below top.
19	26741	F77(4–86–22)	R. W. Imlay, 1957. On west slope of a short steep canyon that drains into Brisbois Gulch from Hole-in-the-Ground. Near edge of NE¼ sec. 35, T. 17 S., R. 27 E., Izee quad., Grant County, Oreg. Nicely Shale lower sixth, about 50 ft above base.
20	25690	REW55–F11	J. A. Calkins, 1955. Roadcut on west side of old road from Suplee to Izee just east of divide between Sheep Creek and Hole-in-the-Ground, SW¼NW¼ sec. 36, T. 17 S., R. 27 E., Izee quad., Grant County, Oreg. Snowshoe Formation, 100–125 ft above base.
20	26751	I57–7–16A and F111 (56–45).	R. W. Imlay, S. W. Muller, W. R. Dickinson, and R. L. Lupher, 1956 and 1957. Dark-gray siltstone, mudstone, and shale in roadcut about 300 ft by road east of summit, between Sheep Creek and Hole-in-the-Ground, at same spot as Mesozoic loc. 25690 and Lupher's loc. 76. Snowshoe Formation, 100–125 ft above base.
20		L76	R. L. Lupher, 1927. Roadcut southwest of South Fork Bridge near top of first big hill and above steepest place on country road. Same spot as Mesozoic locs. 25690 and 26751. Snowshoe Formation, 100–125 ft above base.
21		F76(8–8–34)	W. R. Dickinson, 1957. Concretions on east slope of Pole Canyon. NW¼SW¼ sec. 35, T. 17 S., R. 27 E. Izee quad., Grant County, Oreg. Nicely Shale, near base of upper fourth, about 75 ft above andesite flow.
21	29223	I65–7–3A	R. W. Imlay and W. O. Ross, 1965. Near top of knoll on east side of Pole Canyon about 150 ft above stream, east-central part of sec. 34, T. 17 S., R. 27 E., Izee quad., Grant County, Oreg. Suplee Formation, upper 10–15 ft in a section about 40 ft thick.
22		F39(7–132–9)	W. R. Dickinson, 1957. On west slope of strike ridge that trends south along east side of Big Flat, near center of SE¼SE¼ sec. 4, T. 18 S., R. 27 E., Izee quad., Grant County, Oreg. Suplee Formation, near middle.
23	29228	I65–7–4	R. W. Imlay and W. O. Ross, 1965. At southeast end of Big Flat in north-central part of NE¼ sec. 16, T. 18 S., R. 27 E., Izee quad., Grant County, Oreg. Suplee Formation.
24	26750	I57–7–12A and WRD F104.	S. W. Muller, R. W. Imlay, W. R. Dickinson, L. W. Vigrass, and John Beeson, 1956 and 1957. Black mudstone in bed of Flat Creek at curve in stream channel, north-central part of NW¼NW¼ sec. 15, T. 18 S., R. 27 E., Izee quad., Grant County, Oreg. Probably same place as Lupher's loc. 127. Snowshoe Formation, about 75 ft above base.
24		L127	R. L. Lupher, 1937. In canyon of Flat Creek about half a mile south of sheep camp at east side of Big Flat, NW¼ sec. 15, T. 18 S., R. 27 E., Izee quad., Grant County, Oreg. Probably same spot as Mesozoic loc. 26750. Snowshoe Formation, about 75 ft above base.

Some upper Lower Jurassic fossil localities in eastern Oregon and California—Continued

Locality No. (figs. 1 and 2)	Geological Survey Mesozoic locality	Collector's field No.	Collector, year of collection, description of locality, and stratigraphic assignment
25		F75(56–72)	S. W. Muller, L. W. Vigrass, W. R. Dickinson, and John Beeson, 1956. SW¼ sec. 28, T. 18 S., R. 26 E., Delintment Lake quad., Grant County, Oreg. Nicely Shale.
25	26747	I57–7–8A	R. W. Imlay, 1957. In roadcut about 50 ft south of upper boundary of Suplee Formation. SE. cor. sec. 29, T. 18 S., R. 26 E., Delintment Lake quad., County, Oreg. Nicely Shale, near top of lower third.
25	29222	I65–7–5B	W. O. Ross and R. W. Imlay, 1965. From one large concretion, about 3½ ft in maximum diameter, exposed in old road to former University of Oregon geology campsite, SE cor. sec. 29, T. 18 S., R. 26 E., Delintment Lake quad., Grant County, Oreg. Nicely Shale, about 65 ft above base.
25		L119	R. L. Lupher, 1931. From 400 to 600 ft west of former University of Oregon geology campsite, SE¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake quad., Grant County, Oreg. Nicely Shale, probably upper part.
25		L144	R. L. Lupher, 1934. From northeast side of former University of Oregon geology campsite at east edge of aspens growing around spring, SE¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake quad., Grant County, Oreg. Nicely Shale, from one large concretion about 20 ft below top of formation.
25		L300sh	R. L. Lupher, 1926–37. From 3-ft concretion exposed in old road to University of Oregon geology campsite, SE¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake quad., Grant County, Oreg. Nicely Shale, from 3-ft concretion 10 ft above base of formation.
25		L300ss	R. L. Lupher, 1926. Just below old road to University of Oregon campsite and 100–150 ft south of road from Suplee to Izee. At end of nose that juts northward just below the aspens. SE¼SE¼ sec. 29, T. 18 S., R. 26 E., Delintment Lake quad., Grant County, Oreg. Suplee Formation, 10–20 ft below top.
26		F30(56–79)	S. W. Muller and L. W. Vigrass, 1956. On north slope of hill west of Jim Robertson's ranchhouse, NW¼SE¼SW¼ sec. 28, T. 18 S., R. 26 E., Delintment Lake quad., Grant County, Oreg. Suplee Formation, 25 ft above base in sequence 40 ft thick.
27	29218	I65–7–5A	W. O. Ross and R. W. Imlay, 1965. On east side of Dobson Creek southeast of Jim Robertson's ranchhouse near center of SE¼ sec. 28, T. 18 S., R. 26 E., Delintment Lake quad., Grant County, Oreg. Nicely Shale, about 54 ft above base.
27		L404	R. L. Lupher, 1930. Black shale 300 ft southeast of Jim Robertson's ranchhouse on east side of Dobson Creek, near center of sec. 28, T. 18 S., R. 26 E., Delintment Lake quad., Grant County, Oreg. Nicely Shale.
27		L552	R. L. Lupher, 1934. West side of ridge about 500 ft southeast of Jim Robertson's ranchhouse at same general location as L404. Nicely Shale, from band of concretions.
27		L553	R. L. Lupher, 1934. From band of concretions 10–15 ft higher stratigraphically than loc. 552 on west side of same ridge. Nicely Shale.
28	29326	Bud 139	H. J. Buddenhagen, 1965. Excavation on south side of road about 300 ft west of junction of road to Izee with road to Allison Guard Station, NW¼NW¼-SW¼ sec. 27, T. 18 S., R. 26 E., Delintment Lake quad., Grant County, Oreg. Nicely Shale.
28	29327	Bud 137	H. J. Buddenhagen, 1965. Roadcut on southeast side of road to Izee and about 600 ft east of junction with road to Allison Guard Station, NE¼NW¼SW¼ sec. 27, T. 18 S., R. 26 E., Delintment Lake quad., Grant County, Oreg. Nicely Shale.
28		L121	R. L. Lupher, 1937. About 100 ft south of the road from Suplee to Izee and about 300 ft east of Freeman Creek in north-central part of SW¼ sec. 27 T. 18 S., R. 26 E., Delintment Lake quad., Grant County, Oreg. Nicely Shale.
29	574		Waldemar Lindgren, 1890. In Sailor Canyon near Sterretts mine (now called Trinidad mine on Royal Gorge 7½-min quad.) in SE¼ sec. 34, T. 16 N., R. 13 E., Placer County, Calif. Shown as loc. 7 on fig. 6.1 by Clark and others (1961, p. B–16). Sailor Canyon Formation.
29	2464		Cooper Curtice, 1891. In Sailor Canyon near Sterretts mine at probably same location as Mesozoic loc. 574. Sailor Canyon Formation.
29	28391	LC–61–12a	R. W. Imlay and N. J. Silberling, 1961. About a quarter of a mile north of the North Fork of the American River in south-central part of SW¼NW¼ sec. 27, T. 16 N., R. 13 E., Duncan Peak quad., Placer County, Calif. Shown as loc. 8 on fig. 6.1 by Clark and others (1961, p. B–16). Sailor Canyon Formation.
29	28395	LC–61–7	R. W. Imlay and N. J. Silberling, 1961. About three-fifths of a mile north of North Fork of American River. NW¼NE¼NE¼ sec. 28, T. 16 N., R. 13 E., Duncan Peak quad., Placer County, Calif. Shown as loc. 9 on fig. 6.1 by Clark and others (1961, p. B–16). Sailor Canyon Formation.
29	28396	LC–61–17	L. D. Clark, N. J. Silberling, and R. W. Imlay, 1961. At end of jeep trail about 300 ft north of section line in south-central part of SE¼ sec. 34, T. 16 N., R. 13 E., Royal Gorge quad., Placer County, Calif. Probably same location as Mesozoic loc. 574. Shown as loc. 7 on fig. 6.1 by Clark and others (1961, p. B–16). Sailor Canyon Formation.

SYSTEMATIC DESCRIPTIONS

Family PHYLLOCERATIDAE Zittel, 1884
Genus PHYLLOCERAS Suess, 1865

Phylloceras sp.

Plate 1, figures 12, 13

The genus is represented by only one specimen. The shell is compressed and highly involute and bears fine radial lirae and faint radial folds.

Figured specimen.—USNM 153831.

Occurrence.—Nicely Shale, of Lupher (1941), lower part, at USGS Mesozoic locality 27358.

Partschiceras? sp.

Plate 1, figures 14, 15

The genus is possibly represented by three small smooth internal molds. These have a tiny umbilicus, a subquadrate whorl section, nearly flat flanks, and a broadly rounded venter.

Figured specimen.—USNM 153832.

Occurrences.—Nicely Shale, lower part, at USGS Mesozoic localities 29213 and 29220; Suplee Formation of Lupher (1941) at Mesozoic locality 29228.

Genus HOLCOPHYLLOCERAS Spath, 1927

Holcophylloceras sp.

Plate 1, figures 7–9

The genus is represented by 31 small internal molds of which some bear shell material. Constrictions affect both shell and mold. Weak ribs are present on several specimens.

Figured specimen.—USNM 153833.

Occurrences.—Suplee Formation, upper third, at USGS Mesozoic localities 26732, 27359, 27361, and 29228. Nicely Shale, from base to top, at Mesozoic localities 26745, 26747, 27358, 27360, 27381, and 27392; Lupher's localities 121 and 125.

Family JURAPHYLLITIDAE Arkell, 1950

Tragophylloceras sp.

Plate 1, figures 10, 11

The genus *Tragophylloceras* is probably represented by one small internal mold of which the outermost half whorl is crushed and poorly preserved. The specimen has a compressed whorl section, flattened flanks, and a narrowly rounded venter. The whorl section is more than twice as high as wide. The outermost whorl that is not crushed overlaps about half of the preceding whorl. The umbilical wall is low and vertical and rounds abruptly into the flanks. The body chamber is not known.

An inner whorl exposed in the umbilicus is smooth. The outermost uncrushed whorl bears forwardly inclined ribs that are very weak at its adapical end but become much stronger adorally. These ribs begin faintly low on the flanks, or near the middle of the flanks, and become much stronger ventrally. They incline forward gently on the lower and middle parts of the flanks and arch forward strongly on the upper parts of the flanks and on the venter. In addition, the lower two-thirds of the flanks bear faint spiral markings that resemble strigations but are less persistent.

On the crushed outermost half whorl the lower parts of the flanks are smooth and the upper parts bear broad forwardly arched ribs. These ribs continue across the venter but appear to be reduced in strength along the midline.

At a diameter of 20 mm, the specimen has a whorl height of 9.5 mm, a whorl thickness of 4.3 mm, and an umbilical width of 4.4 mm. The suture line is not preserved.

This ammonite is assigned to *Tragophylloceras* rather than to *Juraphyllites* because its ribs extend across most of the flanks. It resembles immature specimens of *T. loscombi* (J. Sowerby), as figured by Spath (1936, pl. 33, figs. 4, 5a, b), in coarseness of ribbing but differs by having a wider umbilicus and a more distinct umbilical edge. In these respects it resembles *T. undulatum* (Smith) (Howarth and Donovan, 1964, p. 297, pl. 48, figs. 8a, 9a; pl. 49, fig. 1a) but differs by having less sigmoidal ribbing.

The presence of faint spiral lines on the Oregon species probably does not bar an assignment to *Tragophylloceras*. Similar faint spiral lines are shown on several specimens illustrated by Howarth and Donovan (1964, pl. 49, figs. 4a, 5a, and 9a).

Figured specimen.—USNM 153834.

Occurrence.—Nicely Shale, near middle of upper half at USGS Mesozoic locality 29212.

Family LYTOCERATIDAE Neumayr, 1875
Genus LYTOCERAS Suess, 1865

Lytoceras sp.

The genus *Lytoceras* is represented by two fragmentary internal molds. One has very fine, closely spaced ribs that incline forward slightly on the flanks. The other has moderately coarse and more widely spaced ribs.

Occurrences.—Suplee Formation, lower part, at USGS Mesozoic locality 27388 and Lupher's locality 37, Oregon.

Family LIPAROCERATIDAE Hyatt, 1867
Genus METACYMBITES Spath, 1923

Metacymbites? cf. M. centriglobus (Oppel)

Plate 1, figures 1–6

cf. *Ammonites globosus* Quenstedt, 1856, Der Jura, pl. 21, fig. 9; 1885, Die Ammoniten des Schwabischen Jura, pl. 42, figs. 29, 30.
cf. *Ammonites centriglobus* Oppel, 1862, Palaont. Mitt., mus. v. Bayer.-Staats, v. 1, pt. 3, p. 140.
cf. *Metacymbites centriglobus* (Oppel). Spath, 1938, A catalogue of the ammonites of the Liassic family Liparoceratidae in the British Museum (Natural History), p. 95, pl. 10, figs. 8a–c, pl. 11, figs. 6a–c, 7a–d.
cf. *Metacymbites centriglobus* (Oppel). Howarth, 1957, Geol. Soc. London Quart. Jour., v. 113, p. 196, pl. 17, figs. 3a–d, 4.
cf. *Cymbites centriglobus* (Oppel). Schindewolf, 1961, Palaeontographica, v. 117, abt. A., p. 216, pl. 31, figs. 1–17.

One internal mold with fragments of shell adhering is similar in appearance with *Ammonites centriglobus* Oppel.

The mold is very small and spherical, has a deep narrow umbilicus, and represents the adult body whorl. The body chamber occupies about three-fifths of a whorl. The last half of the body chamber is contracted, and its last third is flattened ventrally. The aperture is constricted laterally and is marked ventrally by a fairly long lappet that curves dorsally (downward).

The ornamentation on the shell is weak and inconspicuous. It consists of weak spiral striae on the venter and of forwardly inclined ribs that are very broad and low and are separated by narrow interspaces. These ribs incline forward gently on the lower parts of the flanks, incline forward strongly on the upper parts of the flanks, and arch forward gently on the venter. This arching increases toward the aperture. The entire surface of the shell is covered, also, with striae that parallel the ribs.

The internal mold is nearly smooth but under oblique lighting it shows faint forwardly inclined ribs and spiral striae as on the shell.

Near the middle of the body chamber at a diameter of 8.5 mm, the specimen has a whorl height of 4 mm, a whorl thickness of 6.5 mm, and an umbilical width of about 1 mm. Adorally the umbilicus becomes much wider and the whorl thickness becomes less as the body chamber contracts.

The only suture line exposed lies next to the adult body chamber and is very simple. The saddles are definitely without frills and the lobes appear to be smooth, or nearly so. The sutural pattern evidently is much simpler than on *Metacymbites centriglobus* (Oppel) as illustrated by Spath (1936, fig. 1c–e on p. 447; 1938, p. 93), Schindewolf (1961, p. 219), and Howarth (1957, pl. 17, fig. 4). It is possible, however, that the simplicity of the suture line is related to its adoral position (Arkell and others, 1957, p. L97).

The Oregon specimen differs from *M. centriglobus* (Oppel) by having a slightly longer and less contracted body chamber, slightly stronger and more projected ribs on the flanks, a flattened venter near the aperture, and a much simpler suture line.

The assignment of the Oregon specimen to *Metacymbites* is questioned because of its simpler suture line and because the sutural saddles are not constricted basally. It differs from described species of *Cymbites* by being much stouter, by the body chamber contracting more abruptly at a later growth stage, and by the ribs being inclined forward more strongly.

Figured specimen.—CAS 12780.

Occurrence.—Nicely Shale at Lupher's locality 121. *Metacymbites* is possibly represented, also, by one laterally crushed body whorl at USGS Mesozoic locality 29222.

Genus LIPAROCERAS Hyatt, 1867
Subgenus BECHEICERAS Tureman, 1918

Liparoceras (Becheiceras) cf. L. (B.) bechei (Sowerby)

Plate 1, figures 18, 19

cf. *Ammonites bechei* J. Sowerby, 1821, Mineral conchology, v. 3, p. 143, pl. 280, 281.
cf. *Aegoceras bechei* (J. Sowerby). Wright, 1882, Monograph on the Lias ammonites of the British Islands, p. 380, pl. 41, figs. 1–5.

The subgenus *Becheiceras* is represented by two ammonite fragments from the Nicely Shale of Lupher (1941). One fragment represents part of the venter and the upper part of one flank. It bears weak radial ribs, faint dense spiral striae, and a row of weak widely spaced tubercles from which some radial ribs arise in pairs. Other radial ribs lie between the tubercles. The other fragment represents the umbilicus and the lower part of the flank. It bears a narrow umbilicus, fine radial ribs of variable strength, a row of blunt tubercles, and faint closely spaced spiral striae. The radial ribs become stronger ventrally, some are interrupted by the tubercles, and some lie between the tubercles.

The genus *Liparoceras* is probably represented also in the Suplee Formation of Lupher by a small globose ammonite (pl. 1, figs. 16, 17) that bears weak spiral striae and fainter growth striae but no tubercles. The ammonite is probably immature.

The subgenus *Becheiceras* has been recorded elsewhere in North America from northwestern British Columbia (Frebold, 1964a, p. 2, 8, 9; pl. 3, fig. 1; pl. 4, fig. 1; pl. 5, fig. 1) on the basis of a large internal mold that shows only traces of the ornamentation.

Figured specimens.—USNM 153835–153837.

Occurrences.—Suplee Formation, upper 30 feet, at USGS Mesozoic locality 27359; Nicely Shale near middle at Mesozoic locality 26739 and near top of lower third at Mesozoic locality 29222.

Family DACTYLIOCERATIDAE Hyatt, 1867
Genus REYNESOCERAS Spath, 1936

Reynesoceras cf. R. ragazzonii (Hauer)

Plate 1, figures 22–23

cf. *Ammonites ragazzonii* Hauer. Reynès, 1868, Essai de géologie et de paléontologie Aveyronnaises, p. 90, pl. 1, figs. 1a–3.

cf. *Coeloceras ragazzonii* (Hauer). Fucini, 1900, Palaeontographia Italica, v. 6, p. 66, pl. 13, figs. 6, 7.

cf. *Coeloceras ragazzonii* Hauer. Monestier, 1934, Soc. Géol. Franch Mém., new ser., v. 10, pt. 3 (mém. 23), p. 93, pl. 6, figs. 13–19, 24.

Dactylioceras cf. *D. directum* (Buckman) Dickinson and Vigrass, 1965, Oregon Dept. Geology and Mineral Industries Bull. 58, p. 40.

This species is represented by 68 specimens. Of these, 40 are from the Sailor Canyon Formation, 27 from the Nicely Shale, and 1 from the Suplee Formation. Most are poorly preserved molds except for several small specimens obtained from concretions in the Nicely Shale.

The species is characterized by evolute coiling, by a rounded whorl section, and by fairly strong rather widely spaced nearly radial simple nontuberculate ribs. On small specimens and on inner whorls the ribs are simple, round, prominent, fairly widely spaced, nontuberculate, and inclined slightly forward on the flanks. They are a little stronger on the venter than on the flanks and cross the venter transversely without bifurcating and without reduction in strength along the midline. On the intermediate and outer whorls the ribs are similar, but during growth gradually become less prominent and more closely spaced. Bifurcation of a single rib high on the flanks was noted on one specimen. On all other specimens the ribs are simple. The adult body chamber is unknown, and the suture line is not preserved.

This species shows a remarkable resemblance to *Reynesoceras ragazzonii* (Hauer) as illustrated by Reynes, Monestier, and Fucini listed above in synonymy, but it has less flexuous ribbing than the type specimen illustrated by Hauer (see Arkell and others, 1957, p. L255). *R. simulans* (Fucini) (1905, pl. 9, figs. 8–15) has closer spaced ribbing. *R. subanguinum* (Meneghini) (1867–81, p. 73, pl. 16, figs. 9a, b) has much coarser ribs of which some fork low on the flanks.

Figured specimens.—USNM 153838–153841; Stanford University Museum Paleontology 9851; CAS 12781.

Occurrences.—Nicely Shale at USGS Mesozoic localities 25819, 26739, 26746, 27360, 27378–27380, and 29222; Lupher's locality 72; Dickinson's locality F80. Suplee Formation at Mesozoic locality 27388. Sailor Canyon Formation at Mesozoic localities 574 and 28396. This species ranges through the Nicely Shale and occurs also 20–30 feet above the base of the Suplee Formation north of Seneca, Oreg.

Reynesoceras cf. R. aegrum (Fucini)

Plate 1, figures 20, 21

cf. *Coeloceras aegrum Fucini*, 1905, Palaeontographia Italica, v. 11, p. 120, pl. 7, figs. 1–3.

One small ammonite from the Nicely Shale is characterized by evolute coiling, by a rounded whorl section that is wider than high, and by fairly closely spaced forwardly inclined simple unforked ribs that arch forward slightly on the venter. The innermost whorls exposed in the umbilicus bear tiny tubercles just below the line of involution.

The ribbing of this species is as fine as that on *R. aegrum* (Fucini) (1905, pl. 7, figs. 1a and 2a) and probably a little finer than on *R. fallax* (Fucini) (1905, pl. 8, figs. 14–16; pl. 9, figs. 1–7). Comparisons are difficult because the published illustrations of those species represent somewhat larger specimens whose inner whorls are not well preserved.

Figured specimen.—CAS 12782.

Occurrence.—Nicely Shale at Lupher's locality 552.

Genus PRODACTYLIOCERAS Spath, 1923

Prodactylioceras cf. P. italicum (Meneghini)

Plate 2, figures 14–16

cf. *Stephanoceras lorioli* Bettoni, 1900, Schweizer. paleont. Gesell. Abh., v. 27, p. 76, pl. 7, figs. 12, 13.

cf. *Coeloceras italicum* (Meneghini). Fucini, 1900, Palaeontographia Italica, v. 6, p. 72, pl. 13, fig. 4; 1905, v. 11, p. 115, pl. 6, figs. 11–14.

Zugodactylites cf. *Z. braunianum* (d'Orbigny) [in part]. Dickinson and Vigrass, 1965, Oregon Dept. Geology and Mineral Industries Bull, 58, p. 40.

This species is represented by four specimens. The coiling is highly evolute. The whorl section is rounded and wider than high. The ribs are very fine, gently flexuous, closely spaced, and forwardly inclined and cross the venter transversely and are strongest on the venter. Most of the ribs are simple, but furcation of ribs occurs rarely low on the flanks of the largest whorls. Also, on one specimen (pl. 2, fig. 15), one rib forks high on the flank and the furcation point is tuberculate. On the innermost exposed whorl of the same specimen, tiny tu-

bercles occur on the ribs just below the line of involution at a diameter of about 5 mm.

These specimens are closely comparable in fineness and density of ribbing with the smaller specimens of *P. italicum* (Meneghini) illustrated by Fucini (1900, pl. 13, figs. 4a, b; 1905, pl. 6, figs. 14a–c).

Figured specimens.—USNM 153842 and CAS 12811.

Occurrences.—Nicely Shale at USGS Mesozoic localities 26745 and 29219 and Lupher's locality 300sh; the species has been found near the base and at the top of the lower third of the formation. Hurwal Formation of Smith and Allen (1941) in the Wallowa Mountains at Mesozoic locality 28809.

Prodactylioceras cf. P. mortilleti (Meneghini)

Plate 2, figures 11–13, 19, 20

cf. *Ammonites (Stephanoceras) mortilleti* Meneghini, 1867–81, Paléontologie Lombarde, ser. 4, app. p. 21, pl. 4, fig. 7; pl. 6, figs. 1, 2.

cf. *Coeloceras mortilleti* (Meneghini). Bettoni, 1900, Schweizer. palaeont. Gesell. abb., v. 27, p. 71, pl. 7, fig. 9.

cf. *Coeloceras mortilleti* (Meneghini). Fucini, 1900, Palaeontographia Italica, v. 6, p. 74, pl. 13, fig. 11.

cf. *Coeloceras mortilleti* (Meneghini). Fucini, 1905, Palaeontographia Italica, v. 11, p. 116, pl. 6, fig. 10.

cf. *Coeloceras mortilleti* (Meneghini). Fucini, 1908, Toscana Univ. Annali, v. 28, p. 93, pl. 3, figs. 30, 31.

One fairly large ammonite (pl. 2, fig. 11), representing parts of three whorls, shows some resemblances in coiling and ribbing to the outer whorls of *P. mortilleti* (Meneghini). It has highly evolute coiling, rounded whorls that are wider than high, and moderately spaced nearly straight ribs that incline slightly forward on the flanks. Most of the ribs are simple, but on the next to the largest whorl, three ribs bifurcate near the middle of the flanks. Blunt tubercles occur at the furcation points.

Four small specimens of *Prodactylioceras* bear ribbing comparable with that on the smaller whorls of the larger ammonite just described and possibly represent the same species. These (pl. 2, figs. 12, 13, 19, 20) resemble some ammonites that were referred to *Coeloceras italicum* Fucini by Monestier (1934, pl. 6, figs. 32, 33, 35) and are coarser ribbed than the small ammonites that were compared with *Coeloceras mortilleti* (Meneghini) by Monestier (1934, pl. 5, figs. 31–33, 38, 39). They are appreciably coarser ribbed than the specimens herein compared with *Coeloceras italicum* (Meneghini).

Figured specimens.—USNM 153843 and CAS 12785.

Occurrences.—Nicely Shale at USGS Mesozoic localities 29214 and 29222 and Lupher's locality 300sh; Hurwal Formation in the Wallowa Mountains at Mesozoic locality 28809.

Prodactylioceras cf. P. meneghini (Fucini)

Plate 2, figures 21, 22

cf. *Acogceras subarmatum* Young and Bird in Meneghini, 1867–81, Paléontologie Lombarde, ser. 4, app. 52, pl. 6, figs. 3a–c.

cf. *Deroceras meneghini* Fucini, n. sp., 1908, Toscana Univ. Annali, v. 28, p. 34, pl. 1, fig. 20.

cf. *Deroceras meneghini* Fucini. Monestier, 1934, Soc. Géol. France, mém., new ser., v. 10, Fasc. pt. 3, (mém. 23), p. 92, pl. 5, fig. 1.

Catacoeloceras sp. Dickinson and Vigrass, 1965, Oregon Dept. Geology and Mineral Industries Bull. 58, p. 40.

This species is represented by one specimen from the Suplee Formation and seven from the Nicely Shale.

The species is evolute and has a rounded whorl section. Its ribbing changes considerably during growth. On the innermost whorls, up to a diameter of about 15 mm, the primary ribs are about equal in strength, begin weakly at the line of involution, curve forward gently on the flanks, and terminate in swellings or tubercles on the upper parts of the flanks. On larger whorls up to a diameter of about 70 mm, the primary ribs are irregular in strength and spacing and become more so adorally. About one-third of the primary ribs become swollen on the flanks and terminate in ventrolateral tubercles from which branch pairs of slightly weaker secondary ribs. Between these swollen ribs are from one to four weaker ribs that do not become stronger ventrally and generally do not bear tubercles. Some of the tubercles mark the junction of pairs of primary ribs. All ribs on the venter are of about equal strength and cross the venter transversely. On the largest whorls that are preserved the primary ribs are not differentiated. They are nearly equal in strength and spacing, are unbranched, and are nontuberculate.

This species is assigned to *Prodactylioceras* rather than *Dactylioceras* because of its highly evolute coiling, the irregular distribution of tubercles, the prominence of some of its tubercles, and the frequency of simple ribs. In lateral view it greatly resembles the holotype of *P. meneghini* (Fucini) (Meneghini, 1867–81, pl. 6, figs. 3a–c; refigured by Fucini, 1908, pl. 1, fig. 20) but has less prominent tubercles that are slightly lower on the flanks. It appears, also, to have a stouter whorl section, but according to Fucini (1908, p. 34) the holotype of *P. meneghini* (Fucini) has been deformed by compression. The Oregon species shows even more resemblance to the small specimen illustrated by Monestier (1934, p. 34, pl. 5, fig. 1) in ribbing and tuberculation, but it appears to be a little more evolute and less tuberculate. It has coarser ribs and less prominent less sporadic tubercles than most of the specimens that have been assigned to *P. davoei* (Sowerby) (1822, p. 71, pl. 350; d'Orbigny,

1844, p. 276, pl. 81, figs. 1, 2; Wright, 1880, pl. 31, figs. 1, 2; Quenstedt, 1882–85, pl. 38 figs. 6–9; Arkell, 1956, pl. 32, fig. 3; Frebold, 1964a, pl. 3, fig. 2).

Figured specimens.—CAS 12783 and 12784.

Occurrences.—Nicely shale, lower half, at USGS Mesozoic localities 26739 and 26740 and Lupher's locality 300sh; Suplee Formation at Lupher's locality 45.

Prodactylioceras? sp. juv.

Plate 2, figures 17, 18

One fragmentary internal mold bears fibulate or looped ribs at three places on its outermost whorl. The mold has a depressed subquadrate whorl section that is wider than high. The ribs on the flanks are sharp, high, widely spaced, incline slightly forward, and terminate in prominate tubercles on the margin of the venter. From these tubercles pass pairs of much weaker ribs that cross the venter nearly transversely.

The coarse ribbing resembles that on the inner whorls of *Peronoceras perarmatum* (Young and Bird) (Buckman, 1912, pl. 50), on *Nodicoeloceras crassoides* (Simpson) as illustrated in Wright (1884, pl. 85, figs. 2, 3; Donovan, 1954, p. 17, 53), on *Porpoceras vortex* (Simpson) (Buckman, 1911, pls. 29a, b), and on *Prodactylioceras* (Quenstedt, 1885, pl. 38, fig. 8). The presence of fibulate ribs suggests an assignment to one of these genera, although such ribs occur rarely in *Dactylioceras* according to Howarth (1962, p. 407).

Figured specimen.—USNM 153848.

Occurrence.—Nicely Shale at USGS Mesozoic locality 26740. Some nonillustrated fragments questionably assigned to *Prodactylioceras* occur in the Nicely Shale at Dickinson's locality F80, in the Suplee Formation at Mesozoic locality 29223, and in the Hurwal Formation in the Wallowa Mountains at Mesozoic locality 28810.

Genus DACTYLIOCERAS Hyatt, 1867

Dactylioceras cf. D. acanthus Buckman (non d'Orbigny)

Plate 3, figures 13–6

cf. *Nodicoeloceras acanthus* (d'Orbigny). Buckman, 1927, Type Ammonites, pl. 729a, 729b.

[not]*Ammonites acanthus* d'Orbigny. Thevenin, 1908a, Annales de Paléontologie, v. 3, p. 25, pl. 4, figs. 1–3.

This species is represented by 15 crushed fragmentary molds from the Sailor Canyon Formation. These have all been stretched so much as to produce an apparent variation in the density of ribbing.

The species is evolute. The characteristics of the whorl section and the body chamber are unknown. The ribs on the inner whorls are high, thin, widely spaced, and nearly radial, and most of them bear tubercles at the line of involution. On the middle whorls, at diameters greater than about 30 mm, the ribs gradually become moderately spaced; only every second to fourth rib is tuberculate, and the tubercles arise along a zone a little above the middle of the flanks. The tuberculate ribs are somewhat stronger than the nontuberculate ribs and all give rise to pairs of secondary ribs. These are nearly as strong as the primary ribs and incline slightly forward on the upper parts of the flanks. On the outermost whorls, all ribs are simple, nontuberculate, and nearly equal in strength. The change from tuberculate to nontuberculate ribbing occurs rather abruptly.

This species is similar in size, coiling, and ornamentation to the ammonites that Buckman (1927, pl. 729a, b) figured as *Nodicoeloceras acanthus* (d'Orbigny), but differs by having finer and denser ribbing on its outer whorl. It differs from *Dactylioceras acanthus* (d'Orbigny) Thevenin, 1908a, p. 25, pl. 4, fig. 1) by having fewer tuberculate ribs on its whorls of intermediate size and by lacking forked ribs on its largest whorls. The species is assigned to *Dactylioceras* rather than *Prodactylioceras* because many of the primary ribs bifurcate. Its general appearance, however, is similar to that of *Prodactylioceras rectiradiatum* (Wingrave) (1916, p. 196, 197, pl. 8). It differs from that species by having many forked ribs instead of none and by the ribs on its inner whorls being less regularly tuberculate.

Figured specimen.—USNM 153844.

Occurrences.—Sailor Canyon Formation at USGS Mesozoic localities 28391, 28395, and 28396.

Subgenus ORTHODACTYLITES Buckman, 1926

Dactylioceras (Orthodactylites) cf. D. (O.) kanense McLearn

Plate 3, figure 11

cf. *Dactylioceras kanense* McLearn, 1930, Royal Soc. Canada Trans., ser. 3, v. 24, sec. 4, p. 4, pl. 1, fig. 2; 1932, ser. 3, v. 26, sec. 4, p. 59–62, pl. 3, fig. 5; pl. 4, figs. 1–7, 9; pl. 5, figs. 6–9.

One specimen from eastern Oregon bears fine threadlike unbranched ribs similar to those on the outer whorl of *D. kanense* McLearn (pl. 3, fig. 12). It differs by its ribs becoming stronger ventrally and arching forward less strongly on the venter.

Figured specimen.—USNM 153845.

Occurrence.—Nicely Shale, about 100 feet above base, at USGS Mesozoic locality 26739.

Dactylioceras (Orthodactylites) cf. D. (O.) tenuicostatum (Young and Bird)

Plate 3, figures 1, 2, 8, 9

cf. *Dactylioceras tenuicostatum* (Young and Bird). Wright, 1884, monograph on the Lias ammonites of the British Islands, p. 475, pl. 84, figs. 7, 8; Buckman, Type Ammonites, 1920,

pl. 157; 1927, pl. 157a; Maubeuge, 1957, Inst. Grand-Ducal de Luxembourg, Sec. Sci. Archives, v. 24, pls. 17–19.

A very finely ribbed species of *Dactylioceras* is represented by 30 specimens from the Sailor Canyon Formation, California. Most of these are crushed, stretched, and distorted.

The species has highly evolute coiling. Its ribs are high, thin, very closely spaced, nearly radial, or inclined slightly forward on the flanks. On some specimens every second to fourth rib bifurcates above the middle of the flanks and bears tubercles at the furcation points. On others the presence or absence of furcation cannot be determined owing to defective preservation. Forked ribs and tubercles become less common during growth. The largest whorls bear mostly high thin simple rectiradiate nontuberculate ribs. For example, the specimen shown on plate 3, figure 9, bears simple nontuberculate ribs on the largest whorl and has many forked tuberculate ribs on the third whorl from the largest.

These specimens, as far as their preservation permits comparisons, are remarkably similar to *D.* (*O.*) *tenuicostatum* (Young and Bird). Most of them differ by having fewer bifurcating ribs, particularly on the outer whorls. The specimens have considerably finer ribbing than *D.* (*O.*) *directum* (Buckman) (1926, pl. 654) and less common rib furcation than *D.* (*O.*) *semicelatum* (Simpson) (Buckman, 1913, pl. 31). They greatly resemble *D. densicostatum* Maubeuge (1957, p. 202, pl. 13, fig. 29) in density of ribbing and in scarcity of forked ribs, but differ by their ribbing not becoming denser during growth and by the presence of tubercles.

This species is assigned to *Dactylioceras* rather than to *Prodactylioceras* because of its rectiradiate ribbing (except where altered by deformation), the presence of fairly persistent forked ribs on its inner whorls, and the absence of sporadic nodes on the medium and outer whorls. Nonetheless, it shows some resemblance to a specimen of *Prodactylioceras davoei* (Sowerby) from British Columbia (Frebold, 1964a, p. 10, pl. 3, fig. 2), but differs by having denser ribbing and by being less strongly tuberculate in its inner whorls.

Figured specimen.—USNM 153846.

Occurrences.—Sailor Canyon Formation at USGS Mesozoic localities 574, 2464, and 28396.

Dactylioceras (Orthodactylites) cf. D. (O.) verme (Simpson)

Plate 3, figures 7, 10

Dactylioceras cf. *D. tenuicostatum* (Young and Bird). Dickinson and Vigrass, Oregon Dept. Geology and Mineral Industries Bull. 58, 1965, p. 40.

This species is represented by four fragmentary external molds from the Sailor Canyon Formation and by nine molds from the Nicely Shale.

It is characterized by highly evolute coiling and by high sharp fairly closely spaced simple ribs that trend almost radially and become closer spaced during growth. Furcation occurs rarely above the middle of the flanks on the outermost whorls. The ribbing on the largest whorl is much finer and denser than on the other whorls. On the small inner whorls, at diameters less than 15 mm, the ribs are slightly swollen along the line of involution and possibly bore tubercles. Tubercles are definitely absent on the larger whorls.

The ribbing on the inner whorls resembles that on the inner whorls of *D.* (*O.*) *directum* (Buckman) (1926), pl. 654, figs. 1, 2) except for the absence of furcation. The ribbing on the outer whorl is much finer and denser than in that species. The character of the ribbing is similar, also, to that on *D.* (*O.*) *verme* (Simpson) in Buckman (1927, pl. 68a) but is probably a little coarser than on the holotype of *D.* (*O.*) *verme* (Simpson) (Buckman, 1913, pl. 68).

This species is assigned to *Dactylioceras* rather than to *Prodactylioceras* because of its nearly rectiradiate instead of forwardly inclined ribbing and the absence of any tubercules on its outer whorls. A scarcity of forked ribs is more characteristic of *Prodactylioceras* than of *Dactylioceras*, but does occur on some species of *Dactylioceras* such as *D.* (*O.*) *verme* (Simpson) and *D.* (*O.*) *densicostatum* Maubeuge (1957, p. 202, pl. 13, fig. 29).

Figured specimens.—USNM 153847 and CAS 12786.

Occurrences.—Sailor Canyon Formation at USGS Mesozoic locality 28396; Nicely Shale, middle part, at Mesozoic localities 26739 and 27379 and Lupher's localities 72 and 552.

Dactylioceras? sp.

Plate 3, figures 3–6

Subcollina? sp. Dickinson and Vigrass, 1965, Oregon Dept. Geology and Mineral Industries Bull. 58, p. 40.

This species is represented by one fragmentary but undeformed internal mold from Oregon. The shell is compressed and highly evolute. The septate whorls are depressed ovate and much wider than high. The body whorl is broadly rounded and slightly wider than high. The flanks are convex but become less convex during growth. The venter changes from broadly arched on the internal whorls to moderately arched on the body whorl. The umbilicus is broad. The umbilical wall merges evenly with the flanks. The body chamber is incomplete but is represented by three-fifths of a whorl.

The ribs on the flanks are strong, high, widely spaced, and nearly radial. On the inner septate whorls the flank ribs terminate in distinct tubercles just below the line of involution. From these pass pairs of weak secondary ribs that cross the venter nearly transversely. On the adoral half of the penultimate whorl the flank ribs are strongly swollen ventrally but are not tuberculate. On the body chamber the flank ribs are not swollen ventrally and pass on the ventral margin into pairs of somewhat weaker secondary ribs. Some of the secondary ribs are indistinctly connected with the primary ribs. Adorally on the body chamber, the primary ribs become weaker and the secondary ribs stronger.

At a maximum diameter of 30 mm, the specimen has a whorl height of 7 mm, a whorl thickness of 7.5 mm, and an umbilical width of 17 mm.

The specimen shows some resemblance to *Collina? mucronata* (d'Orbigny) (1845, p. 328, pl. 194, figs. 4–8; Dumortier, 1874, pl. 28, figs. 3, 4; Quenstedt, 1885, pl. 46, fig. 22; Mitzpoulus, 1932, pl. 8, figs. 13a, b) in coiling and ribbing but differs by having a rounded rather than a quadrate whorl section, by lacking ventrolateral tubercles on the body chamber, and by lacking a sinus along the midventral line. It differs from typical species of *Collina* (Monestier, 1931, pl. 1, figs. 33, 38, 41–47; pl. 3, fig. 21) in its rounder whorl section, lack of tubercles except on the smallest whorls, and lack of a keellike swelling on the venter. It differs from *Coeloderoceras* (Arkell and others, 1957, p. L247, 248) by lacking umbilical tubercles on its inner whorls and by having much longer primary ribs.

The Oregon specimen has much coarser ribbing than most species of *Dactylioceras*, but in this respect it resembles the inner whorls of *D. pseudocrassulosum* Fucini (1935, p. 87, pl. 9, figs. 6–8; Fischer, 1965, p. 32, pl. 3, fig. 1).

Figured specimen.—USNM 153849.

Occurrence.—Nicely Shale at USGS Mesozoic locality 26740.

Family HILDOCERATIDAE Hyatt, 1867
Genus LEPTALEOCERAS Buckman, 1918

Leptaleoceras dickinsoni Imlay, n, sp.

Plate 6, figures 7–11

Eleganticeras sp. Dickinson and Vigrass, 1965. Oregon Dept. Geology and Mineral Industries Bull. 58, p. 40.

The species is represented by 17 specimens from the Nicely Shale. The shell is highly evolute and compressed. The whorls are elliptical in section, a little higher than wide, and thickest near the middle. The venter is narrowly arched, bears a low keel, and does not have furrows. The umbilicus is wide. The umbilical wall, preserved only on the septate whorls, is low, vertical at its base, and rounds evenly into the flanks. The body chamber is incomplete but represents at least half a whorl.

The innermost whorls are smooth up to a diameter of about 8 mm. At greater diameters the septate whorls bear rather weak fairly dense gently flexuous ribs that vary somewhat in strength and spacing. These ribs begin at various heights on the umbilical wall, become stronger ventrally, curve slightly forward on the venter, and terminate in smooth areas bordering the keel. On the body chamber the ribbing disappears adorally.

The body chamber is present on the two specimens illustrated but is crushed. The septate part of the shell on those specimens is uncrushed. The specimen illustrated on plate 6, figures 7–9, 11, at a diameter of 34 mm has a whorl height of 13 mm, a whorl thickness of 9 mm, and an umbilical width of 8.5 mm.

The suture line cannot be traced accurately.

This species differs from *Leptaleoceras leptum* Buckman (1917, pl. 26, figs. 1a, b, 2a, b) by having a stouter whorl section, a narrower umbilicus, and finer denser ribbing that appears at an earlier growth stage. The stoutness of the whorls resembles that of *L.* aff. *leptum* Buckman (1917, pl. 26, figs. 3a, b; Arkell and others, 1957, p. L256, figs. 288–4a, b). *L.? pseudoradians* (Reynès) (1868, p. 91, pl. 1, figs. 4a–c, Frebold, 1964a, p. 15, pl. 4, figs. 5–7; pl. 5, figs. 4, 5) has more flexuous ribbing that persists to a later growth stage.

This species is named in honor of W. R. Dickinson of Stanford University who collected the type specimens.

Types.—Holotype, Stanford University Museum Paleontology 9853; paratype, Stanford University Museum Paleontology 9852.

Occurrences.—Nicely Shale, middle and upper parts, at USGS Mesozoic localities 26739, 27358, 27360, and 27380; Lupher's locality 125; Dickinson's locality F76. Questionably present in the Suplee Formation at Mesozoic locality 26733. The species ranges from a little below the middle to near the top of the Nicely Shale.

Leptaleoceras cf. L. leptum Buckman

Plate 6, figures 1–4

cf. *Leptaleoceras leptum* Buckman, 1917, Geol. Soc. London Quart. Jour., v. 73, p. 285, pl. 26, figs. 1a, b, 2a, b.

Eleganticeras cf. *E. pseudoelegans* Buckman. Dickinson and Vigrass, 1965, Oregon Dept. Geology and Mineral Industries Bull. 58, p. 40.

This species is represented by six internal molds most of which have been crushed. It is characterized by highly evolute coiling, compressed whorls, flattened flanks, a narrow unicarinate venter, and by sharp gently flexuous ribs that tend to fade on the largest whorl. The innermost whorls are smooth up to a diameter of about 8 mm. Ribbing develops rapidly on the succeeding half

whorl. The ribs incline forward gently on the lower fourth of the flanks, are nearly radial on the flanks, project slightly forward on the ventral margin, and terminate near the keel. The ribs on the internal mold are separated by interspaces that are about twice as wide. Where the shell is preserved, the ribs are as wide as the interspaces.

The specimen shown on plate 6, figure 2, at a diameter of 22.5 mm, has a whorl height of 8 mm, a whorl thickness of 4 mm, and an umbilical width of 8.5 mm. The suture line is not preserved. This species differs from *L. dickinsoni* Imlay, n. sp. by being a little more evolute and by having much coarser ribbing. It differs from *L. pseudoradians* (Reynes) (1868, p. 91, pl. 1, figs. 4a–c; Monestier, 1934, p. 63, pl. 8, figs. 61, 68; Howarth, 1957, p. 198, pl. 17, figs, 1a, b, 2a, b; Frebold, 1964a, p. 15, pl. 4, figs. 5–7) by its ribs being sparser, less flexuous, and less projected forward on the ventrolateral margin.

Overall it shows more resemblance to *L. leptum* Buckman. Its ribbing is a little sharper than on the small paratype of that species (Buckman, 1917, pl. 26, figs. 2a, b) but is comparable to that on the holotype as well as on the specimen that was described as *L.* aff. *L. leptum* Buckman (1917, pl. 26, figs. 3a, b).

Figured specimens.—USNM 153880, 153881, 155075.

Occurrences.—Nicely Shale, near middle, at USGS Mesozoic localities 26740, 27380, and 27392.

Leptaleoceras? morganense Imlay, n. sp.

Plate 2, figures 1–10

This species is represented by 14 specimens from the Nicely Shale.

The shell is highly evolute and compressed. The whorls are elliptical in section, nearly twice as high as wide, and become relatively higher during growth. The venter bears a single keel that is not bordered by furrows. The umbilical wall is steep and rounds evenly into the flanks. The umbilicus is wide. The body chamber occupies about three-fifths of a whorl. The aperture is bowed gently forward near the middle of the flank.

The ribbing is fairly weak at all stages of growth, although much stronger and more irregular in some specimens than in others. The innermost whorls are smooth. Broad flexuous ribs appear at diameters of 3–10 mm, and they become stronger adorally. These ribs vary from faint on some specimens to moderately conspicious on others. On specimens having the strongest ribbing, the ribs begin near the line of involution, become most prominent at the base of the flanks, become very broad on the upper parts of the flanks, and are separated by much narrower interspaces. On other specimens the ribs appear as broad, weak to indistinct, flexuous undulations.

During subsequent growth at diameters greater than 12–15 mm the ribs gradually become narrow and variably and widely spaced. Some arise in pairs from broad swellings low on the flanks. Others arise faintly near the line of involution or low on the flanks. All are weak but become a little stronger adorally. Growth straie are preserved on some of the largest whorls.

The suture line cannot be traced accurately. At a diameter of 23 mm, the holotype has a whorl height of 8 mm, a whorl thickness of 5 mm, and an umbilical width of 9.5 mm.

This species resembles *Leptaleoceras leptum* Buckman (1917, pl. 26, figs. 1, 2) in its highly evolute coiling, its unicarinate venter, and its weak flexuous ribbing on the septate whorls. It appears, however, to have broader more flexuous ribs on its small septate whorls and more widely spaced ribs on its largest septate whorls. None of the specimens are nearly as large as the holotype of *Leptaleoceras leptum* Buckman which becomes smooth except for growth striae at diameters greater than about 53 mm.

Types.—Holotype, USNM 153850; paratypes, USNM 153851–153855.

Occurrences.—Nicely Shale, about 100 feet above base, at USGS Mesozoic localities 27381 and 27392. Questionably present in the Sailor Canyon Formation at Mesozoic locality 2463 and in the Hurwal Formation in Wallowa Mountains at Mesozoic locality 28807.

Genus ARIETICERAS Seguenza, 1885

Arieticeras cf. A. domarense (Meneghini)

Plate 4, figures 9–12

cf. *Ammonites* (*Harpoceras*) *domarense*, Meneghini, 1867–81. Paléontologic Lombarde, serv. 4, app. p. 7, pl. 1, figs. 5, 6.

cf. *Hildoceras* (*Arieticeras*) *domarense* (Meneghini). Bettoni, 1900, Schweizer, palaeont. Gessell. Abh., v. 27, p. 56, pl. 5, fig. 3.

cf. *Hildoceras domarense* (Meneghini). Fucini, 1908, Toscana Univ. Annali, v. 28, p. 57, pl. 2, figs. 10–14.

cf. *Arieticeras domarense* (Meneghini). Monestier, 1934, Soc. Géol. France Mém., New Ser., v. 10, pt. 3 (mém. 23), p. 62, pl. 7, figs. 23, 25, 27, 29, 30, pl. 11, fig. 15.

cf. *Arieticeras domarense* (Meneghini), Sestini, 1962, Riv. Italiana Paleontologia, v. 68, no. 4, p. 520, pl. 39, figs. 5, 6.

cf. *Arieticeras* cf. *A. algovianum* (Oppel). Frebold, 1964a, Canada Geol. Survey Bull. 116, p. 13, pl. 3, figs. 3a, b; pl. 5, figs. 2, 3.

Orthildaites cf. *O. orthus* Buckman (in part). Dickinson and Vigrass, 1965, Oregon Dept. Geology and Mineral Industries Bull. 58, p. 38–40.

This species is represented by 65 internal molds 13 of which are from the Suplee Formation, 27 from the Nicely Shale, and 25 from the Sailor Canyon Formation.

It has evolute coiling, a wide umbilicus, and an ovate whorl section that is higher than wide. The venter bears

a low keel that is bordered by weak furrows on the internal mold. Furrows are not present, however, where the shell is preserved. The body chamber is incomplete but occupies at least three-fourths of a whorl. The ribs are sharp and are moderate in height and spacing. They begin near the line of involution, are inclined slightly backward on the flanks, curve forward abruptly on the ventral margin and fade out along the margins of the ventral furrows.

The suture line cannot be traced. The specimen shown on plate 4, figures 11 and 12, at a diameter of 36 mm, has a whorl height of 11 mm, a whorl thickness of 9 mm, and an umbilical width of 18 mm.

This species from Oregon closely resembles the illustrated specimens of *Arieticeras domarense* (Meneghini) and may be identical with that species. It differs from the Oregon species herein called *A.* cf. *A. algovianum* (Oppel) by having a higher whorl section and finer more closely spaced more rursidradiate ribs. As it occurs with that species at many localities and has the same stratigraphic range, it may be a variant.

Figured specimens.—USNM 155071, CAS 12807, 12808.

Occurrences.—Suplee Formation at USGS Mesozoic localities 26732 and 26733 and Lupher's locality 77. Nicely Shale at Mesozoic localities 26742, 27378, 27381, 28809, and 29218; Lupher's localities 47, 72, 121, 125, 300sh, and 404. Sailor Canyon Formation at Mesozoic localities 2464 and 28396. The species ranges from the upper third of the Suplee Formation to near the top of the Nicely Shale.

Arieticeras cf. A. algovianum (Oppel)

Plate 4, figures 1–8

cf. *Ammonites algovianus* Oppel. Reynès, 1868, Essai de géologie et de paléontologie Aveyronnaises, p. 92, pl. 2, fig. 1.

cf. *Hildoceras* (*Arieticeras*) *algovianum* (Oppel). Bettoni, 1900, Schweizer. palaeont., Gesell. Abh., v. 27, p. 53, pl. 4, figs. 8, 10, 11.

cf. *Hildoceras algovianum* (Oppel). Fucini, 1908, Toscana Univ. Annali, v. 28, p. 54, pl. 2, figs. 5, 6.

cf. *Hildoceras reynesi* Fucini. Idem, p. 55, pl. 2, figs. 7–9.

cf. *Arieticeras reynesi* Fucini. 1931, Palaeontographia Italica, v. 31, p. 103, pl. 7, figs. 15–19.

cf. *Arieticeras algovianum* (Oppel). Monestier, 1934, Soc. Géol. France mém., new ser., v. 10, pt. 3 (mém. 23), p. 55, pl. 7, figs. 104.

cf. *Arieticeras algovianum* Oppel. N. Fantini Sestini, 1962, Riv. Italiana Paleontologia, v. 68, no. 4, p. 516, pl. 38, fig. 15.

cf. *Arieticeras algovianum* (Oppel). Frebold, 1964a, Canada Geol. Survey Bull. 116, p. 13, pl. 3, figs. 4, 5; pl. 4, fig. 2.

Orthildaites cf. *O. orthus* Buckman (in part). Dickinson and Vigrass, 1965, Oregon, Dept. Geology and Mineral Industries Bull. 58, p. 38–40.

This species is represented by 50 internal molds of which 37 are from the Suplee Formation and 13 are from the Nicely Shale.

It has highly evolute coiling and an ovate whorl section that is a little wider than high. The venter bears a low keel that is bordered by shallow furrows. The ribs begin near the line of involution. On the flanks they are high, fairly narrow, widely spaced and nearly radial, or are inclined slightly backward. On the ventral margin they curve slightly forward and then fade out rather abruptly.

The suture line is not preserved and the specimens are too fragmentary or crushed for accurate measurements. The largest specimens available are nearly the size of those illustrated.

These Oregon specimens greatly resemble the small specimens of *Arieticeras algovianum* (Oppel) such as illustrated by Fucini (1908, pl. 2, figs. 5–9), Monestier (1934, pl. 7, fig. 2), and Frebold (1964a, pl. 3, figs. 4a, b, 5a, b) and may belong to that species.

Figured specimens.—USNM 153883, and CAS 12806.

Occurrences.—Suplee Formation at USGS Mesozoic localities 26732, 26733, and 29224. Nicely Shale at Mesozoic localities 26741, 26742, and 27381; Lupher's locs. 35, 47, and 121. The species ranges from the upper third of the Suplee Formation to near the top of the Nicely Shale. Only one specimen (Mesozoic loc. 27381) was obtained near the middle of the Nicely Shale and only three specimens (Mesozoic loc. 26742) from near the top of that formation.

Arieticeras lupheri Imlay, n. sp.

Plate 4, figures 13–28

Hildaites cf. H. serpentinum (Reinecke) [in part] Dickinson and Vigrass, 1965, Oregon Dept. Geology and Mineral Industries Bull. 58 p. 40.

This species is represented by about 250 specimens. The shell is serpental, highly evolute, and compressed. The whorls are elliptical and much higher than wide. The flanks are flattened. The venter is narrowly arched and bears a single keel that on the shell is bounded by narrow smooth areas. The keel on internal molds is bounded by deep grooves that are bordered by low ridges. The umbilical wall is steep at its base but rounds evenly into the flanks. The umbilicus is very wide. The body chamber on the largest specimen occupies half a whorl and is probably incomplete.

The innermost whorls are smooth up to diameters of about 6–8 mm. Then ribs appear abruptly on the upper parts of the flanks and become fairly strong within half a whorl. These ribs curve forward abruptly on the margins of the venter, become prominent to swollen along the zone of greatest curvature, and then end abruptly near the keel. During subsequent growth at

diameters greater than 12–14 mm the ribs gradually become gently flexuous, slightly prorsiradiate, relatively less prominent ventrally, and extend lower on the flanks. On the largest septate whorls the ribs cover most of the flanks and a few extend to the line of involution. The body chamber bears growth striae and broad low flexuous ribs that become weaker adorally.

The species shows considerable variation in coarseness and density of ribbing. Some specimens (pl. 4, figs. 14–16, 23) have fairly coarse and widely spaced ribs. Other specimens (pl. 4, figs. 17, 21, 26,) have much finer and more closely spaced ribs. Still others (pl. 4, figs. 25, 26, 28) including the holotype have ribs that are intermediate in coarseness and spacing.

The holotype at a diameter of 49 mm has a whorl height of 13.5 mm, a whorl thickness of 8.5 mm, and an unbilical width of 25 mm.

The suture line is characterized by having a very broad first lateral saddle and a rather narrow first lateral lobe that is much longer than the ventral lobe. The second lateral lobe is very small and short.

This species is characterized by its body chamber tending to become smooth adorally, by the ribs on its septate whorls becoming swollen near the venter, and by the smaller septate whorls being smooth on the lower part of the flanks. Both *A. mirficum* (Fucini) (1900, p. 60, pl. 12, figs. 9a–c, 10a, b) and *A. gerardi* Monestier (1934, p. 77, pl. 8, figs. 35–37) have similar rib patterns on their inner whorls as *A. lupheri* Imlay, n. sp. *A. mirificum* (Fucini) may be distinguished by a much stouter whorl section and somewhat coarser ribbing. *A. gerardi* Monestier appears to have sparser ribbing.

This species is named in honor of Ralph L. Lupher who collected some of the type specimens as well as many other ammonites described herein.

Types.—Holotype, CAS 12800; paratypes, CAS 12801–12805; paratype, Stanford University Museum Paleontology 9854; paratypes, USNM 153877, 153878.

Occurrences.—Nicely Shale at USGS Mesozoic localities 26747, 27360, 29218, 29222, 29326, and 29327; Lupher's localities 144, 300sh, 404, and 552; Dickinson's localties F75 and F81. The species has been collected from 10 feet above the base to within 20 feet of the top of the Nicely Shale. Questionably present in Sailor Canyon Formation at Mesozoic locality 28396.

Genus CANAVARIA Gemmellaro 1886

Canavaria cf. C. morosa Fucini

Plate 5, figures 12–14

cf. *Canavaria morosa* Fucini, 1931, Palaeontographia, Italica, v. 31, p. 135, pl. 16, figs. 27–29.

This species is represented by three internal molds from the Suplee Formation. The coiling is highly evolute. The whorl section is ovate, wider than high, but becomes less depressed during growth. The flanks and venter are evenly rounded. The venter bears a single keel. The umbilical wall is low and vertical and rounds evenly into the flanks. The last half whorl of the largest specimen is nonseptate and probably represents part of the adult body chamber as indicated by marked weakening of the ribbing adorally.

The ribs on the septate whorls are strong, widely spaced prorsiradiate on the flanks, and incline slightly forward on the venter. They begin low on the umbilical wall, become much stronger ventrally, become swollen on the margin of the venter, and then fade abruptly. Many of the ribs arise in pairs near the umbilical margin. The furcation points are generally swollen. During growth the ribs gradually become stronger and more prorsiradiate.

The ribs on the nonseptate outer whorl remain prorsiradiate, but become much weaker adorally and are not swollen ventrally or at the furcation points.

This species differs from most described species of *Canavaria* by having more twinned ribs, by its ribs being directed strongly backward, by having swellings rather than true tubercles, and by the ribs fading on the body chamber. These features occur, however, on the various species of *Canavaria* described by Fucini (1931, pls. 15–17). In most respects the Oregon species resembles *C. morosa* Fucini (1931, p. 135, pl. 16, figs. 27–29) but differs by having stronger ribs on its inner whorl and swellings instead of tubercles. The presence of many twinned ribs bar an assignment to *Arieticeras*, although twinning does occur rarely on some species of that genus (Monestier, 1934, pl. 10, figs. 24–26; Fucini, 1908, pl. 2, fig. 37).

Figured specimens.—USNM 153884.

Occurrence.—Suplee Formation, upper 10 feet, at USGS Mesozoic locality 26732.

Canavaria cf. C. excellens (Fucini)

Plate 5, figure 15

cf. *Naxensiceras? excellens* Fucini, n. sp., 1931, Paleontographia Italica, v. 31, p. 140, pl. 18, figs. 15–18.

One small specimen, consisting of both internal and external molds, shows parts of three whorls. The two smallest whorls bear strong widely spaced rectiradiate ribs, many of which bifurcate near the umbilicus. The outer whorl bears somewhat weaker slightly flexuous closely spaced ribs that become stronger ventrally. This species resembles *C. excellens* (Fucini) (1931, p. 140, pl. 18, figs. 15–18) in its outer whorl but has somewhat coarser ribbing on its inner whorls. *C. distefanoi* (Gemmellaro) 1885, p. 117, pl. 1, figs. 14–19; Fucini, 1931, p.

131, pl. 17, figs. 1–5) has sparser ribbing on its outer whorl.

The genus *Canavaria* is probably represented also by another small evolute ammonite (pl. 5, fig. 19) that bears strong rectiradiate closely spaced ribs. The ribs terminate ventrally in small tubercles and are swollen near the umbilical margin.

Figured specimens.—USNM 155073, 155074.

Occurrence.—Hurwal Formation in the Wallowa Mountains at USGS Mesozoic locality 28810.

Genus FONTANELLICERAS Fucini, 1931

Fontanelliceras cf. F. fontanellense (Gemmellaro)

Plate 5, figures 16–18

cf. *Harpoceras fontanellense* Gemmellaro, 1885, Soc. Sci. Nat. Ed. Econ. Palermo, Gior., v. 17, p. 118, pl. 2, figs. 1, 2.

cf. *Harpoceras (Arieticeras) fontanellense* Gemmellaro. Bettom, 1900, Schweizer, palaeont. Gesell. Abh., v. 27, p. 58, pl. 5, figs. 10–12.

cf. *Hildoceras fontanellense* Gemmellaro. Fucini, 1908, Toscana Univ. Annali, v. 28, p. 69, pl. 2, figs. 41–45.

cf. *Arieticeras fontanellense* Gemmellaro. Haas, 1913, Beitr. Paläont. Österreich-Ungarns u. des Orients, v. 26, p. 42, pl. 3, figs. 1, 2.

cf. *Fontanelliceras fontanellense* Gemmellaro. Fucini, 1931, Palaeontographia Italica, v. 31, p. 110, pl. 8, figs. 21–26.

not *Arieticeras fontanellense* Gemmellaro. Monestier, 1934, Soc. Géol. France, Mém, new ser., v. 10, pt. 3 (mém. 23), p. 68, pl. 10, figs. 48–52.

One specimen from the Nicely Shale is slightly compressed laterally. It is characterized by highly evolute coiling, a rounded whorl section that is a little wider than high, a tricarinate bisulcate venter, and by high nearly straight widely spaced ribs. The ribs begin low on the umbilical wall, are radially arranged on the flanks, or in places incline slightly backward, and bend forward slightly on the ventral margin. They become stronger ventrally but do not bear tubercles. The venter bears a rather prominent keel that is bordered by deep furrows. These in turn are bordered by weak ridges that become stronger adorally.

The specimen at a diameter of 24 mm, has a whorl height of 5.5 mm, a whorl thickness of about 7 mm, and an umbilical width of 14 mm. The suture line is not preserved.

The Oregon specimen of *Fontanelliceras* is identical with *F. fontanellense* Gemmellaro, as far as its preservation permits comparisons. In particular, it closely resembles the type specimens illustrated by Gemmellaro (1885, pl. 2, figs. 1, 2; reillustrated by Fucini, 1931, pl. 8, figs. 21, 22). It has sparser ribbing than the specimens assigned to that species by Monestier (1934, pl. 10 figs. 48–52).

Figured specimen.—CAS 12809.

Occurrence.—Nicely Shale at Lupher's locality 47.

Genus HARPOCERAS Waagen, 1869

Harpoceras? sp.

Plate 5, figure 23

cf. *Harpoceras* sp. McLearn, 1932, Royal Soc. Canada Trans., ser. 3, v. 26, sec. 4, p. 66, pl. 7, figs. 1, 2.

One shall specimen bears fairly strong falcoid ribs, most of which arise singly on the umbilical wall, but a few arise from a primary rib near the base of the flanks. This specimen differs from a small *Harpoceras* described by McLearn (1932, p. 66, pl. 7, figs. 1, 2) by having a smaller umbilicus and slightly coarser ribs.

Figured specimen.—CAS 12788.

Occurrence.—Nicely Shale at Lupher's locality 553. Two other fragments of *Harpoceras*, or possibly *Paltarpites*, occur in the Nicely Shale at Lupher's locality 71 and Dickinson's locality F79. One specimen occurs in the Sailor Canyon Formation at USGS Mesozoic locality 28396.

Subgenus HARPOCERATOIDES Buckman, 1909

Harpoceras (Harpoceratoides) cf. H. connectens (Haug)

Plate 5, figures 1–5

cf. *Hildoceras connectens* Haug, n. sp. 1885, Neues Jahrb., Beilage-Band 3, p. 686, pl. 12, figs. 8a, b.

cf. *Harpoceratoides connectens* (Haug). Monestier, 1931, Soc. Géol. France Mem., new ser., v. 7, pt. 1 (mém. 15), p. 32, pl. 8, figs. 6, 7, 11.

Twenty-one fragmentary specimens from the Lower Jurassic sequence in the Wallowa Mountains, Oreg., bear prominent falcoid fasciculate variably spaced ribs. Many of the ribs arise in pairs near the umbilicus and some bifurcate on the lower third of the flanks. These specimens at comparable sizes appear to have less widely spaced ribs and a more gentle rib curve than *H. connectens* (Haug) and somewhat less pronounced primary ribs than *H. alternans* (Simpson) (Buckman, 1909, pl. 9; Monestier, 1931, pl. 8, figs. 12, 13). They show some resemblance, also, to *Hildoceras yokoyamai* Matsumoto and Ono (1947, pl. 1 on page 32, fig. 9) which Arkell (1956, p. 421 assigns to *Lioceratoides*, but apparently have coarser and less fasciculate ribs. The Oregon specimens are assigned to *Harpoceratoides* rather than to *Lioceratoides* because they have fairly closely spaced ribs that do not tend to fade on the larger whorls.

Figured specimens.—USNM 153858.

Occurrences.—Hurwal Formation in the Wallowa Mountains at USGS Mesozoic localities 28807, 28808, 28810, and 28820.

Genus PALTARPITES Buckman, 1922

Paltarpites cf. P. argutus (Buckman)

Plate 5, figures 2–22, 24, 25

cf. *Argutarpites argutus* Buckman, 1923, Type Ammonites, v. 4, pl. 363.

Harpoceras cf. *H. exaratum* (Young and Bird). Dickinson and Vigrass, 1965, Oregon Dept. Geology and Mineral Industries Bull. 58, p. 40.

Eighteen fragmentary molds from the Nicely Shale are assigned to *Paltarpites* rather than *Harpoceras* because of their rather evolute coiling, the presence of falcoid rather than falcate ribs, the development of flat-topped ribs on the larger whorls, and a rounded instead of a sharp umbilical edge. The Oregon species is characterized by the rather sudden development of very fine closely spaced ribs. This change usually occurs on the larger outer whorls, but on some specimens it occurs on small whorls less than 2 inches in diameter. The change in ribbing is similar to that shown on *Harpoceras exaratum* (Young and Bird) as figured by Wright (1882, pl. 62, figs. 1–3), but that species, as well as the North American ammonites compared with it (Imlay, 1955, pl. 11, figs. 12, 13, 15; Frebold, 1957, p. 47, pl. 17, fig. 1; pl. 18, figs. 2, 3; 1959, p. 7, pl. 3, fig. 1; Frebold and Little, 1962, p. 17, pl. 2, figs. 1–9; pl. 3, fig. 5) are involute and have a sharp umbilical edge.

The Oregon species is nearly identical in appearance with *P. argutus* (Buckman) and may belong to that species. The ribs on its larger whorls are a little less projected on the venter and slightly more flexuous on the flanks. These differences are minor and are probably not of specific importance. The fragmentary condition of the specimens of *Paltarpites* from Oregon precludes exact specific identification.

Both *Paltarpites paltus* Buckman (1923, pl. 372a, b) and *P. platypleurus* Buckman (1927, pl. 698) have much broader and flatter ribs on their outer whorls than has the Oregon species.

Figured specimens.—USNM 153856, 153857; CAS 12787.

Occurrences.—Nicely Shale at USGS Mesozoic localities 26740, 27392, 29218, and 29222; Lupher's localities 47, 119, 404, and 553. Questionably present in the Sailor Canyon Formation at Mesozoic locality 2464 (label states "upper zone, west side of Canyon above Sterretts Mine"). The species in the Nicely Shale ranges definitely from near the top of the lower third to the middle and is probably represented also from the upper part of the formation at Lupher's locality 119.

Genus LIOCERATOIDES Spath, 1919

Lioceratoides? sp.

Plate 5, figures 6–11

This species is represented by two small internal molds. The shell is discoidal and moderately evolute. The outer whorl is elliptical in section, higher than wide, and embraces about one-third of the preceding whorl. The flanks are flattened. The venter is narrowly arched and bears a single keel that is bordered by narrow flattened areas. The umbilicus is moderate in width. The umbilical wall rounds evenly into the flanks. The body chamber is incomplete but on the largest specimen is represented by half a whorl.

The shell is marked by broad low irregularly weak widely separated falcate ribs of which some bifurcate near the middle of the flanks. These ribs trend forward on the lower third of the flanks, recurve fairly abruptly near the middle of the flanks, and then curve forward strongly on the margins of the venter.

The smaller of the two specimens illustrated at a maximum diameter of 17.5 mm, has a whorl height of 7 mm, a whorl thickness of 5 mm, and an umbilical width of 5 mm.

The suture line is only partly exposed, but is simple and consists of fairly broad lobes and saddles. The first lateral saddle is broad and consists of two nearly equal branches. The first lateral lobe is weakly trifid. The second lateral lobe is about half as long as the first. The auxiliary lobes rise toward the umbilicus. The sutural pattern is similar to that of *L. grecoi* (Fucini) as illustrated by Haas (1913, pl. 7, fig. 38).

This species has a rib pattern similar to that on small specimens of *Lioceratoides grecoi* (Fucini) (Haas, 1913, pl. 4, figs. 10a, 11; Fucini, 1931, pl. 5, fig. 12) and *L. expulsum* (Fucini) (1931, pl. 5, figs. 5, 6) but differs by its ribs projecting forward more strongly on the ventral margin.

Figured specimens.—USNM 155072.

Occurrence.—Nicely Shale, near middle, at USGS Mesozoic locality 29218.

Genus PROTOGRAMMOCERAS Spath, 1913

Protogrammoceras cf. P. marianii (Fucini)

Plate 6, figures 21–24

cf. *Grammoceras marianii* Fucini, 1904, Palaeontographia. Italica, v. 10, p. 283, pl. 20, figs. 1–3.

This species is represented by one moderately large septate internal mold. The shell is compressed and moderately involute. The whorl is elliptical in section, much higher than wide, and embraces about three-fifths of

the preceding whorl. The flanks are flattened. The venter is narrowly rounded and bears a single keel. The umbilicus is fairly narrow. The umbilical wall is low and vertical and rounds sharply into the flanks. The body chamber is unknown.

The ribbing on the internal whorls is unknown. At the adapical end of the large septate whorl, the ribs are flexuous and rather weak. Adorally they coarsen markedly and become falcoid. The interspaces are considerably wider than the ribs.

The specimen at a diameter of 56 mm has a whorl height of 25 mm, a whorl thickness of 17 mm(?), and an umbilical width of 17 mm.

The suture line, only partially preserved, has a broad first lateral saddle, a fairly narrow second lateral saddle, a fairly long and stout first lateral lobe, and a short and narrow second laternal lobe.

This species resembles *Protogrammoceras marianii* (Fucini) (1904, p. 283, pl. 20, figs. 1–3) in rib curve and in marked coarsening of ribbing adorally from rather fine to very coarse but is a little more involute. It likewise resembles *P. bonarellii* (Fucini) (1900, p. 45, pl. 10, figs. 4, 5a–c; 1923, p. 41, pl. 4, figs. 1, 2; Monestier, 1934, p. 88, pl. 2, figs. 12, 14–17) but is more involute and its ribs coarsen more adorally. Compared with *P. celebratum* (Fucini) (1900, p. 41, pl. 10, figs. 1, 2; Venzo, 1952, pl. A, fig. 1), it is much more involute and has coarser and sparser ribbing.

Figured specimen.—USNM 153859.

Occurrence.—Suplee Formation, upper 10 feet, at USGS Mesozoic locality 26732.

Protogrammoceras cf. P. bonarelli (Fucini)

Plate 7, figures 1–4

cf. *Grammoceras bonarelli* Fucini, 1900, Palaeontographia Italica, v. 6, p. 45, pl. 10, figs. 4, 5a–c.

cf. *Protogrammoceras bonarelli* (Fucini), 1923, Palaeontographia Italica, v. 29, p. 41, pl. 4, figs. 1, 2.

Three small internal molds from the Suplee Formation are possibly immature forms of the same species as the large specimen described herein as *Protogrammoceras* cf. *P. mariani* (Fucini). They appear, however, to have a stouter whorl section and stronger ribbing. They show considerable resemblance, also, to the small whorls of *P. bonarelli* (Fucini) but differ by having some rib furcation at or near the base of the flanks.

The venter on the internal mold bears a low keel that is bordered by narrow furrows. At one place where some shell is preserved the venter bears a single keel only.

The best preserved specimen at a diameter of 32 mm has a whorl height of 12 mm, a whorl thickness of 10.5 mm, and an umbilical width of 12 mm.

Figured specimen.—USNM 153860.

Occurrence.—Suplee Formation, upper 10 feet, at USGS Mesozoic locality 26732.

Protogrammoceras cf. P. nipponicum (Matsumoto and Ono)

Plate 6, figures 12–20

cf. *Grammoceras nipponicum* Matsumoto and Ono, 1947, Kyushu Univ. Fac. Sci., Sci. Repts., Geology, v. 2, no. 1, p. 27, pl. 2, fig. 3.

This species is represented by 13 specimens from the Suplee Formation and 24 from the Hurwal Formation in the Wallowa Mountains, Oreg. Most are crushed molds, but a few from the Suplee Formation retain some shell material.

The shell is compressed and fairly evolute. The whorls are subquadrate in section. The flanks are flattened. The venter is narrowly arched and bears a single keel. The keel is bordered by furrows on the internal mold but not on the shell. The umbilical wall is low and vertical and rounds evenly into the flanks. The body chamber is unknown.

The ribs on the small whorls are moderate in strength and density. They begin near the line of involution, become stronger ventrally, and are about as wide as the interspaces. They are gently flexuous on the flanks and project slightly forward on the venter. During growth the ribs become wider, more closely spaced, more flexuous, and tend to become bundled on the lower parts of the flanks. On the largest whorls the ribs are very broad and rounded, the interspaces very narrow, and the surface is striate.

The specimens are too crushed for accurate measurements. The suture line is imperfectly preserved but is similar in plan to that of *P.* cf. *P. marianii* (Fucini) described and illustrated herein.

This species bears ribbing similar to that of *P. nipponicum* (Matsumoto and Ono) (1947, p. 27, pl. 2, fig. 3) but apparently differs by being less evolute. *P.* cf. *P. meneghini* (Bonarelli), described herein, has slightly finer ribbing on its inner whorls and much finer ribbing on its outer whorls.

Figured specimens.—153861–153863.

Occurrences.—Suplee Formation, upper 30 feet, at USGS Mesozoic localities 25689, 26732, 27359, and 29224; Hurwal Formation in Wallowa Mountains at Mesozoic localities 28808 and 28810.

Protogrammoceras cf. P. meneghini (Bonarelli)

Plate 7, figures 8–13

cf. *Ammonites* sp. indet., Meneghini, 1867–81, Paléontologie Lombarde, ser. 4, p. 47, pl. 9, figs. 1a, b.

cf. *Protogrammoceras meneghini* Bonarelli. Venzo, 1952, Soc. Italiana Sci. Nat. Milano, Atti, v. 91, p. 108, pl. A, figs. 2a–c.

A species of *Protogrammoceras* characterized by very fine and dense ribbing is represented by 7 specimens

from the Suplee Formation, 6 from the Nicely shale, about 20 from the Sailor Canyon Formation, Calif., and 20 from the Hurwal Formation in the Wallowa Mountains, Oreg. The only specimens that are fairly well preserved are from the Suplee Formation and are the basis for the following description.

The species is compressed and moderately evolute. The whorls are subquadrate in section, much higher than wide, and embrace about two-fifths of the preceding whorl. The flanks are flattened. The venter is narrowly arched and bears a high keel that is not bordered by furrows. The umbilicus is about one-third as wide as the diameter of the shell. The umbilical wall is low and vertical, and its edge is sharp. The largest available specimen is entirely septate and the body chamber is unknown.

The ribs on the small whorls are low and closely spaced. They begin near the line of involution, become stronger ventrally, and are a little wider than the interspaces. They are gently flexuous on the flanks, project gently forward on the edge of the venter, and terminate in smooth areas bordering the keel.

During growth the ribs become more flexuous on the flanks and striate near the umbilicus. Additional ribs arise on the lower third of the flanks by branching and by intercalation. The ribs on the upper parts of the flanks are nearly equal in strength and are a little narrower than the interspaces. Some striae occur in the interspaces wherever the shell is preserved. The ribbing on the adult whorl is unknown.

The largest specimen at an estimated diameter of 65 mm has a whorl height of 28 mm and an umbilical width of 22 mm.

The suture line has a very broad first lateral saddle and a much narrower second lateral saddle. The first lateral lobe is fairly stout and is slightly longer than the ventral lobe. The second lateral lobe is a little smaller and shorter than the first lateral lobe. The general sutural pattern is similar to that of *P. meneghinii* (Bonarelli) as illustrated by Venzo (1952, pl. A, fig. 2c on p. 109) except for a much larger second lateral lobe.

This species is similar in coiling, whorl section, and fineness of ribbing to the most finely ribbed variant of *Protogrammoceras madagascariense* (Thevenin) (1908 b, pl. 3, figs. 3a, b, 5) from Madagascar but has less flexuous ribbing and lacks ventral furrows. Its fine ribbing is also closely comparable to that on *P. permirabile* Fucini (1921, p. 17, pl. 3, figs. 8a, b) and *P. amphiceroides* Fucini (1923, p. 44, pl. 4, figs. 10, 11) from Italy. These species are compared by their author with the finely ribbed variant of *P. madagascariense* (Thevein) (1908b, pl. 3, fig. 5 only). The Oregon species likewise resembles *P. meneghini* (Bonarelli) (Meneghini, 1867–81, pl. 9, figs. 1a, b) in rib curve, fineness of ribbing, whorl shape, umbilical width, and lack of ventral furrows, but it possibly differs by having a sharp umbilical edge.

Figured specimens.—USNM 153864, 153865.

Occurrences.—Suplee Formation, upper 10 feet, at USGS Mesozoic localities 26732 and 28033; Nicely shale, basal 5 feet, at Mesozoic locality 26745; Hurwal Formation in Wallowa Mountains at Mesozoic localities 28807, 28809, and 28820; Sailor Canyon Formation at Mesozoic localities 2464 and 28396.

Protogrammoceras? cf. P.? isseli (Fucini)

Plate 6, figures 5, 6

cf. *Grammoceras isseli* Fucini, 1900, Palaeontographia Italica, v. 6, p. 37, pl. 9, figs. 6–8.

cf. *Hildoceras isseli* (Fucini), 1904, Palaeontographia Italica, v. 10, p. 289, pl. 20, figs. 15–18.

The species is represented by one internal mold that contains some shell material. The shell is compressed and moderately evolute. The whorls are elliptical in section, considerably higher than wide, and embrace about one-third of the preceding whorls. The venter is narrowly arched and bears a keel that is bordered by narrow flat areas. The flanks are flattened. The umbilicus is fairly wide. The umbilical wall is vertical and fairly low and rounds rather abruptly into the flanks. The body chamber is unknown.

The ribs as exposed in the umbilicus are fairly fine but they become markedly finer and denser on the adapical half of the outermost whorl. On this half the ribs are gently flexuous and curve forward slightly on the venter. Most of them begin near the line of involution but some arise by intercalation on the lower parts of the flanks. Adorally near the middle of the outermost whorl the ribs on the flank become appreciably stronger, more widely spaced, and more flexuous. On the ventral margin the forward curvature of the ribs remains rather feeble.

The specimen has been compressed slightly laterally but at a diameter of 39 mm has a whorl height of 14 mm, a whorl thickness of 11 mm, and an umbical width of 14 mm. The suture line is not preserved.

This specimen resembles *P.? isseli* (Fucini) in most respects but is a little finer ribbed than most of the specimens of that species that have been illustrated. It is nearly identical in appearance, however, with one specimen illustrated by Fucini (1904, pl. 20, figs. 18a–c). It also greatly resembles *Protogrammoceras? isseli* (Fucini) var. *zouensis* Dubar (1961b, p. 255–257, fig. 10 on p. 256) but becomes more coarsely ribbed adorally. It has

appreciably finer ribbing than *Fuciniceras? portisi* (Fucini) (1900, p. 33, pl. 9, figs. 1–5).

Figured specimen.—USNM 153866.

Occurrence.—Suplee Formation, upper 10 feet, at USGS Mesozoic locality 26732.

Protogrammoceras? ochocoense Imay, n. sp.

Plate 6, figures 25–28

This species is represented by four septate internal molds. All have been crushed except the larger of the septate specimens herein illustrated.

The shell is fairly evolute. The whorls are compressed, elliptical in section, and much higher than wide. The outermost septate whorl embraces about one-fourth of the preceding whorl. The umbilical wall is low and steep and rounds gradually into the flanks. The venter bears a single keel that is bordered by narrow flat areas. The body chamber is unknown.

The innermost whorls are smooth, but ribbing appears at a diameter of about 5 mm and develops rapidly on the next half whorl. The ribs on the small inner whorls begin low on the flanks near the line of involution. They are fine, gently flexuous, somewhat variable in strength and spacing, and become slightly stronger ventrally. Near the venter they curve forward, become broader and lower, and then fade out. The ribs on the largest septate whorl are also gently flexuous. They curve forward on the umbilical wall and on the lower fourth of the flanks, are nearly radial on most of the flanks, and then curve slightly forward on the ventral margin. Adorally on this whorl they become considerably stronger and much more widely spaced. Most ribs begin on the umbilical wall but some begin low on the flanks. The ribs are much sharper wherever shell material is preserved than they are on the internal mold.

The largest illustrated specimen at a diameter of 42 mm has a whorl height of 15 mm, a whorl thickness of 10 mm, and an umbilical width of 17 mm.

The suture line has a very broad first lateral saddle and a stout first lateral lobe that is longer than the ventral lobe.

This species is characterized by its ribs changing from very fine and closely spaced on its inner septate whorls to moderately coarse and fairly widely spaced on its outer septate whorls. This change is much more conspicuous than in *P.? isseli* (Fucini) (1900, pl. 9, figs. 6–8; 1904, pl. 20, figs. 6–8).

Types.—Holotype, CAS 12790; paratype, Stanford University Museum Paleontology 9855.

Occurrences.—Nicely Shale at USGS Mesozoic locality 27381, Lupher's locality 125, and Dickinson's locality F76. The species has been found in the middle and upper parts of the Nicely Shale.

Protogrammoceras? cf. P.? pseudofieldingi (Fucini)

Plate 7, figures 5–7

cf. *Harpoceras fieldingi* Reynes. Fucini, 1900, Palaeontographia Italica, v. 6, p. 25, pl. 7, fig. 8a, b.

cf. *Harpoceras pseudofieldingi* Fucini, 1904, Palaeontographia Italica, v. 10, p. 285, pl. 20, figs. 4a, b.

cf. *Grammoceras pseudofieldingi* Fucini. Monestier, 1934, Soc. Géol. France, Mém., New Ser., v. 10, pt. 3 (Mém. 23), p. 35, pl. 4, figs. 24–26.

One specimen from the Nicely Shale has fairly evolute coiling and a compressed whorl section that is much higher than wide. The venter bears a single keel and is not bisulcate. The umbilical wall is low and vertical at the base and rounds evenly into the flanks. The specimen is nearly smooth, but under oblique lighting shows very broad faint falciform ribs. The suture line is not preserved. At a diameter of 29 mm the whorl height is 12.5 mm, the whorl thickness 7 mm, and the umbilical width 8 mm.

This specimen is similar in size and shape to the small ammonites that Buckman (1914, pls. 93, 106) described under the generic name *Elegantuliceras* but which Arkell (in Arkell and others, 1957, p. L256) assigns questionably to *Eleganticeras*. It differs from those ammonites, however, by having much broader ribs. Its overall appearance is more similar to *Harpoceras pseudofieldingi* Fucini (1904, pl. 20, figs. 4a, b) which is placed questionably in *Protogrammoceras* by Dubar (1961a, p. 246).

Figured specimen.—CAS 12789.

Occurrence.—Nicely Shale at Lupher's locality 553.

Genus FUCINICERAS Haas, 1913

Fuciniceras cf. F. lavinianum (Meneghini) in Fucini

Plate 7, figures 14–16

cf. *Hildoceras lavinianum* Meneghini. Fucini, 1900, Palaeontographia Italica, v. 6, p. 52–56, pl. 11, figs. 6, 7; pl. 12, figs. 1–4.

cf. *Hildoceras lavinianum* Meneghini. Fucini, 1905, Palaeontographia Italica, v. 11, p. 166, pl. 3, figs. 2–14.

cf. *Hildoceratoides lavinianum* Meneghini. Fucini, 1923, Palaeontographia Italica, v. 29, p. 46, pl. 4, fig. 17; pl. 5, fig. 1–6.

Five internal molds have gently flexuous rather weak ribbing similar to that on *F. lavinianum* Meneghini var. *coniungens* Fucini (1900, p. 54, pl. 12, figs. 2, 3; 1905, pl. 3, figs. 10–12; 1923, pl. 5, figs. 3–5). The ribs curve forward low on the flanks, recurve backward on the remainder of the flanks, and then curve forward weakly on the margin of the venter. The ribbing is likewise similar to that on *F. boscense* (Reynes) (Fucini, 1900, pl. 7, fig. 4; 1905, pl. 4, fig. 13; Monestier, 1934, p. 85, pl. 2, figs. 6, 10, 11, 13) but differs by being a little weaker and less inclined backward.

Figured specimen.—USNM 153867.

Occurrence.—Nicely Shale about 100 feet above base, at USGS Mesozoic locality 27392.

Fuciniceras cf. F. acutidorsatum Kovacs

Plate 7, figures 17, 20, 22–24

cf. *Fuciniceras acutidorsatum* Kovacs, 1942, Geologica Hungarica, ser. Palaeont., pt. 17, p. 197, pl. 4, fig. 10.

This species is represented by 12 poorly preserved internal molds. The coiling is moderately evolute. The whorls are elliptical in section and considerably higher than wide. The venter is narrowly arched and bears a low keel that is bordered by narrow flattened areas. The flanks are evenly convex on the smaller whorls and flattened on the largest whorls. The umbilicus is moderately wide. The umbilical wall is low and vertical and rounds evenly into the flanks. The body chamber, exposed on the largest specimen, occupies about three-fourths of the outer whorl and is incomplete.

The ribs are fairly prominent and are moderately spaced. They curve forward on the umbilical wall and on the lowest part of the flanks, curve backward slightly on the flanks, and then curve weakly forward on the venter. Most ribs are single but a few arise in pairs at the base of the flanks.

Measurements cannot be made accurately, and the suture line cannot be traced.

This species resembles *F. acutidoratum* Kovacs (1942, pl. 4, fig. 10) in its ribs being moderately spaced, backwardly inclined, and only slightly curved, but it is less evolute and has a stouter whorl section. In these respects it shows more resemblance to *F. lavinianum* Meneghini var. *retroflexa* Fucini (1900, p. 56, pl. 12, figs. 1a, b). Its ribbing appears to be a little sharper and sparser than in *F. detractum* (Fucini) as figured by Dresnay (1964, p. 154, pl. 1, figs. 2a, b).

Figured specimens.—USNM 153868, 153869, 153879; CAS 12791.

Occurrences.—Suplee Formation, upper part, at USGS Mesozoic localities 26732, 28372, and 29226; Lupher's locality 300ss. Nicely Shale at Mesozoic locality 26741. The species has been collected from the upper third of the Suplee Formation and the lower sixth of the Nicely Shale.

Fuciniceras cf. F. inclytum (Fucini)

Plate 8, figures 15–19, 22

cf. *Hildoceras inclytum* Fucini, 1900, Palaeontographia Italica, v. 6, p. 62, pl. 13, figs. 1, 2.

cf. *Hildoceras inclytum* Fucini, 1904, Palaeontographia Italica, v. 10, p. 264, pl. 21, fig. 20.

cf. *Hildoceratoides inclytum* (Fucini), 1923, Palaeontographia Italica, v. 29, p. 47, pl. 5, figs. 7, 8.

This species is represented by four septate internal molds. The coiling is highly evolute. The whorls are ovate in section and a little higher than wide. The venter is moderately arched and bears a keel. The keel is bordered by furrows on the smallest internal mold and by narrow flattened areas on the largest internal mold. The flanks are evenly convex on the smaller whorls and flattened on the largest whorl. The umbilicus is very wide. The umbilical wall is steeply inclined and rounds evenly into the flanks. The body chamber is unknown.

The ribs are moderately sharp and are widely spaced on the smaller septate whorls and become very strong on the largest septate whorl. They begin low on the umbilical wall, curve backward slightly on the flanks, and terminate on the margins of the venter. The ventral ends of the ribs are curved forward.

Measurements cannot be made accurately.

The suture line, partly preserved on the largest specimen, has broad saddles and a fairly broad trifid first lateral lobe.

This species greatly resembles *F. inclytum* (Fucini) (1900, p. 62, pl. 13, figs. 1, 2) in its evolute whorls and its sharp widely spaced backwardly inclined ribs. It has much sharper and more widely spaced ribs than *F. lavinianum* Meneghini in Fucini (1900, p. 52, pl. 11, figs. 6, 7; pl. 12, figs. 1–4) or *F. acutidorsatum* Kovacs (1942, p. 197, pl. 4, fig. 10).

Figured specimens.—USNM 155076; CAS 12792, 12793.

Occurrences.—Nicely Shale at Lupher's localities 125 and 300sh; Suplee Formation at USGS Mesozoic locality 26732.

Fuciniceras cf. F. capellinii (Fucini)

Plate 8, figures 8, 11–14

cf. *Hildoceras capellinii* Fucini, 1900, Palaeontographia Italica, v. 6, p. 59, pl. 12, fig. 8.

cf. *Hildoceras capellinii* Fucini, 1904, Palaeontographia Italica, v. 10, p. 291, pl. 21, figs. 4, 5, 9.

cf. Fuciniceras capellinii (Fucini). Monestier, 1934, Soc. Géol. France, Mém., new ser., v. 10, pt. 3 (Mém. 23), p. 90, pl. 1, figs. 1 and 6.

This species is represented by 12 distorted internal molds from the Suplee Formation and 13 from the Hurwal Formation in the Wallowa Mountains, Oreg. The coiling is highly evolute. The whorl section is ovate to subquadrate and about as wide as high. The venter is fairly broad and bears a low keel that is bordered by furrows. The umbilicus is very wide. The body chamber is unknown.

The ribs vary from closely to moderately spaced, are moderate in strength, and are coarsest on specimens on

which rib spacing is widest. The ribs on the flanks of small specimens and on inner whorls are nearly straight and radially directed, or are inclined slightly backward. They begin near the line of involution and become stronger ventrally. On the venter these ribs curve forward, weaken abruptly, and then terminate in a lateral keel.

On larger specimens, at diameters greater than about 30 mm, the ribs become stronger, more widely spaced, and falcoid. They curve strongly backward on the lower and middle parts of the flanks and then curve strongly forward on the upper parts of the flanks and on the venter, where they fade rapidly and terminate before reaching the keel.

Fuciniceras cf. *F. capellinii* (Fucini) from Oregon differs from *Fuciniceras inclytum* (Fucini) (1900, pl. 13, figs. 1, 2) by having much coarser and more closely spaced ribs. It differs from *F. capellinii* (Fucini) by having coarser ribbing, more evolute coiling, and probably a stouter whorl section. It differs from species of *Mercaticeras*, such as *M. aptum* (Buckman) (1922, pl. 316), *M. quadratum* (Haug) (1885, p. 638; Dumortier, 1874, pl. 14, figs. 6, 7; pl. 15, fig. 1, 2; Renz, 1905, pl. 10, figs. 3, 3a), and *M. humeralis* Merla (1933, pl. 6, figs. 1–7), by having a unicarinate instead of a tricarinate venter. The various species that Fucini (1923, v. 29, p. 66–70, pl. 11, figs. 18, 20; pl. 12; pl. 13, figs. 1–19) referred to *Murleyiceras*, a synonym of *Mercaticeras*, differ from Oregon species by having broader ribs that do not project as strongly forward on the upper parts of the flanks.

Figured specimen.—USNM 153882.

Occurrences.—Suplee Formation, upper third, at USGS Mesozoic localities 26732 and 26733; Hurwal Formation in Wallowa Mountains, Oreg., at Mesozoic localities 28807, 28810, and 28820.

Fuciniceras sp. A

Plate 7, figure 21

The internal mold of this species is characterized by highly evolute coiling, by moderately strong simple ribs that incline backward rather strongly on the flank, and by the replacement of the ribs by fine flexuous striae on the adapical part of the body chamber. The whorl section is ovate and a little wider than high. The venter bears a low keel that is bounded by narrow smooth areas. The body chamber is incomplete but is represented by about one-third of a whorl.

Figured specimen.—USNM 153870.

Occurrence.—Nicely Shale at USGS Mesozoic locality 27381.

Fuciniceras sp. B

Plate 7, figures 18, 19

One septate specimen from the Nicely Shale is characterized by fairly evolute coiling, a moderately stout form, a single keel that is bordered by furrows, and by low broad backwardly curved ribs. The inner whorls, as exposed in the umbilicus, bear faint broad ribs that are strongest at the line of involution. The outermost preserved septate whorl bears much stronger ribs that arise low on the flanks and that fade out near the ventral sulci. These ribs curve forward on the lower third of the flanks, curve backward strongly on the upper part of the flanks, and then curve slightly forward near the ventral sulci.

The specimen at a diameter of 20.5 mm. has a whorl height of 7.5 mm, a whorl thickness of 8.2 mm, and an umbilical width of 7.7 mm. The suture line cannot be traced.

This specimen bears a little resemblance to an immature specimen of *Fuciniceras capellinii* var. *turgidula* (Fucini) (1908, p. 294, pl. 21, fig. 7) but differs by having broader and lower ribs.

Figured specimen.—CAS 12794.

Occurrence.—Nicely Shale at Lupher's locality 47.

Fuciniceras? cf. F.? intumescens (Fucini)

Plate 8, figures 1–7, 9, 10

cf. *Hildoceras intumescens* Fucini, 1900, Palaeontographia Italica, v. 6, p. 63, pl. 13, figs. 3a, b.

cf. *Fuciniceras? intumescens* (Fucini). Venzo, 1952, Soc. Italiana Sci. Nat., Milano, Atti, v. 91, pl. A, figs. 3a, b facing p. 108.

This species is represented by six specimens. The shell is fairly evolute and compressed. The whorls are elliptical in section, higher than wide, and embrace about one-third of the preceding whorl. The flanks are flattened. The venter is narrowly arched and bears a single keel. The keel is bounded by narrow furrows on internal molds and by narrow smooth areas on the shell. The umbilicus is moderately wide. The umbilical wall is low and vertical at its base and rounds evenly into the flanks. The body chamber is unknown.

The innermost whorls are smooth to diameters of about 6 mm. At larger diameters the whorls bear gently flexuous ribs that arise low on the umbilical wall, become stronger ventrally, and terminate near the keel. The ribs curve forward on the lower part of the flanks, curve backward near the middle of the flanks, and then curve forward again on the margin of the venter. The ribs are moderate in strength and are separated by somewhat wider interspaces that are variable in width.

On the larger whorls the ventral parts of the ribs become rather broad and flat. The surface of the shell is covered with fine striae that parallel the curvature of the ribs.

The specimen shown on plate 8, figures 5, 6, at a diameter of 36 mm, has a whorl height of 13.5 mm, an estimated whorl thickness of 10 mm, and an umbilical width of 14.5 mm. The suture line cannot be traced.

The medium-sized specimens of this species closely resemble the holotype of *Fuciniceras? intumescens* Fucini (1900, p. 63, pl. 13, figs. 3a, b). The large specimens resemble a specimen assigned by Venzo (1952, pl. A, figs. 3a, b) to *F.? intumescens* (Fucini). The Oregon specimens are a little more compressed and their ribs curve forward more strongly on the venter, but all other characteristics appear to be identical. *Fuciniceras primordium* (Matsumoto and Ono) (1947, pl. 1, fig. 3) is likewise similar but is distinguished by less flexuous and somewhat coarser ribs. The small whorls of *Protogrammoceras bassanii* (Fucini) (1900, pl. 10, figs. 7a, b; Hass, 1913, pl. 3, figs. 25–28; Howarth, 1955, pl. 11, figs. 5a, b) have as coarse ribs as the Oregon species but are readily distinguished by the forward sweep of the ribs on the venter.

The characteristics of the Oregon species show that it is closely related to the genera *Fuciniceras* and *Protogrammoceras*, but is not fully typical of either. On *Fuciniceras*, according to Dubar (1961a, p. 252), the ribs are nearly straight and are arranged more or less at right angles to the ventral margin. On *Protogrammoceras* the ribs are broadly arched, are falciform toward the top of the flanks, and are projected forward on the ventral margin. On the Oregon species, by comparison, the ribs are less falciform than in *Protogrammoceras* and more projected ventrally than in *Fuciniceras*. Overall the rib pattern favors an assignment to *Fuciniceras*.

The Oregon species belongs to a group of species that has a rib pattern intermediate between *Fuciniceras* and *Protogrammoceras*. The group includes such species as *F.? ambiguum* (Fucini) (1900, p. 24, pl. 7, figs. 6a–c), *F.? detractum* (Fucini) (1900, pl. 8, figs. 2, 3; 1929, pl. 5, fig. 15), *F.? intumescens* (Fucini) (1900, p. 63, pl. 13, figs. 3a, b), *F.? boscense* (Reynes) (Monestier, 1934, pl. 2, figs. 6, 10, 11, 13), *P.? isseli* (Fucini) (1900, p. 33, pl. 9, figs. 6–9), and *P.? dilectum* (Fucini) (1900, p. 50, pl. 11, figs. 2, 3). On these species the ribs are either less falciform than on *Protogrammoceras*, or are more projected on the venter than in *Fuciniceras*, or are nearly straight on most of the whorls, as in *Fuciniceras*, but they become falciform on the adult body whorl. The presence of such intermediate species suggests that *Protogrammoceras* may be merely a subgenus of *Fuciniceras*, as suggested by Arkell and others (1957, p. L258).

Figured specimens.—USNM 153871, 153872.

Occurrences.—Suplee Formation, upper 10 feet, at USGS Mesozoic locality 26732; Nicely Shale, about 100 feet above base, at Mesozoic locality 27381.

Genus WHITBYICERAS Buckman, 1913

Whitbyiceras? sp.

Plate 5, figures 26–28

This species is represented by one specimen which is mostly undeformed and septate. Its last half whorl is considerably crushed and is only partly septate. The inner whorls, as exposed in the umbilicus, are nearly circular in section and a little wider than high. The outermost whorl that is not crushed is subquadrate in section, a little higher than wide, and embraces about two-fifths of the preceding whorl. The umbilical wall is low and vertical and rounds evenly into the flanks. During growth the flanks change from convex to fairly flat and the venter from broadly to narrowly arched.

The ribs on the inner whorls, as exposed in the umbilicus, begin on the umbilical wall and incline slightly forward on the flanks. Most arise singly, but some arise in pairs. They are stout, become stronger ventrally, and are separated by wider interspaces. Adorally on the outermost preserved whorl the ribs gradually become less stout, gently flexuous, and tend more and more to arise in pairs. On the crushed part of the shell more than half the ribs arise in pairs. All ribs curve gently forward on the ventral margin and terminate in narrow fairly smooth areas bordering the keel. The venter is marked, also, by striae parallel to the curvature of the ribs. On the nonseptate part of the shell the ribbing is much weaker than on the septate part.

The specimen at a diameter of about 27 mm (not considering the keel) has a whorl height of 12 mm, a whorl thickness of 10 mm, and an umbilical width of 8.5 mm. The suture line cannot be traced.

This specimen from Oregon resembles *Whitbyiceras pinque* (Simpson) (Buckman, 1913, pl. 80, figs. 1, 2) in coiling, stoutness of whorls, and the presence of slightly flexuous ribs that commonly arise in pairs at the umbilical margin. It differs by lacking ventral furrows bordering the keel and by having an evenly rounded instead of a sharp umbilical edge. The absence of these features, however, could be related to its smaller size.

Figured specimen.—CAS 12795.

Occurrence.—Suplee(?) Formation at Lupher's locality 45. The formational assignment is questioned because the specimen is preserved in a black limestone matrix that is characteristic of concretions from the Nicely Shale.

Genus FANNINOCERAS McLearn, 1930

Fanninoceras kunae McLearn

Plate 8, figures 25–32

cf. *Fanninoceras kunae* McLearn, 1930, Royal Soc. Canada, Trans., ser. 3, v. 24, sec. 4, p. 5, pl. 2, fig. 4; 1932, idem, ser. 3, v. 26, sec. 4, p. 77–79, pl. 8, figs. 11, 12; pl. 9, figs. 1–6.

This species is represented in collections from eastern Oregon by 15 specimens from the Nicely Shale and 26 from the Hurwal Formation in the Wallowa Mountains. Most of the specimens resemble the coarsely ribbed variant that was named *F. kunae* var. *crassum* McLearn (1932, p. 78, pl. 9, figs. 1–4). The specimens have relatively strong fairly widely spaced flexuous ribs that project forward on the venter. The umbilical wall is low and vertical. The venter ranges from narrowly rounded to sharpened.

The suture line, fairly well preserved on one specimen, is rather simple. The first lateral lobe is narrow, trifid, and slightly longer than the ventral lobe. The second lateral lobe is much shorter and smaller than the first lateral lobe. The first lateral saddle is broad and bifid. The second lateral saddle is about half as wide as the first.

Hypotypes.—USNM 153873, 153874; CAS 12796, 12797.

Occurrences.—Nicely Shale, middle and upper parts, at USGS Mesozoic localities 26740, 27360, and 29218; Lupher's localities 121, 125, and 553. Hurwal Formation in the Wallowa Mountains at Mesozoic localities 28809, 28810, and 28820.

Fanninoceras cf. F. bodegae McLearn

Plate 8, figures 20, 21

cf. *Fanninoceras bodegae* McLearn, 1932, Royal Soc. Canada Trans., ser. 3, v. 26, sec. 4, p. 8, pl. 9, figs. 7–9.

Sixteen specimens from eastern Oregon resemble *F. bodegae* McLearn by having a moderately wide umbilicus, a very low but nearly vertical umbilical wall, and faint to weak ribbing that becomes striate during growth. They differ from *F. fannini* McLearn (1932, p. 72, pl. 7, figs. 7, 8, pl. 8, figs. 1–8) by having much weaker and denser ribbing and a wider umbilicus. The fact that their ribbing is flexuous instead of falcoid shows that they are not immature forms of *Eleganticeras* (Arkell and others, 1957, p. L256).

Figured specimens.—USNM 153875 and CAS 12798.

Occurrences.—Nicely Shale at USGS Mesozoic localities 25819 and 26740 and Lupher's locality 404; Hurwal Formation in the Wallowa Mountains at Mesozoic locality 28820.

Fanninoceras cf. F. carlottense McLearn

Plate 8, figures 23, 24

cf. *Fanninoceras carlottense* McLearn, 1930, Royal Soc. Canada Trans., ser. 3, v. 24, sec. 4, p. 4; idem, ser. 3, v. 26, sec. 4, p. 76, pl. 8, figs. 9, 10.

One specimen has a sharp venter, a tiny umbilicus, and nearly smooth flanks. Faint broad ribs that curve slightly forward on the flanks and bend gently forward near the venter are visible under oblique lighting.

Figured specimen.—USNM 153876.

Occurrence.—Nicely Shale, near top of lower third, at USGS Mesozoic locality 29218.

Genus POLYPLECTUS Buckman, 1890

Polyplectus cf. P. subplanatus (Oppel)

Plate 9, figures 13, 16

cf. *Ammonites complanatus* Bruguiere. d'Orbigny, 1845, Paleontologie francaise. Terrains Jurassiques, v. 1, pl. 114, figs. 1, 2, and 4 only.

cf. *Ammonites subplanatus* Oppel, 1856, Jahresh. Ver. vaterl. Naturk. Würtemberg (Stuttgart), v. 12, p. 244.

cf. *Ammonites elegans* J. Sowerby. Reynès, 1879, Monographie des Ammonites Lias, pl. 4, figs. 1–6; pl. 5, figs. 1–17.

cf. *Harpoceras subplanatum Oppel.* Haug, 1885, Neues Jahrb., Beilage-Band 3, p. 619, 620.

Harpoceras cf. *H. exaratum* (Young and Bird). Dickinson and Vigrass, 1965, Oregon Dept. Geology and Mineral Industries Bull. 58, p. 48.

This species is represented in the basal part of the Snowshoe Formation of Lupher (1941) in Oregon by 30 laterally crushed fragments. These bear falcate ribs that greatly resemble those on *Harpoceras* cf. *H. exaratum* (Young and Bird) which occurs in beds of Toarcian age in Canada (Frebold and Little, 1962, p. 17; Frebold, 1964a, p. 16). The ribbing also greatly resembles that on *Polyplectus subplanatus* (Oppel) from the late Toarcian of Europe. That species is difficult to separate on the basis of its ribbing from *Harpoceras exaratum* (Young and Bird), according to Haug (1885, p. 621, 622) but it has a narrower umbilicus and a sharper venter. It was assigned to *Harpoceras* by Arkell (1956, p. 126, 265) and to *Polyplectus* by Donovan (1958, p. 49; Dean and others, 1961, p. 479).

Assignment of the species in the Snowshoe Formation to *Polyplectus* rather than to *Harpoceras* is based on the presence of a very narrow umbilicus that is well preserved on one of the largest fragments. In *Harpoceras* cf. *H. exaratum* (Young and Bird) the umbilicus is much wider at a comparable shell diameter.

The Oregon species of *Polyplectus* has slightly coarser ribbing and a narrower umbilicus than *P. capellinus* (Quenstedt) (1885, pl. 44, fig. 14) and somewhat

finer ribbing than *P. discoides* Zeiten as figured by Wright (1884, pl. 82, fig. 12).

Figured specimens.—CAS 12799.

Occurrences.—Snowshoe Formation, lower part, at USGS Mesozoic localities 25690, 26750, and 26751; Lupher's localities 76 and 127. The species occurs from 75 to 125 feet above the base of the formation.

Genus GRAMMOCERAS Hyatt, 1867

Grammoceras? spp.

Plate 9, figures 8–12

The ammonite *Grammoceras* is probably represented by about 100 fragments obtained from the basal part of the Snowshoe Formation. All the ammonites are evolute, and keeled and bear simple gently flexuous ribs. Some have fine sharp ribs that are separated by wide interspaces (pl. 9, figs. 8, 9) as on *G. striatulum* (J. de C. Sowerby) (Dean and others, 1961, pl. 74, figs. 3a, b). Others differ by having somewhat coarser ribs (pl. 9, fig. 10) as on *G. thouarsense* (d'Orbigny) (1844, p. 222, pl. 57; Buckman, 1928, pl. 774). Still others have broad flattened ribs that are separated by narrow interspaces (pl. 9, figs. 11, 12) as on *G. (Pseudogrammoceras) regale* Buckman (1904, fig. 138 on p. CXLVI). Probably two or three species are represented, but the wretched preservation of the fragments precludes definite specific or even generic assignment.

The ammonites herein assigned questionably to *Grammoceras* were all obtained from the Snowshoe Formation in association with other ammonites of late Toarcian age. Some were obtained from 100 to 125 feet above the base of the formation associated with *Catuloceras* and *Polyplectus* (USGS Mesozoic locs. 25690 and 26751). Others were obtained at another locality about 75 feet above the base of the formation associated with *Haugia* and *Polyplectus* (USGS Mesozoic loc. 26750). Near this locality the early Bajocian ammonite *Tmetoceras* was obtained from 125 to 200 feet above the base. All fossil collections were made from a sequence of black to brown mudstone that appears to represent uninterrupted deposition from Toarcian into early Bajocian time.

Figured specimens.—USNM 153885, 153886; CAS 12810.

Occurrences.—Snowshoe Formation, lower 75 to 125 feet, at USGS Mesozoic localities 25690, 26750, and 26751; Lupher's locality 76.

Genus DUMORTIERIA Haug, 1885

Dumortieria? cf. D. pusilla Jaworski

Plate 9, figures 1, 6, 7

cf. *Dumortieria pusilla* Jaworski, 1926, Actas Acad. Nac. Cienc. Cordoba, v. 9, p. 213, pl. 4, figs. 10a, b, 11, text figs. 4, 5a on p. 214.

The genus *Dumortieria* is possibly represented in Oregon by 12 specimens that were obtained from concretions in the lower part of the Snowshoe Formation. The ammonites occur in a hard black mudstone associated with many specimens of the planktonic pelecypod that is commonly called *Posidonia ornati* Quenstedt but is now referred to *Bositra buchi* (Römer) (Cox, 1964, p. 47; Jeffries and Minton, 1965, p. 156). Other associated fossils include small oysters and fragmentary ammonites resembling *Catulloceras* and *Brodieia*.

The specimens of *Dumortieria* from Oregon are highly evolute. The whorls are subquadrate in section, and the flanks are flattened. The venter bears a single keel that is bounded by narrow smooth areas. The inner whorls are smooth to a diameter of about 14 mm. The smooth stage of growth is followed abruptly by the appearance of strong thick radial ribs that are nearly as wide as the interspaces. During growth the ribs become higher, more widely spaced, and slightly inclined backward on the flanks. On the outermost whorl that is preserved, the interspaces are several times wider than the ribs. All ribs curve forward abruptly on the margin of the venter and fade out in the smooth areas adjoining the keel.

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

The rather large smooth nucleus of the Oregon specimens is unlike the ribbed nucleus of European species of *Dumortieria*, but resembles that of the Sinemurian genus *Arnioceras*. In fact the specimens were identified by the writer as *Arnioceras* in preliminary reports to field geologists in spite of their association with the pelecypod *Bositra buchi* (Römer) and their reported stratigraphic position well above beds of Sinemurian age. Later the writer collected additional specimens and confirmed their stratigraphic position. The possibility that the specimens have been reworked from beds of Sinemurian age seems unlikely.

The Oregon specimens may be identical specifically with *D. pusilla* Jaworski from Argentina. One specimen shown herein (pl. 9, fig. 6) is almost identical in ribbing and whorl shape with one specimen illustrated by Jaworski (1926, pl. 4, figs. 10a, b). It differs mainly by retaining the smooth stage to a diameter of about 14 mm instead of 8 mm. The other figured specimens from Oregon appear to be a little more compressed and finer ribbed than the Argentine species, but the differences are so small as to be within the range of specific variation.

Figured specimens.—USNM 153887–153889.

Occurrences.—Snowshoe Formation, lower part, at USGS Mesozoic localities 25823, 28030, 29216, and 29217.

Genus CATULLOCERAS Gemmellaro, 1886

Catulloceras cf. C. dumortieri (Thiolliere)

Plate 9, figures 2–5

cf. *Ammonites dumortieri* (Thiolliere). Dumortier, 1874, Études paléontologique sur les dépôts jurassiques du Bassin du Rhone, pt. 4, Lias Supérieur, p. 269, pl. 57, figs. 3, 4.

The genus *Catulloceras* is represented by 15 crushed specimens. These are characterized by evolute coiling, by simple sharp high nearly straight ribs that incline forward slightly on the venter, by a low keel, and by periodic contrictions. They appear to be identical with *C. dumortieri* (Thiolliere) as far as their preservation permits comparison. They also are similar to *Catulloceras?* sp. (Frebold, 1964a, pl. 7, figs. 5–9) from northwestern British Columbia and Yukon territory.

Figured specimens.—USNM 153890, 153891.

Occurrences.—Snowshoe Formation, 100–125 feet above its base, at USGS Mesozoic localities 25690 and 26751 and Lupher's locality 76.

Family HAMMATOCERATIDAE Buckman, 1887
Genus HAUGIA Buckman, 1888

Haugia spp.

Plate 9, figures 14, 15, 17, 18

Twenty-two flattened molds of *Haugia* have been obtained in east-central Oregon from brownish-black mudstone in the lower part of the Snowshoe Formation. The molds are all crushed and fragmentary, but they show the essential characters of the genus. These characters include fairly evolute coiling, a keel, a row of regularly spaced round tubercles near the umbilical margin, and radial to slightly arcuate ribs that arise by two's and three's from the tubercles. Some of the specimens (pl. 9, figs. 17, 18) bear rather coarse ribbing as on *H. grandis* Buckman (1898, p. xxvi; 1888, pl. 23, fig. 14, 15; pl. 24) and *H.* cf. *H. jugosa* (J. Sowerby) (Wright, 1882, pl. 67, figs. 1, 2). Other specimens (pl. 9, figs. 14, 15) bear fairly fine ribbing as on *H. compressa* Buckman (1898, p. xxvii, supplement pl. 2, figs. 8–10).

Figured specimens.—USNM 153892, 153893.

Occurrence.—Snowshoe Formation, 75 feet above base, at USGS Mesozoic locality 26750.

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INDEX

[Italic numbers indicate major references and descriptions]

PLATES 1–9

PLATE 1

[All figures natural size unless otherwise indicated]

FIGURES 1–6. *Metacymbites?* cf. *M. centriglobus* (Oppel) (p. C27).
Lateral, ventral, and apertural views (× 3) and last suture line (× 4½) of specimen, CAS 12780, from Lupher's loc. 121.

7–9. *Holcophylloceras* sp. (p. C26).
Aperture, lateral, and ventral views of specimen, USNM 153833, from USGS Mesozoic loc. 27381.

10, 11. *Tragophylloceras* sp. (p. C26).
Lateral and ventral views (× 2) of specimen, USNM 153834, from USGS Mesozoic loc. 29212.

12, 13. *Phylloceras* sp. (p. C26).
Lateral and ventral views of specimen, USNM 153831, from USGS Mesozoic loc. 27358.

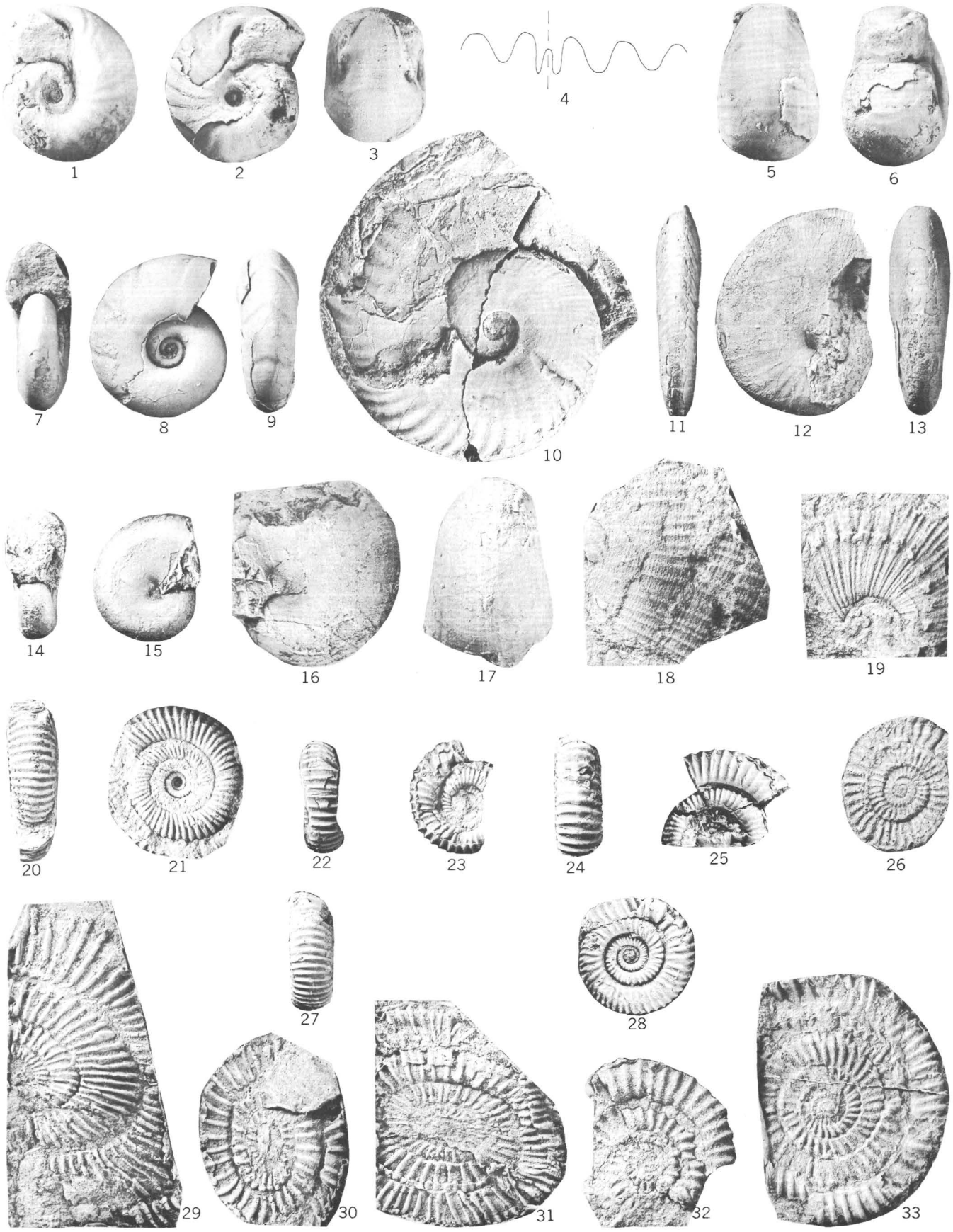
14, 15. *Partschiceras*? sp. (p. C26).
Apertural and lateral views of specimen, USNM 153832, from USGS Mesozoic loc. 29220.

16, 17. *Liparoceras*? sp. juv. (p. C27).
Lateral and ventral views of specimen, USNM 153837, from USGS Mesozoic loc. 27359. Fig. 17 shows weak spiral lirae and is oriented with apertural end down.

18, 19. *Liparoceras* (*Becheiceras*) cf. *L.* (*B.*) *bechei* (Sowerby) (p. C27).
18. View of venter and upper part of one flank. Note row of tubercles. Specimen, USNM 153836, from USGS Mesozoic loc. 29222.
19. View of umbilicus and lower part of flank. Specimen, USNM 153835, from USGS Mesozoic loc. 26739.

20, 21. *Reynesoceras* cf. *R. aegrum* (Fucini) (p. C28).
Ventral and lateral views of specimen, CAS 12782, from Lupher's loc. 552.

22–33. *Reynesoceras* cf. *R. ragazzonii* (Hauer) (p. C28).
22, 23. Ventral and lateral views of specimen, USNM 153840a, from USGS Mesozoic loc. 27360.
24, 25. Ventral and lateral views of specimen, USNM 153841, from USGS Mesozoic loc. 29222.
26. Lateral view of rubber cast of external mold of specimen, USNM 153839, from USGS Mesozoic loc. 26746.
27, 28. Ventral and lateral views of specimen, USNM 153840b, from USGS Mesozoic loc. 27360.
29–31. Lateral views of rubber casts of external molds of specimens, USNM 153838, from USGS Mesozoic loc. 28396.
32. Lateral view of specimen, Stanford Univ. Mus. paleontology 9851, from Dickinson loc. F80.
33. Lateral view of rubber cast of external mold of specimen, CAS 12781, from Lupher's loc. 72.



METACYMBITES?, *HOLCOPHYLLOCERAS*, *TRAGOPHYLLOCERAS*, *PHYLLOCERAS*, *PARTSCHICERAS*?, *LIPAROCERAS* (*BECHEICERAS*), AND *REYNESOCERAS*

PLATE 2

[Figures 1–10 are × 2. All others are natural size]

FIGURES

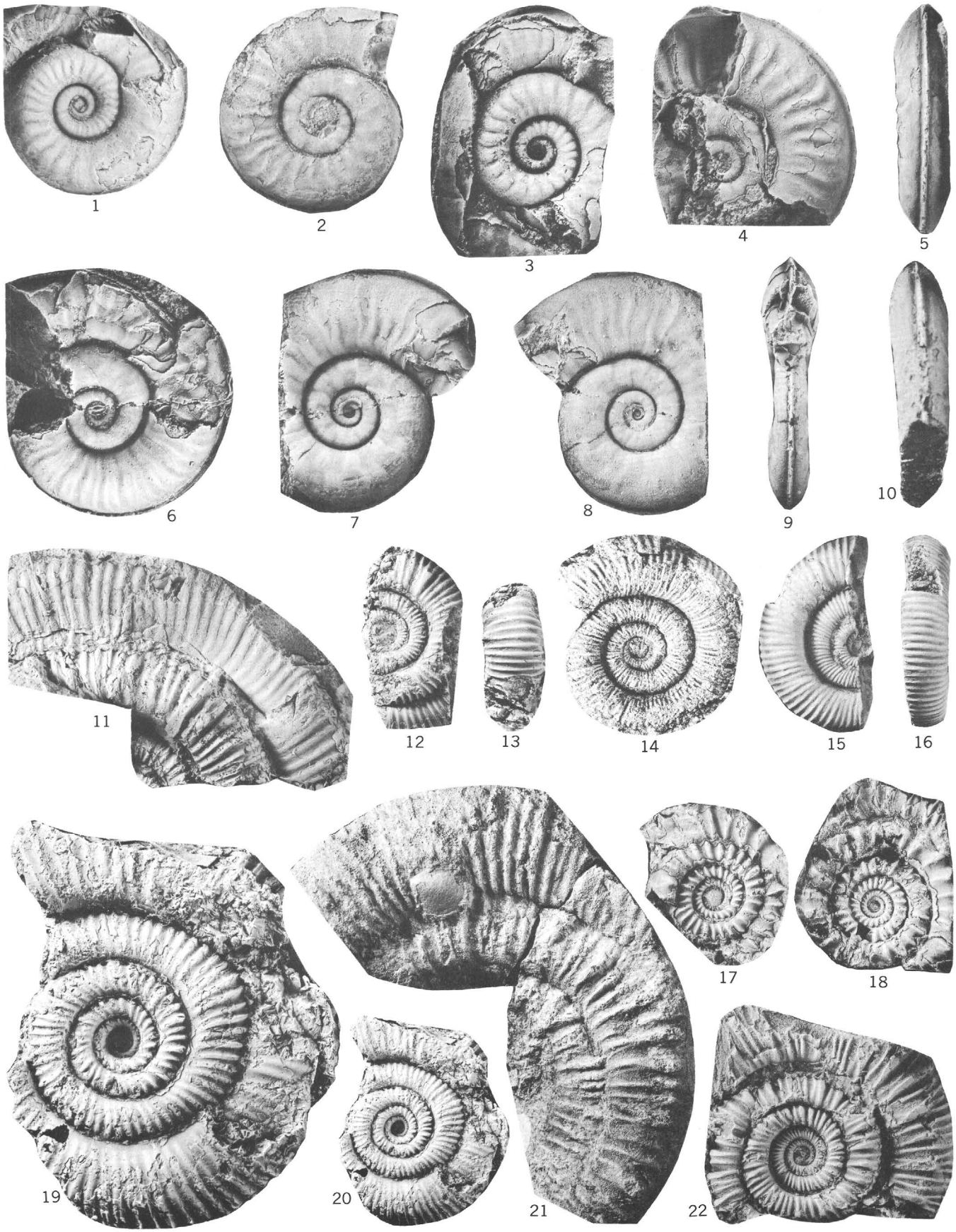
1–10. *Leptaleoceras*? *morganense* Imlay, n. sp. (p. C33).
1. Paratype, USNM 153854 (× 2).
2. Paratype, USNM 153855 (× 2).
3. Paratype, USNM 153852 (× 2).
4, 5. Paratype, USNM 153851 (× 2).
6. Paratype, USNM 153853 (× 2).
7–10. Holotype, USNM 153850 (× 2). All specimens shown in figures 1–10 are from USGS Mesozoic loc. 27381.

11–13, 19, 20. *Prodactylioceras* cf. *P. mortilleti* (Meneghini) (p. C29).
11. Lateral view of specimen, CAS 12785, from Lupher's loc. 300sh.
12, 13. Lateral and ventral views of specimen, USNM 153843a, from USGS Mesozoic loc. 29222.
19, 20. Lateral views (× 2 and × 1) of specimen, 153843b, from USGS Mesozoic loc. 29222. Note tubercles on inner whorls.

14–16. *Prodactylioceras* cf. *P. italicum* (Meneghini) (p. C28).
14. Lateral view of specimen, USNM 153842, from USGS Mesozoic loc. 29219.
15, 16. Lateral and ventral views of specimen, CAS 12811, from Lupher's loc. 300sh.

17, 18. *Prodactylioceras*? sp. juv. (p. C30).
Lateral views of specimen, USNM 153848, from USGS Mesozoic loc. 26740.

21, 22. *Prodactylioceras* cf. *P. meneghini* (Fucini) (p. C29).
21. Lateral view of specimen, CAS 12784, from Lupher's loc. 45.
22. Lateral view of specimen, CAS 12783, from Lupher's loc. 300sh.



LEPTALEOCERAS?, PRODACTYLIOCERAS, AND *PRODACTYLIOCERAS?*

PLATE 3

[All figures natural size unless otherwise indicated]

FIGURES 1, 2, 8, 9. *Dactylioceras* (*Orthodactylites*) cf. *D.* (*O.*) *tenuicostatum* (Young and Bird) (p. C30).
1, 2, and 9 are lateral views of rubber casts of external molds and 8 is an external cast. USNM 153846, from USGS Mesozoic loc. 28396.

3–6. *Dactylioceras*? sp. (p. C31).
3–5. Lateral, sectional, and ventral views.
6. Suture line (× 5) drawn at whorl height of 4 mm and diameter of 16 mm. Specimen, USNM 153849, from USGS Mesozoic loc. 26740.

7, 10. *Dactylioceras* (*Orthodactylites*) cf. *D.* (*O.*) *verme* (Simpson) (p. C31).
7. Lateral view of external cast of specimen, USNM 153847, from USGS Mesozoic loc. 26739.
10. Lateral view of rubber cast of external mold of specimen, CAS 12786, from Lupher's loc. 72.

11. *Dactylioceras* (*Orthodactylites*) cf. *D.* (*O.*) *kanense* McLearn (p. C30).
Lateral view of external cast of specimen, USNM 153845, from USGS Mesozoic loc. 26739.

12. *Dactylioceras* (*Orthodactylites*) *kanense* McLearn (p. C30).
Lateral view of plaster replica of holotype, Canada Natl. Mus. 9051, for comparisons with specimen shown in fig. 11.

13–16. *Dactylioceras* cf. *D. acanthus* Buckman (non d'Orbigny) (p. C30).
Lateral views of rubber casts of external molds of specimens, USNM 153844, from USGS Mesozoic loc. 28396.

DACTYLIOCERAS AND *DACTYLIOCERAS*?

PLATE 4

[All figures natural size unless otherwise indicated]

FIGURES 1–8. *Arieticeras* cf. *A. algovianum* (Oppel) (p. C34).
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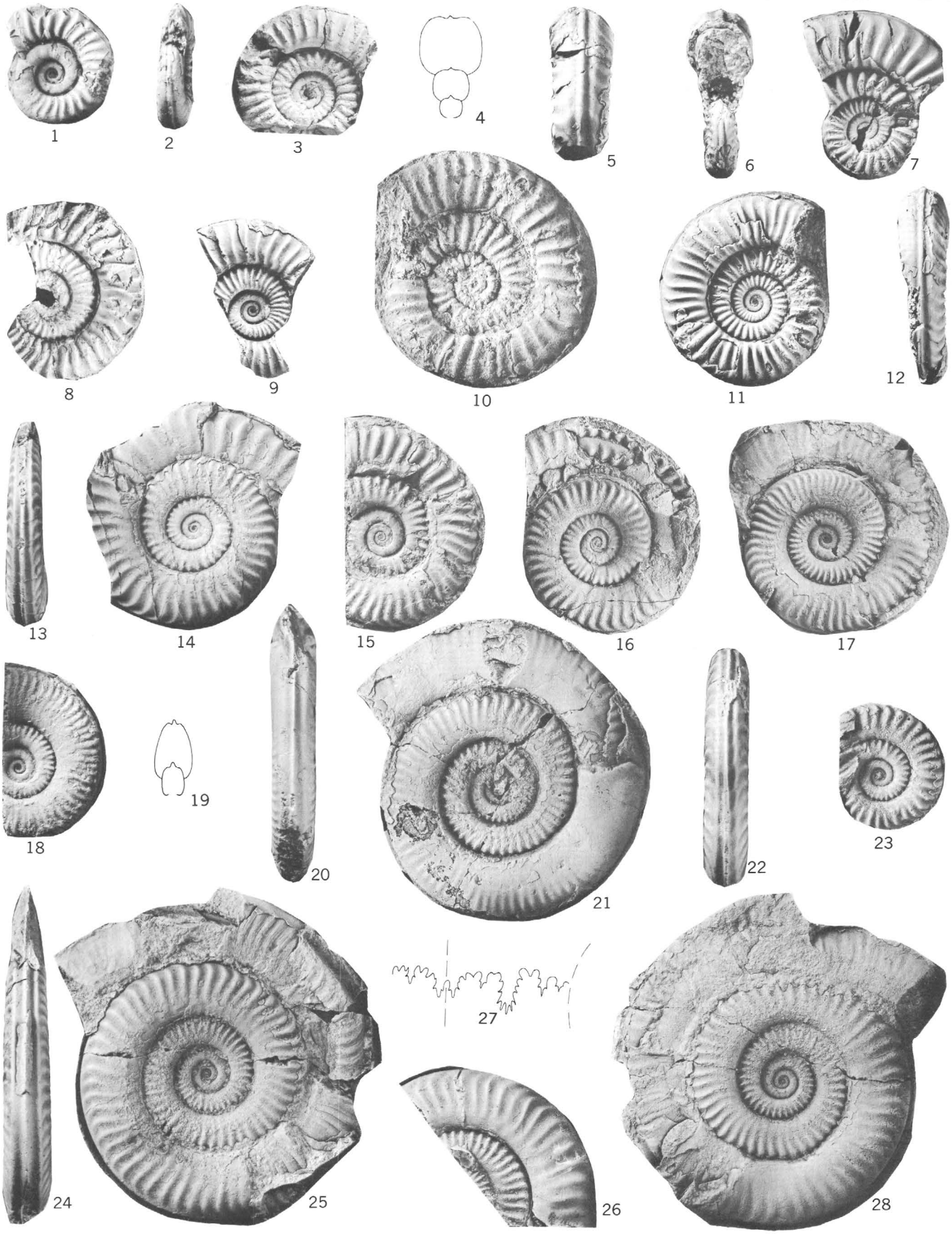
3, 8. Lateral views of specimen, USNM 153883, from USGS Mesozoic loc. 26733.
4–7. Sectional, ventral, apertural, and lateral views of specimen, CAS 12806b, from Lupher's loc. 121.
9–12. *Arieticeras* cf. *A. domarense* (Meneghini) (p. C33).
9. Lateral view of specimen, USNM 155071, from USGS Mesozoic loc. 29218.
10. Lateral view of specimen, CAS 12807, from Lupher's loc. 77.
11, 12. Lateral and ventral views of specimen, CAS 12808, from Lupher's loc. 121.
13–28. *Arieticeras lupheri* Imlay, n. sp. (p. C34).
13, 14. Ventral and lateral views of paratype, USNM 153877, from USGS Mesozoic loc. 26747.
15. Paratype, Stanford Univ. Mus. Paleontology 9854, from Dickinson's loc. F75.
16. Paratype, CAS 12801, from Lupher's loc. 300sh.
17. Paratype, CAS 12802, from Lupher's loc. 300sh.
18, 19. Paratype, CAS 12803, from Lupher's loc. 300sh.
20, 21. Ventral and lateral views of paratype, CAS 12804, from Lupher's loc. 300sh.
22, 26, 27. Ventral and lateral views (× 1) and suture line (× 2) of paratype, CAS 12805, from Lupher's loc. 300sh.
23. Paratype, USNM 153878, from USGS Mesozoic loc. 26747.
24, 25, 28. Ventral and lateral views of holotype, CAS 12800, from Lupher's loc. 300sh.



ARIETICERAS

PLATE 5

[All figures natural size unless otherwise indicated]

FIGURES

1–5. *Harpoceras* (*Harpoceratoides*) cf. *H.* (*H.*) *connectens* (Haug) (p. C36).
Lateral views of specimens, USNM 153858, from USGS Mesozoic loc. 28810. Figs. 1–4 are from rubber imprints of external molds. Fig. 5 is from an external cast.

6–11. *Lioceratoides*? sp. (p. C37).
6–8. Lateral and ventral views of specimen, USNM 155072a (× 2), from USGS Mesozoic loc. 29218.
9–11. Lateral and ventral views of specimen, USNM 155072b (× 2), from USGS Mesozoic loc. 29218.

12–14. *Canavaria* cf. *C. morosa* Fucini (p. C35).
12. Lateral view of specimen, USNM 153884a, from USGS Mesozoic loc. 26732.
13, 14. Lateral and ventral view of specimen, USNM 153884b, from USGS Mesozoic loc. 26732.

15. *Canavaria* cf. *C. excellens* (Fucini) (p. C35).
Lateral view of specimen, USNM 155073, from USGS Mesozoic loc. 28810.

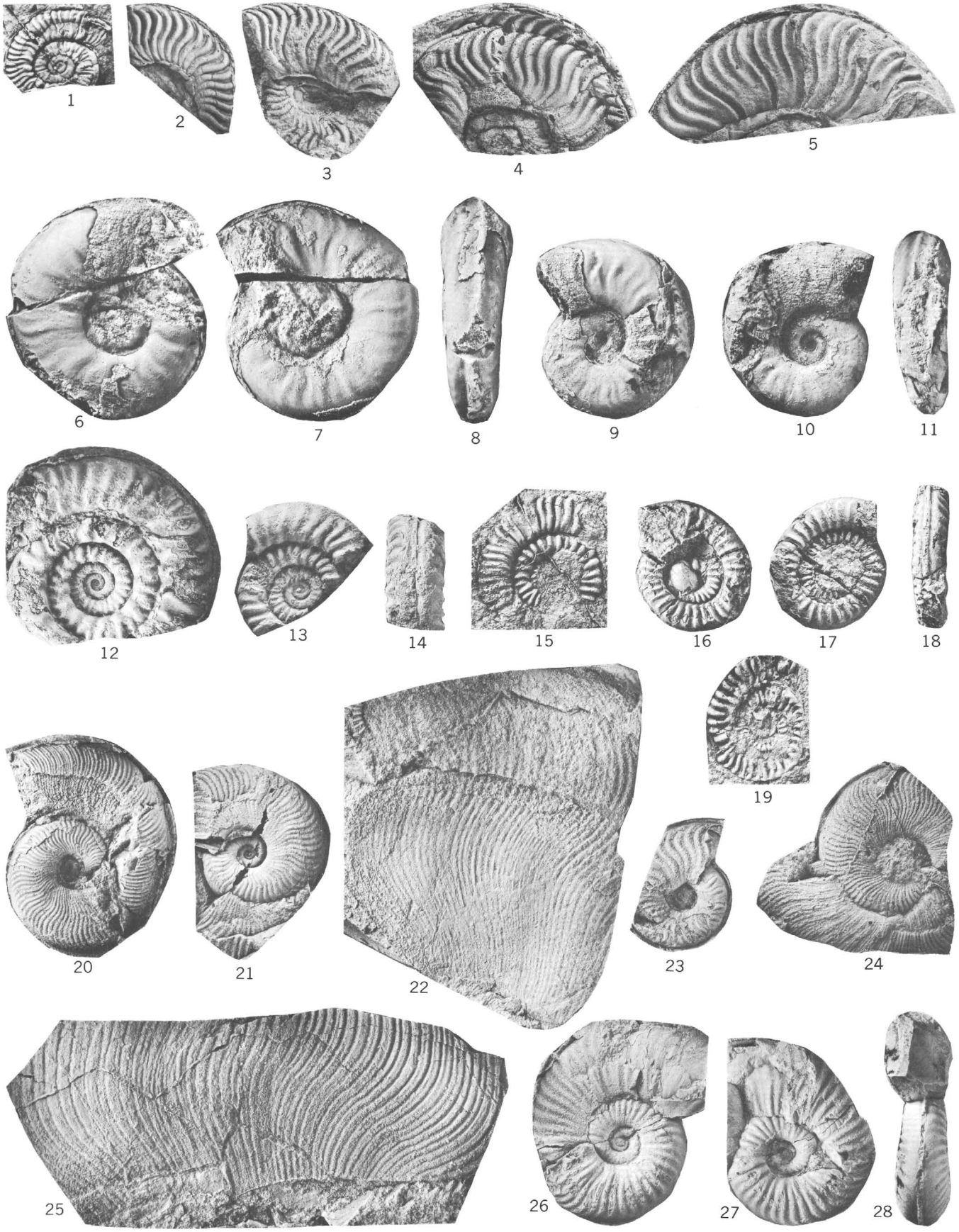
16–18. *Fontanelliceras* cf. *F. fontanallense* (Gemmellaro) (p. C36).
Lateral and ventral views of specimen, CAS 12809, from Lupher's loc. 47.

19. *Canavaria*? sp. (p. C36).
Lateral view of rubber imprint of external mold USNM 155074, from USGS Mesozoic loc. 28810.

20–22, 24, 25. *Paltarpites* cf. *P. argutus* (Buckman) (p. C37).
20. Lateral view of specimen, USNM 153857, from USGS Mesozoic loc. 29222.
21, 22, 25. Lateral views of one small specimen and fragments of outer whorls of two large specimens, CAS 12787, from Lupher's loc. 553.
24. Lateral view of rubber imprint of external mold of specimen, USNM 153856, from USGS Mesozoic loc. 26740.

23. *Harpoceras*? sp. (p. C36).
Lateral view of small specimen, CAS 12788, from Lupher's loc. 553.

26–28. *Whitbyiceras*? sp. (p. C43).
Lateral and apertural views of specimen, CAS 12795, from Lupher's loc. 45.



HARPOCERAS (HARPOCERATOIDES), LIOCERATOIDES?, CANAVARIA, FONTANELLICERAS, PALTARPITES, HARPOCERAS?, AND *WHITBYICERAS?*

PLATE 6

[All figures natural size unless otherwise indicated]

FIGURES 1–4. *Leptaleoceras* cf. *L. leptum* Buckman (p. C32).

1. Lateral view of specimen with fragments of shell adhering, USNM 153881, from USGS Mesozoic loc. 27380.

2, 3. Lateral views of external casts of specimens, USNM 155075, from USGS Mesozoic loc. 27392.

4. Lateral view of external cast of specimen, USNM 153880, from USGS Mesozoic loc. 26740.

5, 6. *Protogrammoceras*? cf. *P.*? *isseli* (Fucini) (p. C39).

Lateral and ventral views of specimen, USNM 153866, from USGS Mesozoic loc. 26732.

7–11. *Leptaleoceras dickinsoni* Imlay, n. sp. (p. C32).

7, 9–11. Cross section, lateral, and ventral views of holotype, Stanford Univ. Mus. Paleontology 9853, from Dickinson's loc. F76. Crushed smooth body chamber present but not shown in fig. 11.

8. Lateral view of paratype, Stanford Univ. Museum Paleontology 9852, from Dickinson's loc. F76.

12–20. *Protogrammoceras* cf. *P. nipponicum* (Matsumoto and Ono) (p. C38).

12, 17. Lateral views of internal molds retaining some shell material. Specimens, USNM 153862, from USGS Mesozoic loc. 26732.

13, 14, 16, 18, 19. Lateral views of rubber imprints of external molds, USNM 153861, from USGS Mesozoic loc. 28810.

15, 20. Lateral view (× 1) and suture line (× 2) drawn at whorl height of 13.5 mm and diameter of 30.5 mm. USMN 153863, from USGS Mesozoic loc. 29224.

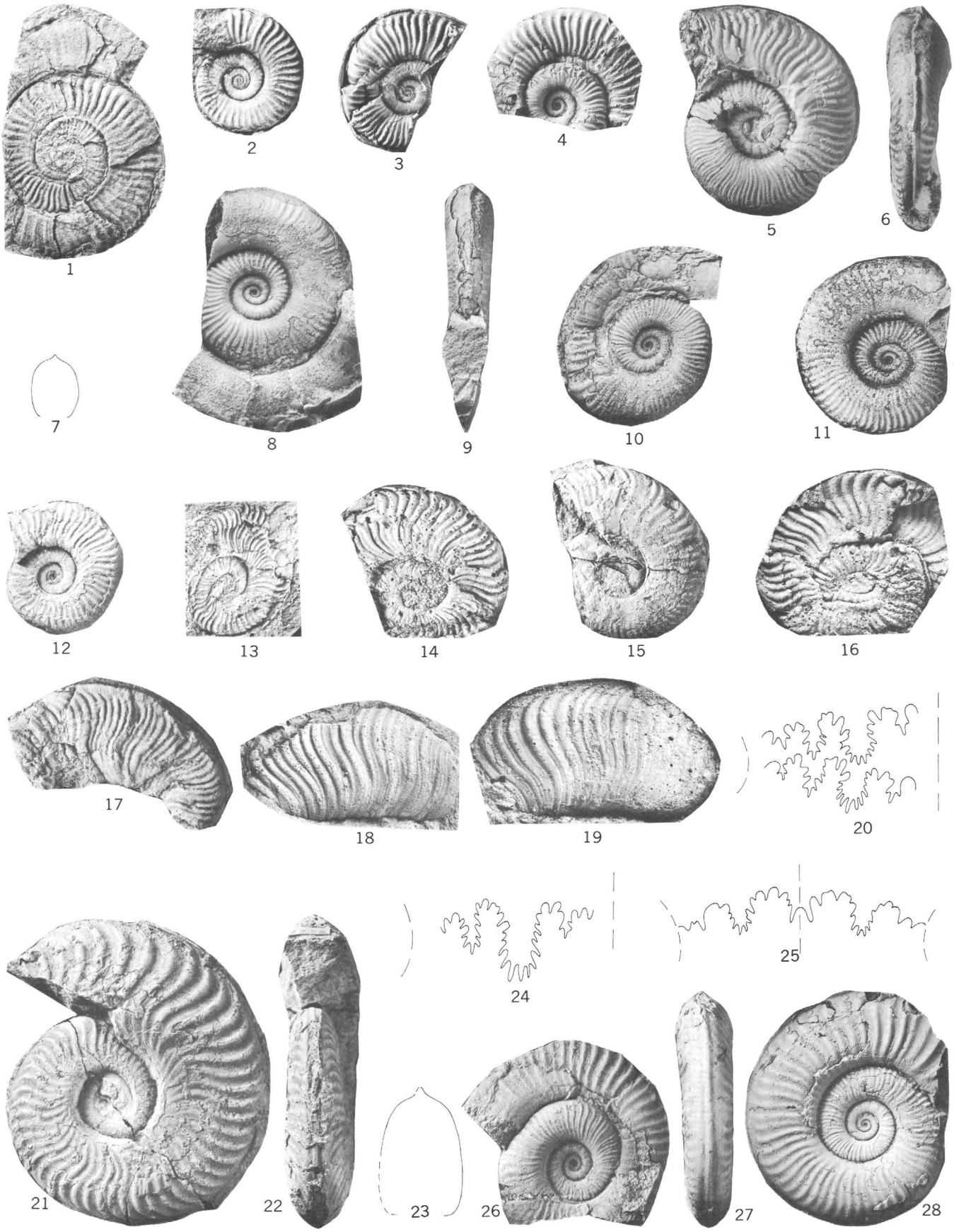
21–24. *Programmoceras* cf. *P. marianii* (Fucini) (p. C37).

Lateral, apertural, and cross sectional views and suture line (× 2) drawn at whorl height of 21 mm. Specimen, USNM 153859, from USGS Mesozoic loc. 26732.

25–28. *Protogrammoceras*? *ochocoense* Imlay, n. sp. (p. C40).

26. Paratype, Stanford Univ. Mus. Paleontology 9855, from Dickinson's loc. F76.

25, 27, 28. Holotype, CAS 12790, from Lupher's loc. 125. Suture line (× 2) drawn at whorl height of 13 mm and diameter of 37 mm.



LEPTALEOCERAS, PROTOGRAMMOCERAS, AND *PROTOGRAMMOCERAS*?

PLATE 7

[All figures natural size unless otherwise indicated]

FIGURES

1–4. *Protogrammoceras* cf. *P. bonarelli* (Fucini) (p. C38).
1, 2. Lateral and ventral views of specimen, USNM 153860a.
3, 4. Lateral and ventral views of specimen, USNM 153860b. Both specimens from USGS Mesozoic loc. 26732.

5–7. *Protogrammoceras?* cf. *P.? pseudofieldingi* (Fucini) (p. C40).
Lateral and ventral views of specimen, CAS 12789 from Lupher's loc. 553.

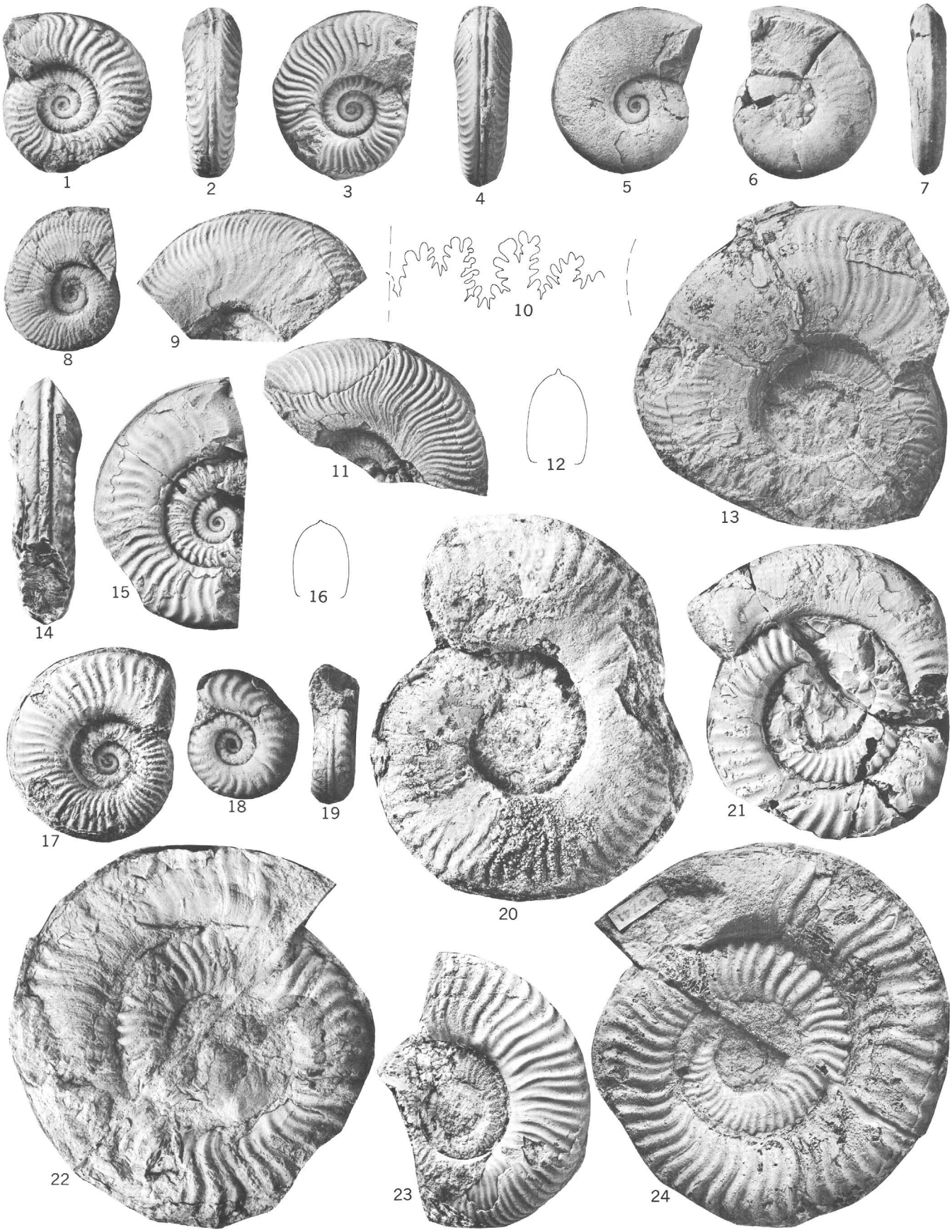
8–13. *Protogrammoceras* cf. *P. meneghini* (Bonarelli) (p. C38).
8, 9, 11, 12. Views of three specimens, USNM 153865, from USGS Mesozoic loc. 26732. Fig. 12 is sectional view of specimen shown in fig. 11.
10, 13. Suture line (× 2) and lateral view of large specimen, USNM 153864, from USGS Mesozoic loc. 28033.

14–16. *Fuciniceras* cf. *F. lavinianum* Meneghini in Fucini (p. C40).
Ventral and lateral views and cross section of specimen, USNM 153867, from USGS Mesozoic loc. 27392.

17, 20, 22–24. *Fuciniceras* cf. *F. acutidorsatum* Kovacs (p. C41).
17. Specimen, USNM 153869, from USGS Mesozoic loc. 26732.
20. Specimen, CAS 12791, from Lupher's loc. 300sh.
22, 24. Specimen, USNM 153879, from USGS Mesozoic loc. 26741.
23. Specimen, USNM 153868, from USGS Mesozoic loc. 29226.

18, 19. *Fuciniceras* sp. B (p. C42).
Lateral and apertural views of specimem, CAS 12794, from Lupher's loc. 47.

21. *Fuciniceras* sp. A (p. C42).
Specimen, USNM 153870, from USGS Mesozoic loc. 27381.



PROTOGRAMMOCERAS?, AND *FUCINICERAS*

PLATE 8

[All figures natural size unless otherwise indicated]

FIGURES 1–7, 9, 10. *Fuciniceras*? cf. *F. intumescens* (Fucini) (p. C42).
1, 2. Ventral and lateral views of specimen, USNM 153872a, from USGS Mesozoic loc. 27381.
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5, 6. Lateral and ventral views of specimen, USNM 153871b, from USGS Mesozoic loc. 26732.
7, 9, 10. Lateral views of specimens, USNM 153872b–d, from USGS Mesozoic loc. 27381.

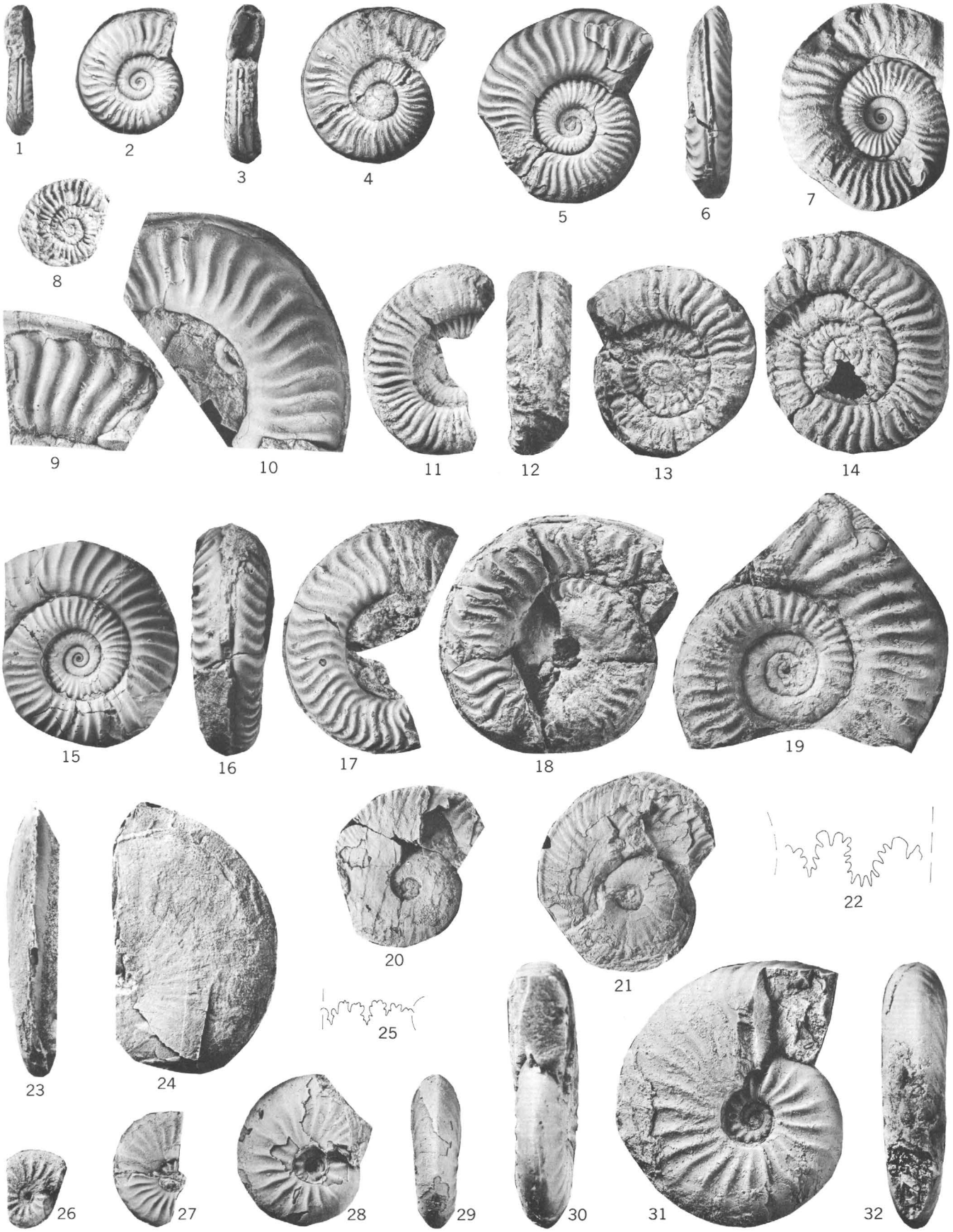
8, 11–14. *Fuciniceras* cf. *F. capellinii* (Fucini) (p. C41).
Specimens USNM 153882, from USGS Mesozoic loc. 26732. Fig. 12 is ventral view of specimen shown in fig. 13.

15–19, 22. *Fuciniceras* cf. *F. inclytum* (Fucini) (p. C41).
15. Small septate specimen, CAS 12792a, from Lupher's loc. 125.
16, 17. Ventral and lateral views of specimen, USNM 155076, from USGS Mesozoic loc. 26732.
18. Specimen, CAS 12793, from Lupher's loc. 300sh.
19, 22. Specimen, CAS 12792b, from Lupher's loc. 125. Suture line (×2) drawn at whorl height of 17 mm and diameter of 50 mm.

20, 21. *Fanninoceras* cf. *F. bodegae* McLearn (p. C44).
20. Specimen, CAS 12798, from Lupher's loc. 404.
21. Specimen, USNM 153875, from USGS Mesozoic loc. 26740.

23, 24. *Fanninoceras* cf. *F. carlottense* McLearn (p. C44).
Ventral and lateral views of specimen, USNM 153876, from USGS Mesozoic loc. 29218.

25–32. *Fanninoceras kunae* McLearn (p. C44).
26. Hypotype, USNM 153873, from USGS Mesozoic loc. 29218.
27. Hypotype, CAS 12796, from Lupher's loc. 553.
28, 29. Lateral and ventral views of hypotype, CAS 12797, from Lupher's loc. 121.
25, 30–32. Suture line, apertural, lateral, and ventral views of hypotype, USNM 153874, from USGS Mesozoic loc. 29218.



FUCINICERAS?, *FUCINICERAS*, AND *FANNINOCERAS*

PLATE 9

[All figures are natural size]

FIGURES 1, 6, 7. *Dumortieria*? cf. *D. pusilla* Jaworski (p. C45).
1. Specimen, USNM 153887, from USGS Mesozoic loc. 29217.
6. Specimen, USNM 153889, from USGS Mesozoic loc. 28030.
7. Specimen, USNM 153888, from USGS Mesozoic loc. 25823.

2–5. *Catulloceras* cf. *C. dumortieri* (Thiolliere) (p. C46).
2–4. Ventral view (fig. 2) and lateral views of specimens, USNM 153891, from USGS Mesozoic loc. 26751.
5. Specimen, USNM 153890, from USGS Mesozoic loc. 25690.

8–12. *Grammoceras*? spp. (p. C45).
8, 9. Specimens, USNM 153886, from USGS Mesozoic loc. 25690, showing fine sharp ribbing.
10. Specimen, CAS 12810, from Lupher's loc. 76, showing coarse ribbing.
11, 12. Specimens, USNM 153885, from USGS Mesozoic loc. 25690, showing broad flattened ribbing.

13, 16. *Polyplectus* cf. *P. subplanatus* (Oppel) (p. C44).
Lateral view of laterally crushed specimens, CAS 12799, from Lupher's loc. 127.

14, 15, 17, 18. *Haugia* spp. (p. C46).
14, 15. Views of rubber imprints of external molds showing fine ribbing and umbilical tubercles. Specimens, USNM 153892, from USGS Mesozoic loc. 26750.
17, 18. External casts showing coarse ribbing and umbilical tubercles. Specimens, USNM 153893, from USGS Mesozoic loc. 26750.

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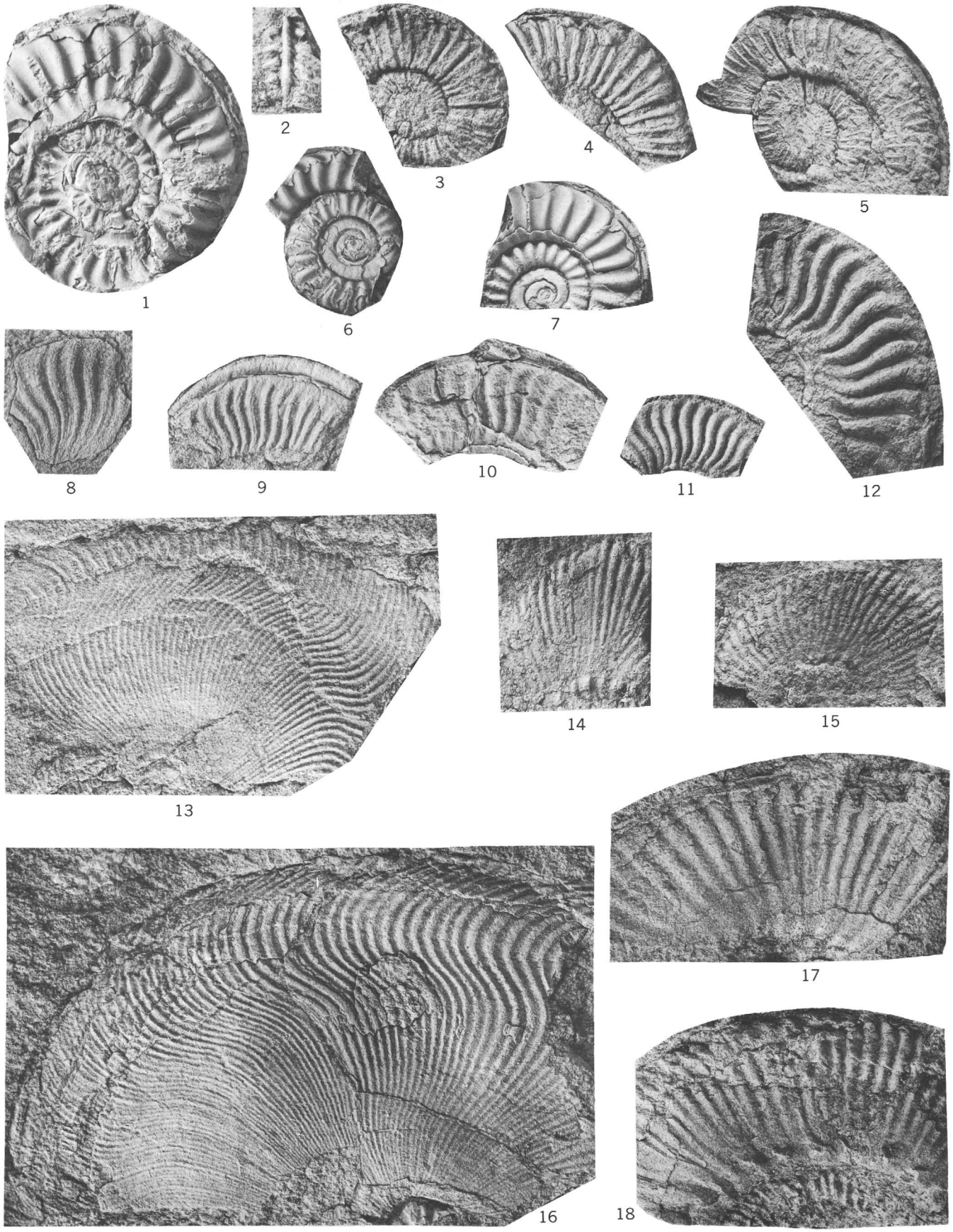

DUMORTIERIA?, *CATULLOCERAS*, *GRAMMOCERAS*?, *POLYPLECTUS*, AND *HAUGIA*