Middle Jurassic (Bajocian) Ammonites from Eastern Oregon

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By RALPH W. IMLAY

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Bajocian ammonites of eastern Oregon greatly resemble those of Alaska and Europe, indicate marine connections with Europe, and permit accurate zonal dating in the Pacific Coast region.
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MIDDLE JURASSIC (BAJOCIAN) AMMONITES FROM EASTERN OREGON

By Ralph W. Imlay

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

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

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

Beds equivalent to the European Otoites souczeri zone include the ammonites Witchellia, Soninia (Papilliceras), Asthenoceras, Pelekodites, Lissoceras, Emileia, Parabigotites, Stephanoceras, Otoites and Normanmites. The last two occur near the top of the ranges of Witchellia, Soninia (Papilliceras), and Emileia.

Beds equivalent to the European Stephanoceras humphriesianum zone contain the ammonites Dorsetenia, Pelekodites, Pocciolomorphus, Chondroceras, Sphaeroceras, Normanmites, Stephanoceras, Teloceras, Stemmatoceras? and probably Zemisterpus. Of these, the last three plus Chondroceras occur above the local range of Dorsetenia and are equivalent to the upper part of the Stephanoceras humphriesianum zone.

The lower part of the upper Bajocian is represented by the ammonites Leptosphinctes, L. (Protosphinctes?), Spiroceras, Sphaeroceras, Normanmites, Stephanoceras, Teloceras, Zemisterpus?, the new genus, Lupherites and Megaspheeroeceras.

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

New taxa described herein include one new genus Lupherites, one new subgenus Witchellia (Latitwitchellia), and 18 new species. The species are named Asthenoceras delicateum, Fontannesia costula, F. intermedi, Witchellia (Latitwitchellia) evoluta, Dorsetenia oregonensis, D. diversistriata, Pelekodites webergi, P. silvisenensis, P. dobonensis, Pocciolomorphus varius, Lissoceras hydei, Docidoceras lupheri, D. warmspringsense, D. sparsicostatum, Emileia buddenhageni, Stephanoceras mowichii, S. (Phaulostephanus?) oregonensis, and Lupherites senescens.

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

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

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

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

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

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

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

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

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

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

**BIOLOGIC ANALYSIS**

The eastern Oregon ammonites of early Middle Jurassic (Bajocian) age described herein number 2,139 specimens. Their distribution by families, subfamilies, genera, and subgenera is shown in table 1. This table shows that the Sonninidae, Hildoceratidae, and Stephanoceratidae are the dominant families and include, respectively, 36, 29, and 18 percent of the total number of specimens. Next in declining numbers are the Otoitidae, Phyloceratidae, Hammatoceratidae, Sphaeroceratidae, Spiroceratidae, Haploceratidae, Stephanoceratidae, Perispinctidae, and Oppelidae. The most common genus is *Asthenoeceras*. Next most common in decreasing order are *Soninia*, *Dorsetensia*, *Stephanoceras*, *Pelekodites*, and *Tmetoceras*. All other genera are represented by fewer than 100 specimens, and eight are represented by fewer than four specimens per genus.
The family Hildoceratidae is represented by the genera *Tmetoceras*, *Fontannesia*, and *Astheneoceras*. Of these, *Tmetoceras* is represented by the worldwide species *T. scissum* (Benecke) of early Bajocian (Aalenian) age. *Fontannesia* is placed here rather than in the Sonniidae because of its close resemblance to *Grammoceras* (Arkell, 1954, p. 564, 597; Westermann and Getty, 1970, p. 240). *Astheneoceras* is of biologic interest because in Oregon it occurs in great abundance in beds that correlate with the *Sonninia sowerbyi* zone, whereas it is rather rare elsewhere in the world. Previously described occurrences include about 20 specimens from the *Sonninia sowerbyi* zone of the Alaska Peninsula (Westermann, 1969, p. 61-63, pl. 14, figs. 1-7) and two specimens from the *Ludwigia murchisona* zone of England (Buckmann, 1889, pl. 33, figs. 13-16).

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

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

The genus *Fontannesia*, defined by Buckman (1905, p. CLXXXVII) and Arkell (1954, p. 563), consists of small to medium-sized shells that have fairly evolute to highly evolute coiling; a compressed subovate to subquadrate whorl section; an inclined umbilical wall that rounds evenly into the flanks; a narrow flattened to fastigate venter; a low to prominent, hollow unfloored keel that may become very weak or disappear on the body chamber; weak to strong, mostly simple, falced ribs that are strongest on the middle and upper parts of the flanks, may be faint on the lower parts, and vary from strong to faint to indistinct on the body chamber. *Fontannesia* differs from *Dorsetensia* in having a rounded instead of a sharp or abrupt umbilical edge, a broader venter, and a longer, more slender first lateral lobe. *Fontannesia* greatly resembles the late Toarcian genus *Grammoceras*, as discussed by Arkell (1954, p.
The family Hammatoceratidae is represented mostly by three narrowly umbilicate species of *Eudmatooceras* that are similar to, and probably in part identical with, species from Eurasia and South America. In addition, the family is represented by a few fragments that are unquestionably referred to *Planammatoceras*. These genera have been discussed in considerable detail recently by Elmi (1963a, p. 60, 1963b, p. 82–90, 101–103), Westermann (1964a, p. 407–412; 1969, p. 63–72), and Geczy (1966, p. 29–33).

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

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

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

This great variability in form and sculpture among specimens of *Euhoploceras* has made specific recognition difficult. In England near Bradford Abbas, 65 species of *Euhoploceras* were recognized by Buckman (1892–94, p. 313–440, pls. 48–103 in part) from many well-preserved specimens obtained from a single bed only seven inches thick (Buckman, 1893, p. 455). These species, as well as 9 other species described from England and Germany, were later considered by Westermann (1966) to be morphological variants of a single species for which he chose the oldest available name *Soninia* (*Euhoploceras*) *adiera* (Waagen) (1867, p. 591, pl. 25, figs. 1a,b). In France the presence of several species of *Euhoploceras* has been recorded (Arkell, 1956, p. 78, 100). In Germany, the taxon *Euhoploceras* has not been recognized as distinct even subgenerically from *Soninia* by the paleontologists who have monographed the sonninid ammonites (Dorn, 1935; Hiltermann, 1939; Oechsle, 1958). They have, however, recognized some of the species that Buckman referred to *Euhoploceras* and have grouped many others under such names as *Soninia sowerbyi* (Sowerby), *S. adiera* (Waagen), *S. polyacantha* (Waagen), and *S. modesta* Buckman. Their concepts of species within *Euhoploceras* evidently are between those of Buckman and Westermann.

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

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

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

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

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

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

The subgenus Papilliceras differs from Sonninia in having more evolute coiling; a higher, thinner whorl section; a median row of lateral tubercles on all or most septate whorls and on some body chambers; simpler, stronger ribs on the lower parts of the flanks and generally curve more evenly around the body chamber. These characteristics in combination and their persistence during growth separate Papilliceras from the highly variable subgenus Euhoploceras with which Papilliceras is associated in Oregon in its earliest occurrences.

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

The new subgenus Witchellia (Latiwitchellia) resembles Witchellia in having a bisulate carinate venter and some rib furcation at the base of the flanks. It differs in having more evolute coiling, stouter whorls that do not become compressed adorally, stronger ribs on the
Table 2.—Morphological comparisons of the various species of Sonninia (Euhoiloceras) in eastern Oregon

<table>
<thead>
<tr>
<th>Species</th>
<th>Coiling from fairly involute to fairly evolute.</th>
<th>Elliptical to subquadrate, much higher than wide.</th>
<th>Low, vertical to very steep, rounds abruptly into flanks.</th>
<th>Variously weak, actes singly and in pairs, May become fairly strongly near adult body chamber.</th>
<th>Simple, flexuous, widely spaced, inclined forward. Varies from broad and flat to fairly strong.</th>
<th>Weak tubercles present only on smallest whorls at diameters less than 15 mm.</th>
<th>Upper two-thirds of Weberg Member.</th>
<th>In England from Discites subzone. In Germany from lower part of subzonal zone.</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.(E.)modesta</td>
<td>Buckman</td>
<td>Subovate, a little higher than wide.</td>
<td>Low, steep, rounds evenly into flanks.</td>
<td>Fairly strong, Most ribs arise singly.</td>
<td>Becomes much stronger adorally, is strongest near middle of flanks.</td>
<td>Tubercles occur rarely at diameters greater than 25 mm.</td>
<td>... do ...</td>
<td>In Great Britain from upper part of Euhoploceras zone and overlying Discites subzone.</td>
</tr>
<tr>
<td>S.(E.)polycaen-tha (Waagen)</td>
<td>Moderately to fairly evolute.</td>
<td>... do ...</td>
<td>Low, steeply inclined, rounds evenly into flanks.</td>
<td>Variously weak to fairly strong, closely to moderately spaced.</td>
<td>Becomes stronger and more widely spaced adorally.</td>
<td>Fairly strong; widely spaced. Secondary ribs arise singly or in pairs from spines, or between spines.</td>
<td>Weak tubercles on inner whorls. Spines occur on all whorls at diameters more than 70-100 mm.</td>
<td>... do ...</td>
</tr>
<tr>
<td>S. (E.)adiera (#Wag) (= S. acanthodes Buckman)</td>
<td>Moderately to fairly evolute.</td>
<td>... do ...</td>
<td>Fairly strong spinose ribs are separated by one or more weak ribs.</td>
<td>Adorally becomes stronger, sparser, more uniform in size.</td>
<td>Strong, nonspinose, highest near middle of flanks. May trend backward low on flanks. May fade out on venter.</td>
<td>Prominent lateral spines persist to diameters of 100 to 120 mm.</td>
<td>Upper part of Weberg Member. and mostly near top.</td>
<td>In England from Discites and Tri- gonites subzones. In Germany from lower part of subzonal zone.</td>
</tr>
<tr>
<td>S. (E.) creas-stepinata Buckman</td>
<td>Fairly evolute.</td>
<td>Broadly ovate to circular.</td>
<td>Moderately high, steep to vertical, rounds evenly into flanks.</td>
<td>Adorally becomes much stronger and sparser. Some paired at spines, fades on venter.</td>
<td>Adorally becomes stronger and more widely spaced.</td>
<td>Prominent lateral spines at all growth stages.</td>
<td>Upper part of Weberg Member.</td>
<td>... do ...</td>
</tr>
<tr>
<td>S. (E.) cf. S. (E.) creas-stepinata Buckman</td>
<td>... do ...</td>
<td>... do ...</td>
<td>Mostly flexuous, weak, closely spaced. Strong, spinose ribs at diameters above 45 mm.</td>
<td>Largest whorl bears only coarse spinose ribs.</td>
<td>Unknown</td>
<td>Spines as on S. creas-stepinata but absent on some small whorls.</td>
<td>... do ...</td>
<td>DiMers from S. creas-stepinata in having small whorls bearing weaker, denser ribbing and fewer spines.</td>
</tr>
</tbody>
</table>
body chamber, and blunt nodes high on the flanks on some specimens. It is associated in eastern Oregon with genera that indicate a correlation with the lower part of the *Sonninia sowerbyi* zone of Europe and is older, therefore, than the oldest occurrences of *Witchellia* in Europe.

The genus *Dorsetensia* has fairly evolve coiling; a high compressed whorl section; a narrow, sharp, keeled vertex; a vertical umbilical wall; a sharp or abruptly rounded umbilical edge; and weak to fairly strong ribs that are mostly simple, are straight to gently flexuous, trend nearly radially on the flanks, curve forward on the venter, and weaken appreciably on the penultimate whorl, or on the body chamber. The ribs on some species may alternate with striae or pass adorally into striae. *Dorsetensia* differs from *Witchellia* in lacking ventral furrows bordering the keel, in having a sharper umbilical edge, in bearing mostly simple, unforked ribs on its intermediate and outer whorls, and in a tendency for its outer whorls to become smoother at an earlier growth stage. *Dorsetensia* in Europe is most common in the lower part of the *Stephanoceras humphriesianum* zone (Dorn, 1935, p. 96) but is fairly common in the *Otoites sauzei* zone (Dorn, 1935, p. 120; Westermann, 1954, p. 29, 25-28). It is not known from the *Sonninia sowerbyi* zone or from the upper Bajocian.

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

*Pelekodites*, as herein defined, is represented in western Europe by the following described species, of which some are probably synonyms of others (See Huf, 1968, p. 81-44):

- *Pelekodites pelekus* Buckman (1923, pl. 389)
- *Nannoceras nannomorphic* Buckman (1923, pl. 445)
- *Spatulites spatians* Buckman (1928, p. 12, pl. 765)
- *Macerites aurifer* Buckman (1929, p. 11, pl. 796)
- *Fontannesia curvata* Buckman (1905, p. ClXXXIX; 1892, pl. 47, figs. 1-5; pl. 67, figs. 6, 7)
- *boweri* Buckman (1895, p. CXC, pl. 24, figs. 1-4)
- *aurita* Buckman (1905, p. CXCI, pl. 24, figs. 5, 6)
- *Poecilomorphus macer* Buckman (1889, p. 110, pl. 22, figs. 23-29)
- *Witchellia deltalaotata* (Quenstedt) (Dorn, 1935, p. 114, pl. 3, figs. 2a, b)
- *Sonninia deltalaotata pinguoides* Hultermann (1939, p. 175, pl. 12, fig. 7)
- *(?Poecilomorphus) schumbergerii* Haug (1903, p. 296, pl. 8, figs. 6a, b)
- *buckmani* Haug (1903, p. 292, pl. 9, fig. 4)

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

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

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

- *Ammonites cycloides* d'Orbigny (1845, p. 370, pl. 121, figs. 1, 2; Buckman, 1889, p. 115, pl. 22, figs. 15, 16; 1827, p. 10)
- *Poecilomorphus regulatus* Buckman (1927, p. 10, pl. 746)
- cf. *P. regulatus* Buckman (1927, p. 10; 1889, pl. 22, figs. 1, 2, 7, 8)
- *umbilicatus* Buckman (1927, p. 10; d'Orbigny, 1846, pl. 121, figs. 4, 5)
- *evolutus* Buckman (1927, p. 10; 1889, pl. 22, figs. 21, 22)
- *primiferus* Buckman (1927, p. 10, pl. 750)
- *fasciatus* Buckman (1927, p. 10; 1889, pl. 22, figs. 17, 18)
- *asper* Buckman (1927, p. 10; 1889, pl. 22, figs. 3, 4)
- *incluens* Buckman (1927, p. 10; 1889, pl. 22, figs. 5, 6)
- *angulinus* Buckman (1927, p. 10, pl. 757)
capillosus Buckman (1927, p. 10; 1889, pl. 22, figs. 11, 12)

minutus (Parona) (Sturani, 1964, p. 26, pl. 4, fig. 3)
buckmani Maubeuge (1955, p. 36, pl. 7, figs. 3a-c)
cf. P. cycloides d’Orbigny (Maubeuge, 1955, p. 36, pl. 7, figs. 2a, b)

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

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

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

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

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

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

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

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

In addition, the ammonites are represented in eastern Oregon in beds of middle Bajocian age by about 60 aptychi, of which most belong to the form genus *Lamellaptychus*. As such aptychi are considered to represent parts of ammonites belonging to the *Haplooceratidae* and *Oppeliidae* (Arkell in Arkell and others, 1957, p. 1437), they could be paired in eastern Oregon with *Lissoceras* or with *Oppelia*.

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

**STRATIGRAPHY**

**STRATIGRAPHIC SUMMARY**

Bajocian rocks in eastern Oregon range in thickness from 1,100 to at least 2,650 feet and probably are several thousand feet thick in the Seneca and Huntington areas. They consist mostly of marine clastic volcanic material ranging from coarse fragmental conglomerate to siltstone and mudstone but locally include submarine lava flows and volcanic breccias. Nonvolcanic sedi-
mentary material includes organic matter, beds of limestone, clastic particles derived from older sedimentary rocks, and probably much of the mudstone and claystone. All sedimentary rock units change laterally within short distances and consequently the sequence of units in one area may be very different than in another area only 10 to 15 miles away. Such changes for the westernmost two areas, as illustrated by Dickinson and Vigrass (1965, fig. 21 on p. 43 and pl. 3), seem remarkable, considering the short distance involved but have been proved by actual tracing of beds and by ammonite correlations. Because of these marked changes, none of the local units merit more than member rank under a broadly defined formation.

Consequently, for the Suplee and Izee area Dickinson and Vigrass (1965, p. 44-59) use the term Snowshoe Formation of Lupher (1941, p. 259-261) in a comprehensive sense to include as members some lithologic units that had been called formations by Lupher (1941, p. 248-250). Their usage is followed herein except that the term Snowshoe Formation is used also for the Seneca area because the formation crops out extensively between Izee and Seneca. Also, the term Shaw Member of the Snowshoe Formation of Dickinson and Vigrass (1965, p. 57, pl. 1) is not used herein because unpublished field studies by H. J. Buddenhagen (written commun., October 1968 and March 1970) show that the “Shaw Member” exposed in the type locality along Shaw Creek and in areas to the southwest is in part lithologically identical with the Callovian Trowbridge Formation of Lupher (1941, p. 263) and in the southern part of the Suplee area contains early Callovian ammonites (Mesozoic locs. 20798-20800). These include Lithistia stantonii Imlay and Xenocephalites vicarius Imlay, which in the Izee area range from the upper part of the Snowshoe formation to the top of the Lonesome Formation (Imlay, 1964b, p. D7).

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

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

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

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

The relationships between the members of the Snowshoe Formation in the Izee area and the Seneca area are not well known because of lack of detailed mapping. Nonetheless the Silvies Member has been traced eastward toward Seneca (Dickinson and Vigrass, 1965, p. 59) where it apparently passes into conglomerate, sandstone, and mudstone exposed in the northern part of Silvies Canyon. The lower part of the upper member of the Snowshoe Formation is correlated with mudstone and siltstone exposed near and west of Seneca on the
<table>
<thead>
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<tbody>
<tr>
<td>Parkinsonia parkinsoni</td>
<td>Upper member (in part)</td>
<td>Twist Creek Siltstone</td>
</tr>
<tr>
<td>Garantiana garantiana</td>
<td>Not identified</td>
<td>Spioconus bifurcatum and Leptosiphonotes</td>
</tr>
<tr>
<td>Streonoaeras subfuraatum</td>
<td>Not identified</td>
<td></td>
</tr>
<tr>
<td>Stephanoaeras humphriesianum</td>
<td>Middle Member</td>
<td>Cynthia Falls Sandstone</td>
</tr>
<tr>
<td>Otoites sauzei</td>
<td>Silvis</td>
<td>Chondroceras alleni, Hypoceras orlokiyi, and Teloceras flexuosus</td>
</tr>
<tr>
<td>Soninna sowbyi</td>
<td>Lower member (in part)</td>
<td></td>
</tr>
<tr>
<td>Graphoconus omeiensus</td>
<td>Snowshoe Formation</td>
<td>Fir Creek Siltstone</td>
</tr>
<tr>
<td>Lobiola murchisonae</td>
<td></td>
<td>Dorenestia oregonensis</td>
</tr>
<tr>
<td>Protoceras solusum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leioconites opillus</td>
<td>Twist Creek Siltstone</td>
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</tbody>
</table>

**Figure 1**—Correlation of some Middle Jurassic (Bajocian) formations in eastern Oregon, California, and Alaska.
presence of *Leptosphinctes*. Both the Warm Springs Member of the Suplee area as well as the upper part of the lower member of the Snowshoe Formation near Izee, are correlated lithologically and faunally with hard, black, thinly laminated mudstone exposed in the southern part of Silvies Canyon. In general, the Bajocian rocks near Seneca differ from those in the Izee area in being harder, much less calcareous, and in containing more coarse clastic material. At least the greater hardness can be ascribed to intrusion by igneous bodies.

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

**SNOWSHOE FORMATION OF SUPLEE AREA**

**WEBERG MEMBER**

*Definition.*—The Weberg Member of the Snowshoe Formation consists mostly of gray to brownish-gray silty to sandy limestone and calcareous sandstone, from 50 to at least 250 feet thick, that rest sharply and unconformably on varioue formations of Early Jurassic, Late Triassic, and Paleozoic ages (Lupher, 1941, p. 248-252; Dickinson and Vigras, 1965, p. 51-54, 94) and is overlain gradationally by the Warm Springs Member. The type section, selected and described by Dickinson and Vigras (1965, p. 51, 94), is on the north side of a gulch that trends southwestward from the SW 1/4 NE 1/4 sec. 19, into the NE corner of the NW 1/4 NE 1/4 sec. 30, T. 18 S., R. 26 E., Grant County, Oregon. At this gulch the Weberg Member rests with angular unconformity on Upper Triassic beds and consists from bottom to top of 3 feet of pebbly calcareous sandstone, 110 feet of gray calcareous sandstone and 90 feet of gray silty to finely sandy limestone.

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

The characteristics of the Weberg Member near the southwestern end of the Mowich upwarp are excellently shown in three closely spaced gulches that drain westward into Warm Springs Creek in the NE 1/4 sec. 30 and the SE 1/4 sec. 19, T. 18 S., R. 26 E. and in a fourth gulch that drains northward into Warm Springs Creek across the eastern part of the NW 1/4 of sec. 19. A section measured along the second gulch from the south has been described by Lupher (1941, p. 250) and by Dickinson and Vigras (1965, p. 94). Another section measured by the writer in the southernmost gulch is described herein. Both sections are illustrated in columnar form in figure 2, along with a rather poorly exposed but very fossiliferous section measured by R. L. Lupher on the east side of North Ammonite Hill in sec. 29, about half a mile east of the southernmost gulch (unpublished notes on p. 2 and 20 in Lupher’s locality book deposited at California Academy of Sciences). These columnar sections show the twofold lithologic divisions of the Weberg Member and the stratigraphic positions of some fossil collections.

**Weberg Member of Snowshoe Formation in gulch slightly northeast of old Washburn place near center of E 1/4 NE 1/4 sec. 30, T. 18 S., R. 26 E., Grant County, Oreg.**

Feet

<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
<th>Length</th>
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<tbody>
<tr>
<td>7. Limestone, thin-bedded to shaly, poorly exposed, yellowish-gray. At top contains Sonninia (Euphotoceras) cf. S. (E.) polyacantha (Waagen) (Mesozoic loc. 29829).</td>
<td>Grades upward into Warm Springs Member.</td>
<td>40</td>
</tr>
<tr>
<td>6. Limestone, thin-bedded, upper 40 feet contains some hard limestone ledges, lower 20 feet is softer and rather poorly exposed. Limestone beds from 40 to 50 feet above base contain Sonninia (Euphotoceras), Witchellia (Latticesiticchia), Fontannesia, Docidoceras, and Asthenoceras (Mesozoic loc. 29828).</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>5. Sandstone, calcareous, medium-gray to yellowish-gray, mostly thin-bedded, fairly well exposed. Upper 10 feet contains many pelecypods and brachiopods and a few cephalopods, including Sonninia dominana Buckman (Mesozoic loc. 29828).</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>4. Sandstone, ledge-forming, medium-yellowish-gray, contains many pelecypods and brachiopods.</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>3. Sandstone, calcareous, medium-gray to yellowish-gray, mostly thin-bedded, poorly exposed, contains</td>
<td></td>
<td>8</td>
</tr>
</tbody>
</table>
Figure 2.—Columnar sections of the Weberg Member of the Snowshoe Formation on the east side of Warm Springs Creek, Suplee area, Grant County, Oreg. Numbers are collectors' field numbers or USGS Mesozoic locality numbers.
The thickness of the Weberg Member varies considerably throughout its extent, owing to westward onlap over an irregular surface and to gradational facies changes upward and eastward into shales of the overlying Warm Springs Member (Dickinson and Vigrass, 1965, p. 51, 52, 58). Maximum thicknesses are attained along a belt of outcrops extending northeast from sec. 19, east of Warm Springs Creek, to secs. 3 and 4, T. 18 S., R. 26 E., near Swamp Creek (Lupher, 1941, p. 250, 252; Dickinson and Vigrass, 1965, p. 51). Eastward from these places the member disappears completely within 3 to 4 miles by changing into dark shales of the Warm Springs Member. Westward from these places it thins to 60 feet or less within 6 to 8 miles owing to the pinching out of the lower part of the member that is characterized by the ammonite Tmetoceras.

WARM SPRINGS MEMBER

Definition.—The Warm Springs Member of the Snowshoe Formation consists mostly of soft, dark-gray, calcareous silty claystone and mudstone that thickens eastward from 100 to 300 feet, grades into the underlying Weberg Member, and at most places grades into the overlying Basey Member (Lupher, 1941, p. 249; Dickinson and Vigrass, 1965, p. 54–57). The gradational upper contact with the Basey Member is covered in most places but is fairly well exposed on the west side of the road along the west fork of Freeman Creek in the west-central part of sec. 34, T. 18 S., R. 26 E., Grant County and in the NW ¼ sec. 3, T. 19 S., R. 26 E., Harney County.

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

Lithologic and stratigraphic features.—The Warm Springs Member is characterized by dark-gray thinly laminated claystone but includes mudstones and some siltstones that fracture into nodular or blocky fragments (Dickinson and Vigrass, 1965, p. 54). Other rock types include thin beds of limestone and fine-grained sandstone at or near the base of the member where it grades into the underlying Weberg Member. Their presence commonly makes arbitrary the selection of a boundary between the members. The Warm Springs Member must likewise contain some fine volcanic material because its upper part in most places grades upward into the volcanic Basey Member (Dickinson and Vigrass, 1965, p. 57). Faunally the member is characterized by an abundance of ammonites and of the pelecypod Bositra buchii (Römer). Rare fossils include fish bones (Mesozoic loc. 29305), rhytchonelid brachiopods, small nondescript oysters and Inoceramus.

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

BASEY MEMBER

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

Lithologic and stratigraphic features.—The Basey Member, as described by Dickinson and Vigrass (1965, p. 56, 57) consists characteristically of massive units of volcanic fragmental rocks, but at its type locality includes andesitic lava flows at its base and about 1,000 feet above its base. It also includes some volcanic siltstone and mudstone that are most common from 500 to 1,000 feet above the base of the member and become more common eastward. East of Mowich Mountain at the south end of the Mowich upwarp the entire member lenses out into siltstone and mudstone that are called informally the middle member of the Snowshoe Formation. Northeast from the type locality the member thins within nine miles from 2,500 to 500 feet.
The sharp lower contact of the Basey Member in the type locality is placed at the base of a flow of andesitic lava. Elsewhere the contact is gradational, is generally poorly exposed, and is placed between fragmental volcanic rocks above and dark-gray claystone and siltstone below. The upper contact with the “Shaw Member” of the Snowshoe Formation is probably unconformable, when one considers that the upper part of the Basey Member contains ammonites of late middle Jurassic age and that the “Shaw Member” contains ammonites of early Callovian age.

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

**SNOWSHOE FORMATION OF IZEE AREA**

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

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

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

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

The Silvies Member of the Snowshoe Formation, as described by Dickinson and Vigrass (1965, p. 45, 49-51), consists of marine fragmental volcanic material that was deposited at the same time as the middle member of the Basye Member of the Snowshoe Formation. The Silvies Member is lithologically similar to the Basye Member but differs in a number of features, most notice-
ably the presence of conglomerate beds, pebbly sandstones, coarser grained sandstone, and conspicuous graded bedding. It is about 1,500 feet thick at its type locality which is at the juncture of secs. 21, 22, 27, and 28, T. 16 S., R. 29 E., Grant County, less than five miles northeast of its westernmost occurrences. The member is reported to thicken and coarsen eastward markedly toward Seneca (Dickinson and Vigrass, 1965, p. 51, 59). The only fossils found in the Silvies Member in the Imlay area consist of fragments of ammonites from near the middle of the NE 1/4 sec. 32, T. 16 S., R. 29 E.

The upper member of the Snowshoe Formation, as described by Dickinson and Vigrass (1965, p. 47), thins southward from about 2,000 feet near the head of Lewis Creek to 1,200 feet along the South Fork of the John Day River and then disappears before reaching Big Flat, owing to overlap by the Trowbridge Formation of Lupher. It consists partly of thin beds of dark mudstone and siltstone as in the underlying members but differs by containing some thicker beds of gray calcareous sandstone. It is generally poorly exposed, but fairly good exposures occur in a roadcut along Lewis Creek in the west half of sec. 7, T. 17 S., R. 29 E., Grant County. The member has furnished one ammonite, *Leptosphinctes*, near its base just above the Silvies Member (Mesozoic loc. 26775) in the SW 1/4 NE 1/4 sec. 32, T. 16 S., R. 29 E. Its upper 500 to 1,000 feet have also furnished ammonites of late Bathonian? to early Callovian age and the pelecypods *Ostrea* and *Bositra* (Imlay, 1964b, p. D7–D9). Apparently the member spans late Bajocian to early Callovian time or includes a disconformity that has not been recognized.

**SNOWSHOE FORMATION OF EMIGRANT CREEK AREA**

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

**SNOWSHOE FORMATION OF SENECA AREA**

The Snowshoe Formation of Bajocian age in the Seneca area crops out irregularly from the southern margin of T. 16 S. near Seneca to the middle of T. 18 S., and from R. 30 E. to R. 32 E. Within these townships, as shown on a generalized geologic map of the Canyon City quadrangle (Brown and Thayer, 1966), the Snowshoe Formation occurs in the areas bearing the symbol for the Snowshoe Formation, as well as in most of the areas bearing the symbol for the Trowbridge and Lonesome Formations of Lupher. Actually, on the basis of many occurrences of Bajocian ammonites the Snowshoe Formation extends south as far as Flat Creek in T. 18 S., R. 31 E. where it is identified by the presence of *Normannites* (Mesozoic loc. 29413) just north of the creek in the NE 1/4 sec. 7, T. 18 S., R. 31 E. Just south of the creek, however, some pebbly sandstone exposed on a ridge has furnished the early Callovian ammonite *Xenocephalites vicarius* Imlay in the NW 1/4 sec. 17, T. 18 S., R. 31 E. (Lupher's loc. 52) and in the south-central part of sec. 16, T. 18 S., R. 31 E. (Mesozoic locs. 29419 and 29420). The only other ammonites not of Bajocian age that have been found near Seneca are from the eastern part of Antelope Valley in the NW 1/4 SE 1/4 sec. 9, T. 17 S., R. 32 E., Grant County. These include *Harpocephas* and questionable *Gramioceras* (Mesozoic loc. 29409) and are definitely of Turolian age.

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

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

The fossils found in the Snowshoe Formation of the Seneca area consist mostly of ammonites and the pelecypod *Bositra buchii* (Römer) but include some fish bones (Mesozoic loc. 29790) and the pelecypod *Inoceramus* (Lupher's locs. 28 and 57 and Mesozoic loc. 29415). The pelecypod *Bositra* occurs throughout the sequence in beds correlating with the European *Otoites sauzei*
zone (Lupher's loc. 57 and Mesozoic locs. 28026, 28027), the *Stephanoceras humphriesianum* zone (Lupher's loc. 28), and with basal upper Bajocian as identified by *Spiroceras* (Mesozoic loc. 28029).

**UNNAMED BEDS IN CLOVER CREEK AREA**

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

**UNNAMED BEDS IN JUNIPER MOUNTAIN AREA**

The Middle Jurassic (Bajocian) is represented by about 2,000 feet of mostly noncalcereous black to yellowish-gray shale, graywacke and conglomerate exposed along and south of Pole Creek on the southeastern and southern slopes of Juniper Mountain in secs. 5 to 8, T. 16 S., R. 41 E., Malheur County, Oreg. (Wagner and others, 1963). These beds are underlain by a much greater thickness of similar appearing beds that near their base have furnished fossils of probable Early Jurassic age. They are overlain by unfossiliferous dark gray to black shale, apparently many thousands of feet thick, that lithologically resembles the lower Callovian Trowbridge Formation of the Izee area (Lupher, 1941, p. 227, 255-266, Dickinson and Vigrass, 1965, p. 60-63) as well as some Callovian beds exposed near Mineral (abandoned) in westernmost Idaho (Imlay, 1964b, p. D2, D3).

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

**UNNAMED BEDS IN HUNTINGTON AREA**

Middle Jurassic beds of Bajocian age have been identified by ammonites, such as *Tmetoceras*, *Spiroceras*, and *Stephanoceras*, in the central and southwestern parts of the Huntington quadrangle. These beds, according to Howard Brooks (written commun., March 25, 1970), are part of a series, probably several thousand feet thick, that consists mostly of sheared and slightly metamorphosed massive to thin-bedded graywacke, tuffaceous sandstone, and siltstone. Minor amounts of interbedded water-laid tuff, conglomerate, quartzose sandstone, limestone, and a few lava flows are also present. This series rests conformably on several hundred feet of red to green conglomeratic beds which in turn rest discordantly on Upper Triassic volcanic and sedimentary rocks (Brooks, 1967). The conglomeratic unit has furnished ammonites of Early Jurassic, probably Sinemurian age (Mesozoic locs. 29846-29851). The overlying graywacke series near its base has furnished the ammonite, *Crucibliceras*, of late Sinemurian age (Mesozoic locs. 29785, 29833). The graywacke series extends southward across the Huntington quadrangle into the southeastern part of the Bridgeport quadrangle.

**AMMONITE FAUNULES AND CORRELATIONS**

**SNOWSHOE FORMATION IN THE SUPLEE AREA**

**WEBERG MEMBER**

The stratigraphic distribution of ammonites in the Weberg Member (fig. 3) shows that the member contains two ammonite assemblages and that the upper assemblage is divisible into two faunules. The lower assemblage is characterized by *Tmetoceras seissum* (Benecke) in association with *Praestrigites* cf. *P. deltatus* (Buckman) (Lupher's locs. 207, 266, and 467) and *Eudmetoceras* (Lupher’s loc. 207). The upper assemblage is characterized by *Sonninia (Euhoploceras)* modesta Buckman, S. (E.) *dominans* Buckman, and *Dovidoceras sparsicostatum* Imlay, n. sp., which species extend through the entire Weberg Member above the *Tmetoceras*-bearing beds. In addition, the upper part of the beds containing these species may be distinguished from the lower part by the presence of *Witchellia (Latiwitchellia) evoluta* Imlay, n. sp., *Sonninia (Euhoploceras)* adicea (Waagen), S. (E.) *crassispinata* Buckman, and *Dovidoceras lupheri* Imlay, n. sp.

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

<table>
<thead>
<tr>
<th>Species</th>
<th>Weberg Member of Snowshoe Formation</th>
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<tr>
<td><em>Phylloceras</em> sp</td>
<td><img src="image1.png" alt="Lower" /> <img src="image2.png" alt="Middle" /> <img src="image3.png" alt="Upper" /></td>
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<td><em>Calliphylloceras</em> sp</td>
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<td><em>Holoophylloceras</em> sp</td>
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<td><em>Asthenoceras delicosum</em> Imlay, n. sp</td>
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<td><em>Fontanella costula</em> Imlay, n. sp</td>
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<td>cf. <em>P. incrassata</em> Buckman</td>
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<td>cf. <em>P. evoluta</em> (Buckman)</td>
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<td><em>Smetooceras scissum</em> (Benecke)</td>
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<td>cf. <em>S. (E.) hauthali</em> (Burckhardt)</td>
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<td>cf. <em>S. (E.) amaltheiforme</em> (Vacell)</td>
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<td><em>Soninella</em> (Bupholoceras) modesta Buckman</td>
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<td><em>dominans</em> Buckman</td>
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<td><em>dominans polyzoantha</em> (Waagen)</td>
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<td>cf. <em>dominans polyzoantha</em> (Waagen)</td>
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<td>altissima (Waagen)</td>
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<td><em>crassispinata</em> Buckman</td>
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<td>cf. <em>S. (E.) espinaxitensis</em> Tornquist</td>
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<td><em>Withezzia (Latewhithecera) evoluta</em> Imlay, n. sp</td>
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<td><em>Pelekodites webergi</em> Imlay, n. sp</td>
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<td><em>Proestrigites</em> cf. <em>P. deltoius</em> (Buckman)</td>
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<td>Strigoceras cf. <em>S. Longivertens</em> (Buckman)</td>
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<td><em>Hedetomyites</em> cf. <em>H. hebes</em> Buckman</td>
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<td><em>Liassoceras</em> sp</td>
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<td><em>Deectoceras lupheri</em> Imlay, n. sp</td>
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<td>urumpringsense Imlay, n. sp</td>
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<td>sparelozostum Imlay, n. sp</td>
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<td>cf. <em>libe Maubourge</em></td>
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<td><em>Stephanoceras</em> aff. <em>S. nodosum</em> (Quenstedt)</td>
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<td>(Skirroceras) juhzei Imlay</td>
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<td>cf. <em>S. juhzei</em> Imlay</td>
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<td>cf. <em>S. dolihozeros</em> (Buckman)</td>
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**Figure 3.**—Stratigraphic distribution of Bajocian ammonite species in the Weberg Member of the Snowshoe Formation in the Suphee area.
the genera Asthenoceras, Eudmecitoeceras, Sonninia (Papillliceras), Fontannesia, Pelekodites, Praestrigites, Strigoceras, Hebetoxytites, Lissoceras, Docidoceras, and Stephanoceras. Of these, Eudmecitoeceras and Praestrigites range upward from the beds characterized by Tmetoceras scissum (Benecke) into the beds characterized by Witchellia (Laticwttellia) evoluta Imlay, n. sp. Species that begin above the base of the Sonninia modesta assemblage but range to its top include Asthenoceras delicatum Imlay, n. sp., Fontannesia costula Imlay, n. sp., F. Cie. F. carinata Buckman, Pelekodites webergi Imlay, n. sp., Strigoceras cf. S. languidum (Buckman), Hebetoxytites cf. H. hebes Buckman, Docidoceras warmspingsense Imlay, n. sp., and Stephanoceras (Skirroceras) cf. S. (S.) dolichoecus Buckman. The genus Lissoceras is represented by a single specimen from the upper part of the zone. The subgenus Sonninia (Papillliceras) is represented by three specimens from the very top of the Weberg Member and by three specimens from near the middle of the member, apparently below the middle of the Sonninia modesta assemblage. Tmetoceras scissum (Benecke) in the Weberg Member occurs in sandy beds in the lower part of the member on the east side of Dobson Creek (Vigrass’ loc. 3) in the SE1/4 sec. 28, T. 18 S., R. 26 E., and on the west side of Swamp Creek (Vigrass’ loc. 121a) in the SW1/4 sec. 34, T. 17 S., R. 26 E. At Dobson Creek Tmetoceras occurs 50 feet above the base of the member and is overlain 30 feet higher by Docidoceras sparsicoastatum Imlay, n. sp. (Vigrass’ loc. 86). Near Swamp Creek, Tmetoceras occurs in yellowish sandy limestone underlyiny gray limestone beds that contain Sonninia modesta Buckman and Fontannesia, as discussed under the description of Tmetoceras scissum. Northeast of Swamp Creek the sandy beds containing Tmetoceras continue for about 4 miles, but the overlying limestone beds are replaced laterally within a mile by dark shale of the Warm Springs Member (Dickinson and Vigrass, 1965, p. 52). Consequently for about 3 miles Tmetoceras occurs near the top of the Weberg Member. Nonetheless, the presence of Docidoceras from the upper part of the sandy beds in secs. 25 and 26, T. 17 S., R. 26 E., indicates that at least the basal part of the Sonninia modesta assemblage is represented.

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

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

The lower fauna of the Sonninia modesta assemblage on the east side of Warm Springs Creek occurs in 60 to 85 feet of light-gray to brownish-gray sandy limestone and calcareous sandstone that is locally pebbly. It is present in the third to sixth units below the top of the Weberg Member as described by Lupher (1941, p. 230), the third to fifth units of the member as described herein under Stratigraphy, and in most of the lower sandstone division as described by Dickinson and Vigrass (1965, p. 94). Within this 60 to 85 feet of beds the upper 45 to 60 feet contain at their top a unit bearing many terebratulid brachiopods, contain at their base a thin bed bearing many rhyynchonellid brachiopods, contain many pelecypods throughout, and have furnished some ammonites belonging mainly to Sonninia (Euhopliloceras), Fontannesia, Docidoceras, Pelekodites, and Asthenoceras. The lower 15 to 25 feet of the sequence contain many pelecypods and a few ammonites which include Sonninia modesta Buckman and Docidoceras sparsicoastatum Imlay, n. sp. The pelecypods occurring in these sandy beds include Ostrea, Gryphaea, Homomya, Pleuromya, Pholadomya, Trigonia, Gervillia, Astarte, Isoocyprina, Protocardia, and Camptonectes.
<table>
<thead>
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<td>Leptosphinctes</td>
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**Figure 4.**—European ranges of certain Bajocian ammonite genera present in eastern Oregon.
The upper faunule of the Sonninia modesta assemblage, characterized by Witcheilia (Latiteichellia), has the same areal distribution as the lower faunule in the area between North Ammonite Hill and Swamp Creek. It has not been recognized east of North Ammonite Hill or northeast of Swamp Creek. It has been recognized at many places in the westernmost outcrops of the Weberg Member west of Warm Springs Creek. It has furnished many ammonites but very few pelecypods or brachiopods.

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

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

Against such a precise correlation with only the Hyperlioceras discites subzone are several faunal considerations. First, such Oregon species as Sonninia (Euhoploceras) adicra (Waagen) and S. (E.) cros­ siepinata Buckman are known in England from both the H. discites subzone and the overlying Shirburnia trigonalis subzone (Buckman, 1892, p. 322, 325; 1926, pl. 669; Morton, 1965, p. 199). Second, the ranges of some Jurassic ammonite genera in western North America are slightly different than in Europe (Westermann, 1969, p. 18). Third, such ammonites as Stephanoceras and Papilliceras in Europe have not been found as low as the H. discites subzone. For example, in England Papilliceras occurs mainly in the Otoites sauzei subzone, and the oldest known species, Sonninia (Papilliceras) arenata (Quenstedt) in Buckman (1927, pl. 709) is recorded from the Shirburnia trigonalis subzone (Davies, in Buckman, 1930, v. 7, p. 36). Stephanoceras in Europe ranges from the middle part of the Sonninia soeverbyi zone into the lower part of the upper Bajocian and attains its greatest development in the Stephanoceras humphriesianum zone (Arkell, 1956, p. 232, 264, 300; 1952a, p. 74). Apparently the oldest species of Stephanoceras in England is S. mollis (Buckman) (1922, p. 341) from the base of the Witcheilia laevinscula subzone (Davies, in Buckman, 1930, v. 7, p. 35), a little higher than the oldest occurrence of Papilliceras.

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

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

In summation, the lower part of the Weberg Member that contains Tmetoceras in association with Praestrig-
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<td>and Liroxyites</td>
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<td>Stephanoceras humphriesianum</td>
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Figure 5.—Correlation of Bajocian ammonite faunas in eastern Oregon, Alaska, and Europe.
ites is correlated with the European Graphoceras concaum zone at the top of the lower Bajocian (Aalenian). The middle and upper parts of the Webeg Member that contain an association of Soninia (Euhoploceras), Docidoceras, Eudmetoceras, Praeestrigites, and Fontannesia correlate mostly or entirely with the Hyperlioceras discites subzone at the base of the Soninia sowerbyi zone. The highest beds locally are probably as young as the next younger Shirbumirna trigonalis subzone based mainly on the appearance of Stephanoceras. Such an age is suggested, also, by the resemblance of the new subgenus Latitietchellia to Zugophorites Buckman (1922, p. 341) and by the fact that Euhoploceras in England ranges into the S. trigonalis subzone.

WARM SPRINGS MEMBER

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

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

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

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

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

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

The middle part of the Warm Springs Member probably correlates with the lower part of the Otoites sauzei zone, as suggested by its stratigraphic position directly below several hundred feet of beds containing ammonites strongly indicative of the Otoites sauzei zone and by the presence of Dorsetensia throughout. That genus in Europe is most common in the lower part of the Stephanoceras humphriesianum zone, is fairly common in the underlying Otoites sauzei zone (Buckman, 1892, p. 203; Dorn, 1953, p. 120; Huf, 1968, p. 16, 72-110; Arkell, 1952b, p. 249, 295), and is not definitely known from older beds.

Dorsetensia has been recorded from older beds in southern Germany but all such records appear to be erroneous (Arnold Zeiss written commun., July 1970). For example, one specimen of Dorsetensia listed by Dorn (1953, pl. 19, fig. 1) as from the Soninia sowerbyi zone is actually from the Stephanoceras humphriesianum
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<td>Soninia (Tapillocoerus) stantoni (Crickmay)</td>
<td></td>
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<tr>
<td>cf. S. (T.) arenata (Quenstedt)</td>
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<tr>
<td>cf. S. (T.) juramentana (Crickmay)</td>
<td></td>
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<tr>
<td>sp</td>
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<tr>
<td>Witheilla connata (Buckman)</td>
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<tr>
<td>Pelekiotites silvicentis Imlay, n. sp</td>
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<tr>
<td>dextrosea Imlay, n. sp</td>
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<tr>
<td>Pevolomorphus cf. P. varulis Imlay, n. sp</td>
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<tr>
<td>Linosoceras hydei Imlay, n. sp</td>
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<tr>
<td>Smilitea buddenhageni Imlay, n. sp</td>
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<tr>
<td>sp. undet</td>
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<td>Otoites contractus (J. de C. Sowerby)</td>
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<tr>
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<tr>
<td>N. (N. Orvignyi) Longhi</td>
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<tr>
<td>cf. N. (N.) densus (Buckman)</td>
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<tr>
<td>cf. S. nodosum (Quenstedt)</td>
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<tr>
<td>(Skirroconus) kirschneri Imlay</td>
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</tr>
<tr>
<td>cf. S. (S.) kirschneri Imlay</td>
<td></td>
</tr>
<tr>
<td>(S.) jublet Imlay</td>
<td></td>
</tr>
<tr>
<td>cf. S. (S.) jublet Imlay</td>
<td></td>
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<tr>
<td>cf. S. (S.) leptogyrus (Buckman)</td>
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<tr>
<td>cf. S. (S.) oregonensis Imlay, n. sp</td>
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<tr>
<td>Parabigotites oregonensis Imlay</td>
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**Figure 6.**—Stratigraphic distribution of Bajocian ammonite species in the Warm Springs and Basey Members of the Snowshoe Formation in the Supplee area.
zone (Huf, 1968, p. 98, 102). Also, two specimens identified as *Dorsetensia* by Dorn (1933, pl. 24, fig. 5, pl. 26, figs. 1a, b) and listed from the ‘Witchellia’ pinguis zone (Dorn, 1935, p. 96, 105, 120; Westermann, 1967, p. 160) actually belong to *Soninina stephani* Buckman, according to Oechsle (1958, p. 86, 106) and Huf (1968, p. 98, 110). That species is typical of the genus *Shirbuerinia* according to Arkell (1933, pl. 33, fig. 1) and differs markedly in whorl shape from *Dorsetensia*.

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

**BASEY MEMBER**

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

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

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

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

The middle part of the Basey Member definitely correlates with the *Stephanoceras humphriesianum* zone as shown by the presence of *Sphaeroceras*, which is not known below that zone (Westermann, 1956a, p. 24–35; Arkell, 1952a, p. 77; Arkell, 1956, p. 32, 50, 100, 142, 262, 278) and *Dorsetensia* which is not known higher (Arkell, 1952b, p. 263, 285).

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

LOWER MEMBER

The lower member of the Snowshoe Formation has yielded ammonites of late Toarcian age in its lower 125 feet (Imlay, 1968, p. C14, C16, C44-C46), ammonites of early Bajocian (Aalenian age from 125 to 200 feet above its base, and ammonites of middle Bajocian age from 225 feet upward (fig. 7). The early Bajocian (Aalenian) is represented mainly by *Tmetoceras scissum* (Benecke) which in the upper 50 feet of its range is associated with some tuberculate ammonites referred questionably to *Planammatoceras*. Of these ammonites, *Tmetoceras* ranges throughout the substage (Arkell, 1956, p. 34; Westermann, 1964a, p. 435) and *Planammatoceras*, if correctly identified, suggests correlation with the *Ludwigia murchisonae* zone (Arkell and others, 1957, p. 1267; Elmbl, 1963b, p. 82–90, 101–103; Westermann, 1969, p. 66), or with the upper instead of the lower part of the lower Bajocian.

The middle Bajocian part of the lower member contains the ammonites *Asthenceras delicaturn* Imlay, n. sp., *Sonninia (Papilliceras*) sp., *Withnellia connata* (Buckman), *Dorsetensia cf. D. subtexta* Buckman, *Pelekodites silvicensns* Imlay, n. sp., *Lissoceras hydei* Imlay, n. sp., and *Stephanoceras (Skirrocera8) juhlei* Imlay (fig. 7). These same species occur in the Warm Springs Member of the Snowshoe Formation and have the same general age connotations discussed under that member. In fact, the presence only 250 feet above the base of the lower member of such ammonites as *Dorsetensia, Lissoceras hydei* Imlay, n. sp., and *Pelekodites silvicensns* Imlay, n. sp. suggests that all higher beds in the lower member may be equivalent to only the middle and upper parts of the Warm Springs Member and may not be older than the *Otoites sauzei* zone. This leaves only 255 feet, or slightly more, above the highest occurrence of *Tmetoceras* to account for the time represented by the middle and upper parts of the Weberg Member, as well as the lower part of the Warm Springs Member. These few feet, however, have not furnished any ammonites that are restricted to the Weberg Member of the Supplee area, but only *Asthenceras delicaturn* Imlay, n. sp., which ranges through the Warm Springs Member.

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

MIDDLE MEMBER

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

UPPER MEMBER

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

SNOWSHOE FORMATION IN THE SENECA AREA

Three distinct ammonite assemblages are recognizable in the Seneca area in the southwestern part of the Seneca quadrangle and in nearby parts of the Logdell and Calamity Butte quadrangles (fig. 8). The oldest assemblage is identical specifically with that in the upper part of the Warm Springs Member and that in the lower part of the Basy Member of the Snowshoe Formation in the Supplee area. The next higher, or middle, assemblage is identical with that in the highest part of the Basy Member of the Snowshoe Formation. The highest ammonite assemblage, characterized by *Spirecera8*, is
<table>
<thead>
<tr>
<th>Species</th>
<th>Snowshoe Formation</th>
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<tbody>
<tr>
<td></td>
<td>Lower member</td>
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<tr>
<td>Holophyloceras sp</td>
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<tr>
<td>Asthenoceras delicatum Imlay, n. sp</td>
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<td>Tmetoceras scissum (Benecke)</td>
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<tr>
<td>Planammatoceras? sp</td>
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<tr>
<td>Soninia (Papilliceras) sp</td>
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<td>Witchellia connata (Buckman)</td>
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<td>Dorsetensia cf. D. subtexta Buckman</td>
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<td>oregonensis Imlay, n. sp</td>
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<tr>
<td>sp</td>
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<td>Pelekodites silviesensis Imlay, n. sp</td>
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<tr>
<td>Poeclibomorphus varius Imlay, n. sp</td>
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<tr>
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<td>Normannites (Itinaceites) cf. N. (I.) gracilis Westermann</td>
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<tr>
<td>(Skirroceras) kirschneri Imlay</td>
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<td>(S.) juhlei Imlay</td>
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<tr>
<td>(S.) sp</td>
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<tr>
<td>(Phaulostephanus?) cf. S. (P.) oregonense Imlay, n. sp</td>
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<tr>
<td>Parabigotites cf. P. crassicostatus Imlay</td>
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Figure 7.—Stratigraphic distribution of Bajocian ammonite species in the Snowshoe Formation in the Izee area.
<table>
<thead>
<tr>
<th>Genera or subgenera</th>
<th>West side of Mowich upwarp (Suplee area)</th>
<th>East side of Mowich upwarp (Izee area)</th>
<th>Seneca and Emigrant Creek areas</th>
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<tbody>
<tr>
<td>Phylloceras --------</td>
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<td>Parabigotites -----</td>
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Figure 8.—Stratigraphic distribution of Bajocian ammonite genera in the Snowshoe Formation in the Suplee, Izee, Seneca, and Emigrant Creek areas.
not known from the Suplee or Izee areas but does occur in the Juniper Mountain area in Malheur County and probably also near the center of the Huntington quadrangle in Baker County, Ore.

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

- *Asthenceras delicatum* Imlay, n. sp. (Lupher's loc. 490)
- *Sonninia* cf. *S. nodatipinguis* (Buckman) (Lupher's loc. 272)
- *(Papilliceras) stanthoni* (Crickmay) (Lupher's loc. 57, Mesozoic locs. 21617, 29026)
- *Witchellia connata* (Buckman) (Lupher's loc. 57 and Mesozoic loc. 28026).
- *Dorsetensia diversistrata* Imlay, n. sp. (Lupher's loc. 57)
- *Sonninia* *oerogensens* Imlay, n. sp. (Lupher's loc. 272).
- *Pelekodites silviesensis* Imlay, n. sp. (Lupher's loc. 57 and 272)
- *Lissoceras hydei* Imlay, n. sp. (Lupher's loc. 57 and Mesozoic locs. 21617 and 29027)
- *Otoites contractus* (J. de C. Sowerby) (Lupher's loc. 57)
- *Chondroceras sp.* (Lupher's loc. 57)
- *Normannites* *kialagvikensis* Imlay (Lupher's loc. 57)
- *Sonninia* *braikenidii* (J. de C. Sowerby) (Lupher's loc. 57)
- *normosus* Buckman (Mesozoic loc. 21617)
- *aff. N. itinac* (McLearn) (Lupher's loc. 272)
- *Stephanoceras* sp. B (Lupher's loc. 57)
- *cf. S. nodosum* (Quenstedt) (Lupher's loc. 57)
- *(Skirroceras) kirschneri* Imlay (Lupher's loc. 272)
- *(S.) juhllei* Imlay (Lupher's loc. 272 and Mesozoic loc. 29233)

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

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

The next higher ammonite assemblage in the Seneca area occurs both south and north of the assemblage just discussed. In the northern part of the area it has been identified in a large roadcut, exposing about 250 feet of shale, on the east side of U.S. Highway 395 about 0.6 mile south of Seneca (Lupher's loc. 28, Vigrass' loc. 242, Mesozoic locs. 29790 and 29792). In the southern part of the area the assemblage has been identified from Camp Creek southward about 21 1/2 miles to the north side of Flat Creek near the southern margins of the Seneca and Logdell quadrangles (Mesozoic locs. 25318, 25692, 26771, 29413, 29415, Lupher's locs. 55 and 56). Directly south of Flat Creek occur beds of early Callovian age, but about 2 miles still farther south the middle Bajocian is represented on Hall Creek in the Calamity Butte quadrangle (Mesozoic loc. 26777) by tuffaceous beds that appear to be the same as on Camp Creek.

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

- *Phylloceras sp.* (Mesozoic loc. 29790)
- *Poecilomorphus varius* Imlay, n. sp. (Lupher's loc. 28, Mesozoic locs. 29790, 29792)
- *Megaphasoceras rotundum* Imlay (Lupher's loc. 28)
- *Chondroceras allani* (McLearn) (Mesozoic loc. 29413)
- *cf. C. allani* (McLearn) (Lupher's loc. 28)
- *Normannites orbignyi* Buckman (Mesozoic locs. 26777, 29415, 29790)
- *(Hinsaites) crickmayi* (McLearn) (Mesozoic locs. 29413, 29790)
- *cf. N. (L.) crickmayi* (McLearn) (Mesozoic loc. 25692)
- *(L.) sp.* (Mesozoic loc. 26777)
- *cf. N. (Epalxites) anceps* (Quenstedt) (Mesozoic loc. 29413)
- *Stephanoceras* cf. *S. nodosum* (Quenstedt) (Lupher's loc. 28)
- *sp. A* (Mesozoic loc. 25318)
- *(Skirroceras) kirschneri* Imlay (Lupher's loc. 55, Mesozoic loc. 29790)
- *cf. S. (S.) kirschneri* Imlay (Lupher's loc. 28, Mesozoic loc. 29792)
- *aff. S. (S.) juhllei* Imlay (Mesozoic loc. 29413)
- *cf. S. (S.) juhllei* Imlay (Vigrass' loc. 242)
- *S. (S.) sp.* (Lupher's loc. 28, Mesozoic locs. 26771, 26777, 29415)
- *Stemmatoceeras* ? sp. (Lupher's loc. 28)
- *Leptosphinotes* cf. *L. leptus* Buckman (Lupher's loc. 28)

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

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

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

**Spiroceras bifurcatum** (Quenstedt) (Mesozoic locs. 28017, 28022, 29232, 29234)
**annulatum** (Deshayes) (Mesozoic locs. 28018, 29232)
**cf. S. annulatum** (Deshayes) (Mesozoic loc. 29236)
sp. (Mesozoic loc. 25824)
**Sphaeroceras** cf. **S. bronngiarti** (J. de C. Sowerby) Mesozoic locs. 28017, 28018, 29236
**Normannites aff. N. orbignyi** Buckman (Mesozoic locs. 25821, 25820, 29231, 29232)
**N. (Itinsaites) erickmayi** (McLearn) (Mesozoic loc. 25824)
**Stephanoceras** sp. D. (Mesozoic loc. 2920)
sp. C (Mesozoic loc. 29221)
spp. (Lupher's loc. 5; Mesozoic locs. 25817, 28019-28021, 29235)
**cf. S. (Skirroceras) kirscheni** Imlay (Lupher's loc. 30)
**cf. S. (S.) juhlei** Imlay (Lupher's loc. 30)
**Teloceeras** sp. (Lupher's loc. 30)
**Zemistephanus?** cf. Z. richardsoni (Whiteaves) (Lupher's loc. 30)
**Lupherites senecaensis** Imlay, n. sp. (Lupher's loc. 30)
**Leptosphinctes** cf. **L. evolutus** Imlay (Lupher's loc. 30)
(Prorsisphinctes) spp. juv. (Lupher's loc. 30)

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

The other faunule, at the top of the Jurassic sequence near Seneca, is definitely of late Bajocian age as shown by the presence of Spirorceras bifurcatum (Quenstedt), which in Eurasia and Africa is characteristic of the lower and middle parts of the upper Bajocian sequence (Arkell, 1952b, p. 296). This age determination is not contradicted by the presence of Sphaeroceras, normal nites, and Stephanoceras which in those continents range upward from the lower Bajocian into the lower to middle parts of the upper Bajocian (Westermann, 1956a, p. 24-35; Arkell, 1952a, p. 77; Arkell, 1956, p. 32, 50, 63, 99, 100, 122, 142, 176, 292, 262-264, 278, 300, 483; Pavia, 1969, p. 445-451). Also, the species described herein as Normannites aff. *N. orbignyi* Buckman and Stephanoceras sp. C and D are normal associates of Spirorceras and Leptosphinctes farther east in Oregon in the Juniper Mountain area.

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

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

**Oppelia** cf. **O. unbradiata** (J. de C. Sowerby) (Lupher's loc. 8)
Chondroceras sp. (Lupher’s locs. 8 and 135)
Pocelomorphus varius Imlay, n. sp. (Lupher’s loc. 136)
Normannites cf. N. quenstedti Roche (Lupher’s loc. 8)
Stephanoceras spp. (Lupher’s loc. 8)
Stemmatacotum aff. S. albertense McLearn (Lupher’s loc. 8)
Lupherites seecenasius Imlay, n. sp. (Lupher’s loc. 8)
Sphaeroceras cf. S. bronniartii (J. de C. Sowerby) (Lupher’s loc. 8).

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

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

SNOWSHOE FORMATION IN THE EMIGRANT CREEK AREA

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

Pocelomorphus? sp. (Mesozoic loc. 26772)
Chondroceras mani (McLearn) (Mesozoic loc. 26770)
Normannites orbignyi Buckman (Mesozoic locs. 26772, 25759)
(Elleina) crickmayi (McLearn) (Mesozoic locs. 26770, 26772, 29410)
Stephanoceras (Skirrocera) kirschneri Imlay (Mesozoic locs. 26770, 26772, 29410)
(S.) sp. (Mesozoic loc. 27579)
Teloceras itinac McLearn (Mesozoic locs. 26770, 29410)
Zenistophanus cf. Z. richardsoni (Whiteaves) (Mesozoic loc. 29410).

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

BAJOCIAN BEDS IN CLOVER CREEK AREA

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

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

BAJOCIAN BEDS IN JUNIPER MOUNTAIN AREA

In the Juniper Mountain area the lower Bajocian (Aalenian) is represented by Tmetoceras scissum (Benecke) (Mesozoic locs. 28374 and 28373) found in the SW. cor., sec. 5, T. 16 S., R. 41 E. To the southwest, nearly along the strike, in the NE1/4 sec. 7, were found ammonites that furnish a correlation with the lower part of the Sonninia sowerbyi zone of Europe and with the middle and upper parts of the Weberg Member of the Snowshoe Formation in the Supplee area. These include Fontannesia cf. F. luculenta Buckman, Asthenoceras delicatum Imlay, n. sp., EuTmetoceras sp., and Docitoceras sp. sp. juv. (Mesozoic locs. 28380 and 28381). About 800 to 1,000 feet higher stratigraphically were found fragments of Stephanoceras (Mesozoic loc. 28232) which could represent the upper part of the
Soninia sowerbyi zone or even higher Bajocian. Still another 800 to 1,000 feet higher and about 300 feet north of Pole Creek in the northwest quarter of sec. 5, were found ammonites of early late Bajocian age (Mesozoic locs. 28649, 28650). Such an age is indicated by the association of Spiroceras, Leptosphinctes (Prorsisphinctes), Normannites, and Stephanoceras. This fauna is the same as found at the top of the Jurassic sequence near Seneca, Oreg., as discussed previously.

BAJOCIAN BEDS IN HUNTINGTON AREA

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

COMPARISONS WITH OTHER FAUNAS

SOUTHERN ALASKA

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

<table>
<thead>
<tr>
<th>TABLE 3.—Comparisons of Bajocian ammonites in eastern Oregon and southern Alaska</th>
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<tr>
<td><strong>European zones</strong></td>
</tr>
<tr>
<td><strong>Parvimonia parviformi</strong></td>
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<tr>
<td><strong>Garantiana garaentiana</strong></td>
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<tr>
<td><strong>Stephanoceras humphriesianum</strong></td>
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<tr>
<td><strong>Otoites sauciei</strong></td>
</tr>
<tr>
<td><strong>Soninia sowerbyi (upper and middle parts)</strong></td>
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<tr>
<td><strong>Graphoceras concavum</strong></td>
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<tr>
<td><strong>Ludwigia murchisonae</strong></td>
</tr>
<tr>
<td><strong>Tmetoceras scissum</strong></td>
</tr>
<tr>
<td><strong>Leioceras opalinum</strong></td>
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Overall, the affinities of the Bajocian ammonites in southern Alaska are close with Bajocian ammonites in eastern Oregon except for ammonites for the time represented by the lower part of the Soninia sowerbyi zone. Definite comparisons cannot be made, however, for the times represented by the upper part of the Soninia sowerbyi zone and the lower part of the Stephanoceras humphriesianum zone because beds of those ages in Alaska have furnished few ammonites (Imlay, 1964a, p. B9, B12–B15; Westermann, 1969, p. 17–22). For example, at Wide Bay on the Alaska Peninsula, some of the Soninia sowerbyi zone could be represented by 240–300 feet (80–100 m) of unfossiliferous shale and sandstone that overlie beds characterized by Witchellia sutneroides Westermann (1969, p. 21) and underlie the lowest beds characterized by ammonites of the Otoites sauciei zone (Imlay, 1964a, p. B18; Westermann, 1969, p. 22).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**BRITISH COLUMBIA AND ALBERTA**

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

The lower Bajocian (*Aalenian*) is represented by *Tmenoceras* and *Erycites* (equals *Erycites* of Westermann, 1964a, p. 355) in three areas in southwestern British Columbia (Frebold, 1951; in Frebold and others, 1969, p. 21, 24, 25, fig. 1 opposite p. 1). Correlation with the lower part of the Kialagvik Formation on Wide Bay, Alaskan Peninsula, is furnished by the species present.

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

Another ammonite faunule, represented by *Sonninia*, has been collected in the Rocky Mountains near Lake Minnewanka in southwestern Alberta. It consists of a few poorly preserved ammonites that have been identified as *Sonninia* spp. undet. (Frebold, 1957, p. 48, 49, pl. 19, figs. 2a, b, pl. 20) and *Sonninia gracilis* (Whiteaves) (Frebold, 1957, p. 48, pl. 19, figs. 1a, b) and have been correlated with the *Sonninia sowerbyi* zone by Frebold (1957, p. 13; 1964, table 1 opposite p. 24). The same ammonites have been assigned to *Witchella, Soninia* (*Euoploceeras*) and questionably to *S. (Alaskoceras)* by Westermann (1969, p. 26, 94, 99, 107). No faunal evidence has been found in western Canada for the presence of beds equivalent to the European *Otoites* *sauzei* zone or the *Parabigotites crassicostatus* ammonite faunule of southern Alaska and eastern Oregon. Furthermore, the possibility that the *sauzei* zone is represented in the Manning Park area, British Columbia, by an association of *Zemistephanus richardsoni* (Whiteaves) and *Graphoceras crickmayi* Frebold, as suggested by Frebold (in Frebold and others, 1969, p. 18, 22, 25, 26, 32, 33, 35, pl. 2) seems most unlikely, considering the range of *Zemistephanus* in Alaska (Imlay, 1964a, p. B15, B16, 33, 35, and B52), and the range of *Graphoceras* in Europe ( Arkell, 1956, p. 33).

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

WESTERN INTERIOR OF THE UNITED STATES

Marine Jurassic beds equivalent to the European *Stephanoceras humphriesianum* zone have been identified in the western interior of the United States only

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

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

NORTHERN CALIFORNIA

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

- *Papilliceras juramontanum* Crickmay (unit 8)
- *Holoclytoceras faleiferum* Crickmay (unit 7)
- *Papilliceras blackwelderi* Crickmay (unit 7)
- *Otoites reesidei* Crickmay (unit 7)
- *Chondroceras russelli* Crickmay (unit 7)
- *Papilliceras stantonii* Crickmay (unit 5)
- *Stiphromorphites schucherti* Crickmay (unit 4)

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

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

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

The species described as Stiphromorphites schucherti Crickmay (1933, p. 909, pl. 28, figs. 1–3) was considered by Westermann (1960, p. 99) to be related to Sonninia (Euhoploceras) bifurcata Westermann (1969, p. 94–101, pls. 23–26) from the wide Bay area on the Alaskan Peninsula. It appears to differ, however, by lacking tubercles on all exposed whorls, by having rib furcation near the umbilicus instead of above the middle of the flanks, and by the ribs on its outer whors fading on the margins of the venter. In these respects it shows more resemblance to Sonninia nodatipinguis (Buckman) (1923, pl. 398), with which it was compared by Crickmay (1933, p. 910), and to S. tuxedniensis Imlay (1964a, p. B32, pl. 2, figs. 5–10) from southern Alaska. If these comparisons are valid, the presence of S. schucherti indicates correlation with the Otoites sauzei zone, whereas its identification with the subgenus Euhoploceras would indicate correlation with the lower part of the Sonninia sowerbyi zone.

In addition to these ammonites, one external mold of Stephanoceras was collected by Dr. G. E. G. Westermann from the lower part of the upper half of the Mormon Formation and was labeled by him as Stephanoceras (Skirvoceras) bayleanum (Oppel). This specimen is nearly identical with Stephanoceras rhytus Buckman (1921, pl. 250a,b) from the Otoites sauzei zone in England (Davies, in Buckman, 1930, v. 7, p. 34) in its highly evolute coiling and in the fineness and density of its secondary ribs. It likewise closely resembles S. (S.) juhle1 Imlay (1964a, fig. B47, pl. 16, figs. 1, 2, 3–6, pl. 17) from Alaska and Oregon in ribbing but apparently is a little more evolute. It is slightly finer ribbed than the holotype of S. (S.) bayleanum (Oppel) (d’Orbigny, 1846, pl. 133) from the Otoites sauzei zone and is much finer and denser ribbed than the specimens assigned to that species by Fallot and Blanchet (1923, p. 155, pl. 5, figs. 1–3). The close resemblance of this California specimen to S. juhle1 Imlay suggests that it is a variant of that species and has the same age significance.

EAST-CENTRAL CALIFORNIA

The middle Bajocian (Aalenian) is represented near the middle of the Sailor Canyon Formation by the ammonite Tmetoceras in association with the pelecypod Bositra buchii (Römer). These were obtained from about 8,500 to 11,000 feet above the base of the formation on the north side of the North Fork of the American River near the center of SE1/4 sec. 26 (USGS Mesozoic loc. 28389) and the NW1/4 SW1/4 sec. 25 (USGS Mesozoic loc. 28888), T. 16 N., R. 13 E., Royal Gorge quadrangle, Placer County, Calif., (L. D. Clark, written commun. September 1970).

SOUTHERN CALIFORNIA

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

EUROPE

During Bajocian time, the ammonite succession in Europe both resembled and differed from that in eastern Oregon as shown in table 4. The resemblances show clearly that certain genera and species lived at about the same time and in the same order in both areas. The differences, except in the basal Tmetoceras-bearing beds, cannot be explained by collection failure because the same, or similar, differences exist between the Bajocian ammonites of Alaska and those of Europe (Imlay, 1962, p. A4; 1964a, p. B21; Westermann, 1969, p. 29–31). Apparently during Bajocian time some faunal differentiation occurred in the Pacific Ocean different from that in the seas of Europe (Imlay, 1963, p. 1024, 1080–1082). Nonetheless the affinities of most of the Bajocian ammonites of Oregon are remarkably close to ammonites of the same age in Europe.
Table 4.—Comparisons of Bajocian ammonites in eastern Oregon and Europe

<table>
<thead>
<tr>
<th>European zones</th>
<th>Taxa represented by identical or similar species</th>
<th>Taxa differences with Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parkinsonia partimensi</td>
<td>Not identified</td>
<td>Abundance of Parkinsoniidae. Presence of Meganephropoceras</td>
</tr>
<tr>
<td>Geranioceras grandis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steneoceras subfurcatum</td>
<td>Spiroceras, Leptaphaioceras, and Sphaeroconus</td>
<td>Absence of Parkinsoniidae. Presence of Mesaphroceras</td>
</tr>
<tr>
<td>Stephanoceras humphriesianum</td>
<td>Tulaeum, Normammites, Sphaeroconus, Cheioconus, Stephanoceras, and Paleonocerina</td>
<td>Presence of Zemioceras</td>
</tr>
<tr>
<td>Otoites scutellum</td>
<td>Witchellia, Dorostennia, P-applicari, Eumelia, Otoites, Stephanoceras, Normammites and Peledites</td>
<td>Presence of Picephalites and Actheosus. Rarity of Sonninia</td>
</tr>
<tr>
<td>Sonninia sowerbyi (Upper and middle part)</td>
<td>Witchellia, Papillari, and Stephanoceras</td>
<td>Presence of Actheosus. Absence of Shihtartina and Fissileberina</td>
</tr>
<tr>
<td>Graphioceras concavum</td>
<td>Tulioceras and Prantegister</td>
<td>Absence of Graphioceras</td>
</tr>
<tr>
<td>Ludovicoceras murchisoni</td>
<td>Tulioceras and Tuberculicolus Planammatoceras.pr.</td>
<td></td>
</tr>
<tr>
<td>Tulioceras scutellum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liosceras apalium</td>
<td>Not identified</td>
<td></td>
</tr>
</tbody>
</table>

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

PALEOGEOGRAPHIC SETTING

The Bajocian rocks of east-central Oregon were deposited in the western part of a sea that transgressed eastward from the Pacific Coast region far into the western interior of the continent (Imlay, 1967, fig. 13 on p. 64). Deposition of lower Bajocian (Aalenian) beds, identified by Tulioceras, occurred at least as far as eastern Oregon as far east as Westgate in west-central Nevada (Corvalán, 1962), and as far east as southwestern British Columbia (Frebold, 1951, pp. 18-20; Frebold and others, 1969, p. 21). Deposition of lower middle Bajocian marine beds, corresponding to the European Sonninia sowerbyi zone, occurred as far east as the Snake River area in eastern Oregon and as far east in Canada as southwestern Alberta (Frebold, 1957, p. 48, 49; 1964, p. 2; McLearn, 1926; Frebold and others, 1969, p. 35). Deposition of slightly younger marine beds, corresponding to the European Stephanoceras humphriesianum zone, occurred as far east as western Montana and southern Alberta and apparently were replaced farther east and south by red beds and gypsum. Finally the transgression was climaxied by deposition of formal marine upper Bajocian sediments in eastern Oregon as well as throughout the western interior region as far east as the Dakotas and as far south as southwestern Utah (Imlay, 1967, p. 22-35, 59). Failure to find any Upper Bajocian fossils in British Columbia (Frebold and others, 1969, p. 16) or in the Rocky Mountains of Alberta (Frebold, 1957, p. 13; 1964, p. 5) indicates that main transgression came from the west rather than through Canada.

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

Conditions of deposition, as described by Dickinson and Vigrass (1965, p. 58-60), varied considerably in time and space, depending on the positions of volcanic vents and islands of Triassic or Paleozoic rocks and depending on the rapidity and amount of subsidence of the basins. Unquestionably the Weberg Member of the Snowshoe Formation in the Izea area was deposited in fairly shallow waters of a sea that was transgressing westward. This is shown by the presence of numerous thick-shelled pelecypods, including Ostrea and Gryphaea, and by the fact that the basal part of the formation contains younger and younger ammonites from east to west. The lower part of the overlying Warm Springs Member was also deposited in shallow water, as shown by the presence of Ostrea.
The remainder of the Warn1 Springs Member, as well as the lower member of the Snowshoe Formation in the Izee area, were probably deposited in deeper water than was the Weberg Member, as suggested by the absence of benthonic mollusks and by the fact that the sea transgressed westward but the water need not have been deeper than neritic zone depth. Deposition in quiet waters is clearly shown, however, by the homogeneous character of the mudstones and siltstones, the presence of fine laminations in these rocks, and an abundance of well-preserved specimens of the fragile pelecypod *Bositra buchii* (Römer) (equals *Posidonia ornata* (Quenstedt)). As this species probably swam freely (Jefferies and Minton, 1965, p. 156-179), its presence is not an indication of depth.

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

**GEOGRAPHIC DISTRIBUTION**

The geographic occurrences of the ammonities described herein are shown on plate 48 and tables 5 to 10. Detailed descriptions of the individual localities follow table 10.
TABLE 5.—Geographic distribution of Bajocian ammonites in the Weberg Member of the Snowshoe Formation in the Suplee area

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

<table>
<thead>
<tr>
<th>Species</th>
<th>Grant County</th>
<th>Dayville quadrangle</th>
<th>Crook County</th>
<th>Delmont Lake quadrangle</th>
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</thead>
<tbody>
<tr>
<td>Psiloceras sp.</td>
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<tr>
<td>Callipetloceras sp.</td>
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<td>Holoceras sp.</td>
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<tr>
<td>Antiloceras lexioceras Inlay, n. sp.</td>
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<tr>
<td><em>T. sp.</em></td>
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<td>Festenoceras carpus Inlay, n. sp.</td>
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<tr>
<td>cf. <em>P. leucoceras Buckman</em></td>
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<td>cf. <em>P. sarmaticus Buckman</em></td>
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<td>cf. <em>P. eothetusa (Buckman)</em></td>
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<tr>
<td><em>Eudactyloceras</em> (Euoploceles) cf. <em>E. (K.) hauhaii</em> (Buckman)*</td>
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<tr>
<td>cf. <em>E. (K.) klimakompkia (Vacek)</em></td>
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<tr>
<td>cf. <em>E. (K.) subquadrifrons</em> (Vacek)*</td>
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<tr>
<td><em>Seukenia</em> (Euoploceles) dominus Buckman</td>
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<tr>
<td>cf. <em>S. (K.) dominus Buckman</em></td>
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<tr>
<td><em>polycopina</em> (Waagen)</td>
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<tr>
<td><em>adæra</em> (Waagen)</td>
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<tr>
<td><em>crassispina</em> Buckman</td>
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<tr>
<td>cf. <em>S. (K.) crassispina</em> Buckman</td>
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<tr>
<td><em>Papilliceras</em> (K.) rossii (Crümmay)</td>
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<tr>
<td>cf. <em>S. (K.) rossii</em> (Tournqut)*</td>
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<tr>
<td><em>Plithecites</em> cf. <em>S. dolichoceras</em> (Buckman)*</td>
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<tr>
<td><em>Strioploceras</em> cf. <em>S. languidum</em> (Buckman)*</td>
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<td><em>Heteroceras</em> cf. <em>H. lehman</em> Buckman*</td>
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<td><em>Lactispora</em></td>
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<tr>
<td><em>Decidoceras</em> Inlay, n. sp.</td>
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<tr>
<td><em>wurzlesporites</em> Inlay, n. sp.</td>
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<tr>
<td><em>sparsoceras</em> Inlay, n. sp.</td>
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<tr>
<td>cf. <em>D. lehman</em> Muusorge</td>
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<tr>
<td><em>S. sp.</em></td>
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<tr>
<td><em>Stephanoceras</em> aff. <em>S. nodosum</em> (Quenstedt)</td>
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<tr>
<td>(Stephanoceras) <em>julii</em> Inlay</td>
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<tr>
<td>cf. <em>S. (S.) dalichoceras</em> Buckman*</td>
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<tr>
<td>Species</td>
<td>Locality</td>
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<tr>
<td><em>Bajocianites</em></td>
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<tr>
<td><em>Docidoceras</em></td>
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<tr>
<td><em>Lupherites</em></td>
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<tr>
<td><em>Praestrigites</em></td>
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<tr>
<td><em>Strigoceras</em></td>
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</tbody>
</table>

**Table 5:** Geographic distribution of Bajocian ammonites in the Wadling Member of the Showshoe formation in the Suplee area—Continued

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**Geographic Distribution**

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<table>
<thead>
<tr>
<th>Location</th>
<th>Species</th>
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<tr>
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### Table 6.—Geographic distribution of Bajocian ammonites in the Warm Springs Member of the Snowshoe Formation in the Suplee area

[One- and two-digit numbers refer to numbers on pl. 46, E, F, H. Other numbers are USGS Mesozoic locality numbers or collector's field numbers]

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<tr>
<td>Holophylloceras sp.</td>
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<td><em>D. complexus</em> Buckman</td>
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### Table 7.—Geographic distribution of Bajocian ammonites in the Basey Member of the Snowshoe Formation in the Suplee area

[One- and two-digit numbers refer to numbers on pl. 46, E, F, H. Other numbers are U.S.G.S. Mesozoic locality numbers or collector's field numbers]

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

[Nos. 110-132 refer to numbers on pl. 46, B. G. Other numbers are USGS Mesozoic locality numbers or collector's field numbers]

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

[No. 133-143 refer to numbers on pl. 48, I, J, K. Other numbers are USGS Mesozoic locality numbers.]

<table>
<thead>
<tr>
<th>Loc. No. (pl. 48)</th>
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<th>Collector, year of collection, description of locality, and stratigraphic assignment</th>
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<tbody>
<tr>
<td>1</td>
<td>V141</td>
<td>L. W. Vigras and others, 1956. South-facing slope of a minor tributary to Spring Creek, 1,800 ft north of an old barn on Spring Creek, SW1/4 NW1/4 sec. 7, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Warm Springs Member of Snowshoe Formation, upper part.</td>
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<tr>
<td>3</td>
<td>27376</td>
<td>B. W. Imlay, 1958. On road from Suplee to the South Fork of John Day River, just west of Beaver Creek, west-central part of SW1/4 SW1/4 sec. 20, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Basey Member of Snowshoe Formation, near base in area where member is about 1,400 ft thick.</td>
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<tr>
<td>4</td>
<td>V401</td>
<td>L. W. Vigras, 1957. About 100 ft east of a small channel, 1,400 ft north of road from Ilee to Suplee, and 600 ft west of road from Pine Creek to the Southwest Ranch houses, west-central part of SW1/4 NW1/4 sec. 23, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Basey Member, near base, below a sandstone unit.</td>
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<td>6</td>
<td></td>
<td>R. L. Lupher, 1938. Hill directly east of Wm. Harris Ranch house (abandoned) on upper part of Pine Creek, NE1/4 SW1/4 sec. 26, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Above coarse grit bed in Weberg Member of Snowshoe Formation.</td>
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<td>7</td>
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<td>R. L. Lupher, 1938. Same place as V158 in upper part of Weberg Member of Snowshoe Formation.</td>
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<td>9</td>
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<td>R. L. Lupher, 1928. Hill directly east of Wm. Harris Ranch house (abandoned) on upper part of Pine Creek, NE1/4 SW1/4 sec. 26, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Above coarse grit bed in Weberg Member of Snowshoe Formation.</td>
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<td>10</td>
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<td>R. L. Lupher, 1928. In hills a little east of Lupher’s loc. 207 and probably lower stratigraphically.</td>
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<td>11</td>
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<td>R. L. Lupher, 1930. First angular spur east of Old Wm. Harris Ranch house, southern part of N1/4 SW1/4 sec. 26, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Above coarse grit bed in Weberg Member of Snowshoe Formation.</td>
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<td>12</td>
<td></td>
<td>R. L. Lupher, 1931. From coarse grit and calcareous sandstone in lower part of griddy sequence on spur east of the Old Wm. Harris Ranch house, same location as Lupher’s loc. 208. Lower part of Weberg Member of Snowshoe Formation.</td>
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<td>13</td>
<td></td>
<td>R. L. Lupher, 1931. From brown sandstone stratigraphically above L467 at same location.</td>
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<td>14</td>
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<td>R. L. Lupher, 1931. From gully 100 ft east of Old Wm. Harris barn. Stratigraphically above L467 at same location.</td>
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<td>17</td>
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<td>R. W. Imlay, 1964. Same as loc. 29396 except 25 ft higher stratigraphically.</td>
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### MIDDLE JURASSIC (BAJOCEAN) AMMONITES FROM EASTERN OREGON

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<td>13</td>
<td>V146</td>
<td>W. O. Ross and R. W. Imlay, 1969. On north-west-facing slope of low ridge southwest from Old Harris Place, SW(\frac{1}{4})SW(\frac{1}{4})SW(\frac{1}{4})SW(\frac{1}{4})sec. 26, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Lower part of Weberg Member of Snowshoe Formation.</td>
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<td>14</td>
<td>V201</td>
<td>W. O. Ross and R. W. Imlay, 1969. Road-cut on low hill just north of area mapped as New Member of the Snowshoe Formation by Dickinson and Vigrass, 1965, west half of pl. 1, NE(\frac{1}{4})SW(\frac{1}{4})NE(\frac{1}{4})sec. 32, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Lower part of Weberg Member of Snowshoe Formation, probably 1,400-1,500 ft above base (See Dickinson and Vigrass, 1965, p. 252, Dayville 30-min quad., Grant County, Oreg. Basey Member of Snowshoe Formation).</td>
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<tr>
<td>15</td>
<td>V146</td>
<td>L. W. Vigrass, W. R. Dickson, S. W. Muller, and J. H. Beeson, 1966. Road-cut on north side of small gully running southwest from volcanic cap rock to Swamp Creek, near center of NE(\frac{1}{4})NE(\frac{1}{4})NW(\frac{1}{4})sec. 33, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Lower part of Weberg Member of Snowshoe Formation, about 1,400 ft. above base and near top of member.</td>
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<td>16</td>
<td>V201</td>
<td>R. L. Lupher, 1931. About 0.6 mile southwest of loc. 29508 (in southern part of NW(\frac{1}{4})NE(\frac{1}{4})sec. 34, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Warms Springs Member of Snowshoe Formation, lower base.</td>
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<tr>
<td>17</td>
<td>V155</td>
<td>L. W. Vigrass, S. W. Muller, W. R. Dickson, and S. W. Muller, 1966. On top of ridge, 1,100 ft. east-northeast of hairpin juncture of Swamp Creek road with road to Pine Creek, SW(\frac{1}{4})SW(\frac{1}{4})sec. 34, T. 17 S., R. 26 E., Grant County, Oreg. Top of Weberg Member of Snowshoe Formation.</td>
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<td>18</td>
<td>V130</td>
<td>L. W. Vigrass, S. W. Muller, W. R. Dickson, and J. H. Beeson, 1966. Bulldozer cut on northeast side of low ridge, 2,500 ft. east-northeast of hairpin juncture of Swamp Creek road with road to Pine Creek, SE(\frac{1}{4})NW(\frac{1}{4})sec. 34, T. 17 S., R. 26 E., Grant County, Oreg. Warms Springs Member of Snowshoe Formation, upper part.</td>
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<td>19</td>
<td>V150</td>
<td>L. W. Vigrass, S. W. Muller, W. R. Dickson, and J. H. Beeson, 1966. Bulldozer cut on southeast side of right angle bend in road along Swamp Creek, NW(\frac{1}{4})NE(\frac{1}{4})sec. 34, T. 17 S., R. 26 E., Grant County, Oreg. Middle of Weberg Member of Snowshoe Formation.</td>
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<td>19</td>
<td>V203</td>
<td>R. W. Imlay and W. O. Ross, 1966. East side of Swamp Creek in south-central part of NW(\frac{1}{4})sec. 34, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Near Vigrass’ loc. 129. Near top of Weberg Member of Snowshoe Formation.</td>
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<td>20</td>
<td>V210</td>
<td>L. W. Vigrass, S. W. Muller, W. R. Dickson, and J. H. Beeson, 1966. Crest of north-northeast nose 300 ft west of Swamp Creek, SW(\frac{1}{4})NE(\frac{1}{4})sec. 34, T. 17 S., R. 26 E., Grant County, Oreg. Near middle of Weberg Member of Snowshoe Formation.</td>
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<td>21</td>
<td>V210</td>
<td>L. W. Vigrass, S. W. Muller, W. R. Dickson, and J. H. Beeson, 1966. About 50 ft southwest of loc. 210 and possibly 50 ft higher stratigraphically in Weberg Member.</td>
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<td>22</td>
<td>V210</td>
<td>L. W. Vigrass, S. W. Muller, W. R. Dickson, and J. H. Beeson, 1966. Same location as V210 but about 20 ft higher stratigraphically in Weberg Member.</td>
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<td>23</td>
<td>V210</td>
<td>R. W. Imlay and W. O. Ross, 1966. At north end of low ridge 300 ft west of Swamp Creek, SW(\frac{1}{4})NE(\frac{1}{4})sec. 34, T. 17 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Probable same place as Vigrass’ loc. 129. Near ridge of Weberg Member of Snowshoe Formation.</td>
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<td>24</td>
<td>V210</td>
<td>R. L. Lupher, 1930. From measured section (Lupher, 1941, p. 252) east of the hairpin juncture of Swamp Creek road with road to Pine Creek, NE(\frac{1}{4})SW(\frac{1}{4})sec. 3, T. 18 S., R. 26 E., Dayville 30-min quad., Grant County, Oreg. Basey Member of Snowshoe Formation, upper part.</td>
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<td>25</td>
<td>V210</td>
<td>L. W. Vigrass, S. W. Muller, W. R. Dickson, and J. H. Beeson, 1966. On center of abandoned road at head of creek that flows past the Basey Ranch house, SW(\frac{1}{4})SE(\frac{1}{4})sec. 14, T. 18 S., R. 26 E., Crook County, Oreg. Between 2 and 4 ft above base of Weberg Member of Snowshoe Formation.</td>
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<td>26</td>
<td>V210</td>
<td>R. L. Lupher, 1930. At same place as Lupher’s loc. 301 but about 8 ft lower stratigraphically. Upper part of Weberg Member of the Snowshoe Formation.</td>
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<td>27</td>
<td>V210</td>
<td>L. W. Vigrass, S. W. Muller, W. R. Dickson, and J. H. Beeson, 1966. South side of east-northeast ridge 750 ft east of Camp Creek, NW(\frac{1}{4})NE(\frac{1}{4})sec. 1, T. 18 S., R. 26 E., Crook County, Oreg. Weberg Member of Snowshoe Formation, probably near middle.</td>
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<td>28</td>
<td>V210</td>
<td>L. W. Vigrass, S. W. Muller, W. R. Dickson, and J. H. Beeson, 1966. On center of abandoned road at head of creek that flows past the Basey Ranch house, SW(\frac{1}{4})SE(\frac{1}{4})sec. 14, T. 18 S., R. 26 E., Crook County, Oreg. Between 2 and 4 ft above base of Weberg Member of Snowshoe Formation.</td>
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<td>29</td>
<td>V210</td>
<td>R. L. Lupher, 1937. From black sandy shale on ditch bank on east side of Beaver Creek opposite lower cabin between the mouths of Warren Springs Creek and Clear Creek. Probably in SE(\frac{1}{4})SW(\frac{1}{4})sec. 8, T. 18 S., R. 30 E., Dayville 30-min quad., Grant County, Oreg. Warms Springs Member of Snowshoe Formation, probably upper part.</td>
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<td>30</td>
<td>V210</td>
<td>R. W. Imlay and W. O. Ross, 1966. On center of abandoned road at head of creek that flows past the Basey Ranch house, SW(\frac{1}{4})SE(\frac{1}{4})sec. 14, T. 18 S., R. 26 E., Crook County, Oreg. Between 2 and 4 ft above base of Weberg Member of Snowshoe Formation.</td>
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<td>31</td>
<td>V210</td>
<td>R. L. Lupher, 1930. Probable same place as Vigrass’ loc. 129. Near ridge of Weberg Member of Snowshoe Formation.</td>
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**Notes:**

1. **Loc. No. (pl. 48):** Location number and page number in parentheses indicate the geographic location of the specimen collection.
2. **Geological Survey Monocline localities:** The localities mentioned refer to specific geological survey monoclines which are used to identify and map geologic features and stratigraphic units.
3. **Collector’s field numbers:** Field numbers used by collectors to uniquely identify the specimen collection.
4. **Collector, year of collection, description of locality, and stratigraphic assignment:** Detailed information about the collector, the year of collection, the specific locality description, and the stratigraphic assignment of the specimen.
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Locality:

L206: R. L. Lupher, 1928. From shale exposed on westward-trending ridge capped with porphyry. About 1/2 mile west of Warm Springs Creek opposite the Weberg Ranch house. Probably from northern part of NE4 sec. 19, T. 18 S., R. 26 E. Dayville quad., Crook County, Oreg. Warm Springs Member of Snowshoe Formation.


L212: R. L. Lupher, 1928. Sandstone along ditch north and above Lupher's loc. 211 which is in the Warm Springs Member. Presence of Delphosites at Lupher's loc. 212 shows that it was derived from Weberg Member to the south or east and probably in the SE4 sec. 19, T. 18 S., R. 26 E., Dayville quad., Grant County, Oreg.


46 MIDDLE JURASSIC (BAJOICIAN) AMMONITES FROM EASTERN OREGON

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<tr>
<td>43</td>
<td>L229</td>
<td>R. L. Lupher, 1929, from gullies north of Old Washburn Place, NE1/4 NW1/4 SE1/4 sec. 30, T. 18 S., R. 26 E., Delimit Lake 15-min. quadr., Grant County, Oreg. Mostly upper 20 ft of sandstone beds at top of Weberg Member of Snowshoe Formation.</td>
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<tr>
<td>44</td>
<td>L228N</td>
<td>R. L. Lupher, 1928, in low hills east of Warm Springs Creek and north of Colpitts Spring. Probably mostly near center of north half of NE1/4 sec. 30, T. 18 S., R. 26 E., Delimit Lake 15-min. quadr., Grant County, Oreg. Webber Member of Snowshoe Formation, probably upper part.</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>L228</td>
<td>R. W. Imlay, 1957, in gully east of Old Washburn Place, east of road, southwest part NE1/4 NW1/4 sec. 30, T. 18 S., R. 26 E., Delimit Lake 15-min. quadr., Grant County, Oreg. Near top of Weberg Member of Snowshoe Formation.</td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>L230</td>
<td>R. W. Imlay, 1927, in gully east of Old Washburn Place in south-central part of NE1/4 NW1/4 sec. 30, T. 18 S., R. 26 E., Delimit Lake 15-min. quadr., Grant County, Oreg. From 30 ft of yellowish-gray, calcareous sandstone which is about 75 ft above base of sandstone division and 65 ft below base of limestone division of the Weberg Member of the Snowshoe Formation.</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>L229</td>
<td>R. W. Imlay, 1957, from sandy calcareous shale containing many pelecypods and directly overlying brachiopod-bearing beds at Luper's loc. 226. Forms middle part of a 40-50 ft unit that consists mostly of highly fossiliferous light-gray sandy limestone.</td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>L228</td>
<td>R. L. Lupher, 1927, in low hills east of Warm Springs Creek in vicinity of Colpitts (old Washburn) Ranch. Probably from east half of NE1/4 sec. 30, T. 18 S., R. 26 E., Delimit Lake 15-min. quadr., Grant County, Oreg. Upper part of Sonninia-bearing beds in upper part of Weberg Member of Snowshoe Formation.</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>L228</td>
<td>R. L. Lupher, 1928, in gullies north of Old Washburn Place near the middle of the Weberg Member of the Snowshoe Formation.</td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>L228</td>
<td>R. L. Lupher, 1928, from sandy calcareous shale in middle of 80-85 ft sequence in upper part of Weberg Member of Snowshoe Formation. L226 is highest stratigraphically than L228 and lower than L320.</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>L228</td>
<td>R. L. Lupher, 1928, same locality as L226. L228-229 but near top of hill. From Sonninia-bearing limestone in upper part of Weberg Member of Snowshoe Formation. Includes beds of Luper's loc. 226.</td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>L228</td>
<td>R. L. Lupher, 1928, from 1 ft of brown calcareous sandstone overlying Ichthyosaurus-bearing beds near Middle on North Ammonite Hill. Probably near center of NW1/4 sec. 20, T. 18 S., R. 26 E., Delimit Lake 15-min. quadr., Grant County, Oreg. Base of Sonninia-bearing beds in upper part of Weberg Member.</td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>L228</td>
<td>R. L. Lupher, 1927, near mouth of gully 200 ft east of county road and east of Colpitts (old Washburn) Ranch house, south-central part of NE1/4 NW1/4 sec. 30, T. 18 S., R. 26 E., Delimit Lake 15-min. quadr., Grant County, Oreg. Webber Member of Snowshoe Formation, probably upper part.</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>L228</td>
<td>R. L. Lupher, 1927, from sandy calcareous shale near the middle of the Weberg Member of the Snowshoe Formation.</td>
<td></td>
</tr>
<tr>
<td>Loc. No. (pl. 48)</td>
<td>Geological Survey Meonolc localities</td>
<td>Collector's numbers</td>
<td>Collector, year of collection, description of locality, and stratigraphic assignment</td>
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<tr>
<td>L106A</td>
<td>R. L. Lupher, 1928. No data available.</td>
<td></td>
<td>Presumably from top of Weberg Member near L106 which is in the basal part of the Warm Springs Member on divide between Beaver Creek and Warm Springs Creek on south slope of North Ammonite Hill. More exact locality unknown.</td>
</tr>
<tr>
<td>L561</td>
<td>R. L. Lupher, 1934. Same location as L560. Warm Springs Member of Snowshoe Formation, probably upper part.</td>
<td></td>
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</tr>
<tr>
<td>L600</td>
<td>R. L. Lupher, 1934. Same location as L600. Warm Springs Member of Snowshoe Formation, probably upper part.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L666</td>
<td>R. L. Lupher, 1934. Same location as L600. Lower than L561. Lower part of Snowshoe Member of Snowshoe Formation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L2775</td>
<td>L.W. Vignes and others, 1966. Builder cut on divide southwest of junction of road to Boundary Spring with Suplee-Ucular road. ESE\NW4 sec. 30, T. 18 S., R. 26 E., Delimit Lake 15-min. quadr., Grant County, Oreg. Warm Springs Member of Snowshoe Formatiion, near base.</td>
<td></td>
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</tr>
<tr>
<td>V16</td>
<td>R. W. Imlay, 1937. South side of North Ammonite Hill, on road just West of road to Boundary Spring. Same place as loc. V106, near base of Warm Springs Member of Snowshoe Formation.</td>
<td></td>
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</tr>
<tr>
<td>L206</td>
<td>R. L. Lupher, 1934. Same location as L205. Warm Springs Member of Snowshoe Formation, probably upper part.</td>
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</tr>
<tr>
<td>V14</td>
<td>R. W. Imlay, 1937. South side of North Ammonite Hill, on road just West of road to Boundary Spring. Same place as loc. V106, near base of Warm Springs Member of Snowshoe Formation.</td>
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</tr>
<tr>
<td>L106</td>
<td>R. L. Lupher, 1928. No data available.</td>
<td></td>
<td>Presumably from top of Weberg Member near L106 which is in the basal part of the Warm Springs Member on divide between Beaver Creek and Warm Springs Creek on south slope of North Ammonite Hill. More exact locality unknown.</td>
</tr>
<tr>
<td>Loc. No. (pl. 48)</td>
<td>Geological Survey Monocot localities</td>
<td>Collector's field numbers</td>
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<tr>
<td>61………… 36760</td>
<td>L306 157-7-C</td>
<td>R. W. Imlay, 1937. South side of South Ammonite Hill, SW1/4 sec. 25, T. 18 S., R. 26 E., Grant County, Oreg. Upper part of Weberg Member of Snowshoe Formation.</td>
<td></td>
</tr>
<tr>
<td>61………… 36761</td>
<td>L306 157-7-B</td>
<td>R. W. Imlay, 1937. Same description as locality 36760 except from upper third of Weberg Member.</td>
<td></td>
</tr>
<tr>
<td>61………… L306</td>
<td>L306 157-7-C</td>
<td>R. L. Lusher, 1927. Western slope of South Ammonite Hill about 600 ft south of county road and 50 ft west of a north-south trending fence. Probably SW1/4 sec. 25, T. 18 S., R. 26 E., Delinment Lake 15-min quad., Grant County, Oreg. Upper part of Weberg Member of Snowshoe Formation.</td>
<td></td>
</tr>
<tr>
<td>62………… V11</td>
<td>V11 166-7-C</td>
<td>L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. South-east of South Ammonite Hill, NE1/4 SW1/4 sec. 25, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation, 100 ft above base.</td>
<td></td>
</tr>
<tr>
<td>63………… L316</td>
<td>L316 166-7-C</td>
<td>R. L. Lusher, 1937. From 600 ft south of Sulphur Creek road and 150 ft west of Boundary Spur road between North and South Ammonite Hill. Probably in NE1/4 SW1/4 sec. 25, T. 18 S., R. 26 E., Delinment Lake 15-min quad., Grant County, Oreg. Worn Springs Member of Snowshoe Formation.</td>
<td></td>
</tr>
<tr>
<td>63………… V201</td>
<td>V201 166-7-C</td>
<td>L. W. Vigrass, W. R. Dickinson, S. W. Muller, and J. H. Beeson, 1956. Saddle between South Ammonite Hill and pyramidal hill to south. NE1/4 SW1/4 sec. 25, T. 18 S., R. 26 E., Delinment Lake 15-min quad., Grant County, Oreg. Worn Springs Member of Snowshoe Formation.</td>
<td></td>
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<tr>
<td>64………… 29401</td>
<td>V37 166-7-C</td>
<td>L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. South slope of pyramidal hill directly south of South Ammonite Hill, NE1/4 SW1/4 sec. 25, T. 18 S., R. 26 E., Grant County, Oreg. Worn Springs Member of Snowshoe Formation.</td>
<td></td>
</tr>
<tr>
<td>64………… V287</td>
<td>V287 166-7-C</td>
<td>R. L. Lusher, 1937. From long strike ridge east of Dobson Creek near center of SE1/4 sec. 28, T. 18 S., R. 26 E., Grant County, Oreg. Worn Springs Member of Snowshoe Formation.</td>
<td></td>
</tr>
<tr>
<td>65………… V287</td>
<td>V287 166-7-C</td>
<td>L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. Float along irrigation ditch 400 ft west of Freeman Creek and 1000 ft south of Bear Creek. See Fig. 48 for details.</td>
<td></td>
</tr>
<tr>
<td>67………… V287</td>
<td>V287 166-7-C</td>
<td>W. R. Dickinson, S. W. Muller, L. W. Vigrass, and J. H. Beeson, 1956. Roadcut at sharp bend in road west of Freeman Creek, SW1/4 NE1/4 sec. 27, T. 18 S., R. 26 E., Delinment Lake 15-min quad., Grant County, Oreg. Worn Springs Member of Snowshoe Formation, near top.</td>
<td></td>
</tr>
<tr>
<td>69………… D94</td>
<td>D94 166-7-C</td>
<td>R. W. Dickinson, S. W. Muller, L. W. Vigrass, and J. H. Beeson, 1956. West side of ridge southeast of Jim Robertson Ranch house, NE1/4 SW1/4 sec. 28, T. 18 S., R. 26 E., Delinment Lake 15-min quad., Grant County, Oreg. Worn Springs Member of Snowshoe Formation, near middle.</td>
<td></td>
</tr>
<tr>
<td>70………… V87 = D98</td>
<td>V87 = D98 166-7-C</td>
<td>L. W. Vigrass, S. W. Muller, W. R. Dickinson, and J. H. Beeson, 1956. On west slope of ridge east of Robbons Creek, near center of NE1/4 sec. 28, T. 18 S., R. 26 E., Grant County, Oreg. Weberg Member of Snowshoe Formation, 50 ft above base.</td>
<td></td>
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<tr>
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<tr>
<td>79</td>
<td>29183</td>
<td>196-7-9C</td>
<td>W. O. Ross and R. W. Imlay, 1969. Roadcut in SE4 of NW4 sec. 22, T. 18 S., R. 26 E., Delunitent Lake 15-min quad., Grant County, Oreg. Basey Member of Snowshoe Formation, probably at least 800 ft above base in area where member is about 1,400 ft thick.</td>
</tr>
<tr>
<td>80</td>
<td>29197</td>
<td>196-7-9D</td>
<td>W. R. Dickinson and S. W. Muller, 1957. Low roadcut in valley of Freeman Creek, South central part of NE4 of NW4 sec. 3, T. 19 S., R. 26 E., Delunitent Lake 15-min quad., Hancock County, Oreg. Warm Springs Member of Snowshoe Formation, near top.</td>
</tr>
<tr>
<td>83</td>
<td>29188</td>
<td>196-7-10C</td>
<td>R. W. Imlay and W. O. Ross, 1969. Roadcut just east of small stream that flows into Dobson Creek. SE corner of NE4 of NW4 sec. 4, T. 19 S., R. 26 E., Delunitent Lake 15-min quad., Hancock County, Oreg. Basey Member of Snowshoe Formation, probably at least 400 ft above base in area where member is about 2,000 ft thick.</td>
</tr>
<tr>
<td>85</td>
<td>29190</td>
<td>196-7-10E</td>
<td>R. W. Imlay and W. W. Imlay, 1969. Cut on road to Allison guard station. SE corner of NS4 of SE4 sec. 19 S., R. 26 E., Delunitent Lake 15-min quad., Hancock County, Oreg. Basey Member of Snowshoe Formation, about 400 ft above base in area where member is about 1,000 ft thick.</td>
</tr>
<tr>
<td>86</td>
<td>29191</td>
<td>196-7-10F</td>
<td>W. O. Ross and R. W. Imlay, 1969. Roadcut on hilltop of road to Allison guard station. Probably same place as Dickinson's locality 101. NE1 of SE4 sec. 19 S., R. 26 E., Delunitent Lake 15-min quad., Hancock County, Oreg. Basey Member of Snowshoe Formation, about 400 ft above base in area where member is about 1,000 ft thick.</td>
</tr>
<tr>
<td>87</td>
<td>29192</td>
<td>196-7-10G</td>
<td>W. O. Ross and R. W. Imlay, 1969. Roadcut on road in west fork of Mowich Creek. NE corner of SE4 of NW4 sec. 19 S., R. 26 E., Delunitent Lake 15-min quad., Hancock County, Oreg. Basey Member of Snowshoe Formation, about 800 ft above base in area where member is about 1,000 ft thick.</td>
</tr>
<tr>
<td>90</td>
<td>29195</td>
<td>196-7-10J</td>
<td>W. R. Imlay and W. O. Ross, 1966. Cut on south side of road around north side of Big Mowich Mountain, near center of NE4 of NW4 sec. 19 S., R. 26 E., Delunitent Lake 15-min quad., Hancock County, Oreg. Basey Member of Snowshoe Formation, about 800 ft above base in area where member is about 1,000 ft thick.</td>
</tr>
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**GEOGRAPHIC DISTRIBUTION**

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<thead>
<tr>
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<tr>
<td>94</td>
<td>29199</td>
<td>196-7-10N</td>
<td>R. W. Imlay and W. R. Dickinson, 1957. Roadcut on main road from John Day to Izeez about 100 yards up road from outcrop of conglomerate, SW4 of SE4 sec. 22, T. 16 S., R. 29 E., Izeez 15-min quad., Grant County, Oreg. Snowshoe Formation, base of upper member just above Silo Member.</td>
</tr>
<tr>
<td>95</td>
<td>29200</td>
<td>196-7-10O</td>
<td>R. W. Imlay and R. W. Dickinson, 1967. Roadcut on west side of road through Silo Creek. NE corner of SE4 of NW4 sec. 6, T. 17 S., R. 17 E., Izeez 15-min quad., Grant County, Oreg. Snowshoe Formation, lower part of middle member, about 700 ft above base of formation.</td>
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<td>98</td>
<td>29203</td>
<td>196-7-10R</td>
<td>W. O. Ross and W. W. Imlay, 1969. Roadcut on southwest side of Lewis Creek. NE corner of NE4 of SE4 sec. 6, T. 17 S., R. 26 E., Izeez 15-min quad., Grant County, Oreg. Snowshoe Formation, lower part of middle member, about 750 ft above base of formation.</td>
</tr>
<tr>
<td>Loc. No. (pl. 48)</td>
<td>Geological Survey Monocle localities</td>
<td>Collector's field numbers</td>
<td>Collector, year of collection, description of locality, and stratigraphic assignment</td>
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<tr>
<td>102.</td>
<td>L75</td>
<td>R. L. Lupher, 1957.</td>
<td>On north side of knoll about 100 ft south of sharp bend in road and 300 ft south of South Fork Bridge, SW1/4 sec. 17 S., R. 28 E., llee 15 min. qaud., Grant County, Ore. Snowshoe Formation, middle member, about 170 ft above base of formation.</td>
</tr>
<tr>
<td>103.</td>
<td>D102</td>
<td>R. W. Imlay, R. L. Dickinson, and L. W. Vigran, 1956.</td>
<td>Black mudstone and siltstone on open area north of Flat Creek, NE4NW4 sec. 15, T. 18 S., R. 27 E., llee 15 min. qaud., Grant County, Ore. Probably same place as Dickinson's loc. 102, Snowshoe Formation, middle member.</td>
</tr>
<tr>
<td>104.</td>
<td>165-7-4C and D112</td>
<td>W. O. Ross and R. W. Imlay, 1950.</td>
<td>About 250 yd southeast of South Fork Bridge, on spur east of mouth of Sheep Creek, NE4SW4 sec. 30, T. 17 S., R. 28 E., llee 15 min. qaud., Grant County, Ore. Lower member of Snowshoe Formation, about 250 ft above base.</td>
</tr>
<tr>
<td>105.</td>
<td>165-7-16C and D113</td>
<td>R. W. Imlay, 1957.</td>
<td>On low, narrow spur parallel to old meadow along south side of South Fork of John Day River, North-central part of SW1/4SE1/4 sec. 30, T. 17 S., R. 28 E., llee 15 min. qaud., Grant County, Ore. Lower member of Snowshoe Formation, about 225 ft above base.</td>
</tr>
<tr>
<td>106.</td>
<td>L71</td>
<td>R. L. Lupher, 1957.</td>
<td>Half mile east of South Fork Bridge and one-fourth of a mile south of South Fork of John Day River at head of small alluvial fan in a large draw, probably NE4NW4 sec. 33, T. 18 S., R. 28 E., llee 15 min. qaud., Grant County, Ore. Snowshoe Formation, middle member, at least 1,500 ft above base of formation.</td>
</tr>
<tr>
<td>107.</td>
<td>D114</td>
<td>W. R. Dickinson, 1957.</td>
<td>On north side of South Fork of John Day River and on east slope of the largest gully between Sheep Creek and Buck Creek, NE4NW4 sec. 31, T. 17 S., R. 28 E., llee 15 min. qaud., Grant County, Ore. Snowshoe Formation, near top of middle member.</td>
</tr>
<tr>
<td>109.</td>
<td>165-7-19A and D105</td>
<td>R. W. Imlay, L. R. Luper, and J. P. Eves, 1957.</td>
<td>Bed of Flat Creek, SW1/4SW1/4 sec. 10 (near south side), T. 18 S., R. 28 E., llee 15 min. qaud., Grant County, Ore. Lower member of Snowshoe Formation, 125-175 ft above base.</td>
</tr>
<tr>
<td>110.</td>
<td>165-7-12B and D106</td>
<td>R. W. Imlay, 1957.</td>
<td>Bed of Flat Creek, about half way between localities 26753 and 26754. Lower member of Snowshoe Formation, about 185-190 ft above base.</td>
</tr>
<tr>
<td>111.</td>
<td>165-7-17C</td>
<td>R. W. Imlay, 1957.</td>
<td>Bed of Flat Creek, SW1/4SW1/4 sec. 10, T. 18 S., R. 28 E., llee 15 min. qaud., Grant County, Ore. Lower member of Snowshoe Formation, about 200 ft above base.</td>
</tr>
<tr>
<td>112.</td>
<td>165-7-17A and D107</td>
<td>R. W. Imlay, 1957.</td>
<td>Bed of Flat Creek, SW1/4SW1/4 sec. 10, T. 18 S., R. 28 E., llee 15 min. qaud., Grant County, Ore. Lower member of Snowshoe Formation, about 250 ft above base.</td>
</tr>
<tr>
<td>113.</td>
<td>D108(66-47)</td>
<td>S. W. Muller, 1956.</td>
<td>On east slope of canyon of Flat Creek about 100 ft above bed of creek, NE4NW4 sec. 15, T. 18 S., R. 27 E., llee 15 min. qaud., Grant County, Ore. Lower member of Snowshoe Formation, about 250 ft above base.</td>
</tr>
<tr>
<td>114.</td>
<td>165-7-13B</td>
<td>R. L. Lupher, 1957.</td>
<td>On east side of Flat Creek, 100 ft above stream bed, and 250 yards N. 29° W. from mouth of first main tributary that comes into Flat Creek from the west below Big Flat, probably south-central part of NW1/4 sec. 15, T. 18 S., R. 27 E., llee 15 min. qaud., Grant County, Ore. Probably same place as Lupher's loc. 128, Snowshoe Formation, middle member.</td>
</tr>
<tr>
<td>115.</td>
<td>165-7-30B</td>
<td>R. W. Imlay, W. L. Eves, and L. W. Vigran, 1956.</td>
<td>Black mudstone and siltstone on open area south of Flat Creek, NE4NW4 sec. 15, T. 18 S., R. 27 E., llee 15 min. qaud., Grant County, Ore. Probably near Lupher's loc. 128, Snowshoe Formation, 600 ft below top in middle member.</td>
</tr>
<tr>
<td>Loc. No.</td>
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<tr>
<td>118</td>
<td>L54</td>
<td>R. L. Lupher, 1927</td>
<td>Shales in first roadcut at Seneca at north end of Silvis Canyon, NW 1/4 NW 1/4 sec. 1, T. 17 S., R. 31 E., Seneca 15-min. quad., Grant County, Oreg. Snowshoe Formation.</td>
</tr>
<tr>
<td>119</td>
<td>L35</td>
<td>R. L. Lupher, 1927</td>
<td>Float from middle (7) part of conglomerate exposed at Lupher's loc. 5.</td>
</tr>
<tr>
<td>120</td>
<td>L28</td>
<td>A. K. Guard, 1927</td>
<td>Conglomerate sandstone about 40 ft thick on ridge northeast of road above slopes of Lupher's loc. 28 at north edge of Soda Valley. Most fossils collected from talus between outcrop of conglomerate and road. All fossils belong to the Mesozoic. NE1/4 NW1/4 sec. 2, T. 17 S., R. 31 E., Seneca 15-min. quad., Grant County, Oreg. Snowshoe Formation.</td>
</tr>
<tr>
<td>121</td>
<td>L36</td>
<td>R. L. Lupher, 1927</td>
<td>Float from lower part of conglomerate exposed at Lupher's loc. 6.</td>
</tr>
<tr>
<td>122</td>
<td>L28</td>
<td>A. K. Guard, 1927</td>
<td>Conglomerate sandstone about 40 ft thick on ridge northeast of road above slopes of Lupher's loc. 28 at north edge of Soda Valley. Most fossils collected from talus between outcrop of conglomerate and road. All fossils belong to the Mesozoic. NE1/4 NW1/4 sec. 2, T. 17 S., R. 31 E., Seneca 15-min. quad., Grant County, Oreg. Snowshoe Formation.</td>
</tr>
<tr>
<td>123</td>
<td>L28</td>
<td>A. K. Guard, 1927</td>
<td>Conglomerate sandstone about 40 ft thick on ridge northeast of road above slopes of Lupher's loc. 28 at north edge of Soda Valley. Most fossils collected from talus between outcrop of conglomerate and road. All fossils belong to the Mesozoic. NE1/4 NW1/4 sec. 2, T. 17 S., R. 31 E., Seneca 15-min. quad., Grant County, Oreg. Snowshoe Formation.</td>
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<tr>
<td>126</td>
<td>L272</td>
<td>R. L. Lupher, 1927</td>
<td>From baked shale near porphyry intrusion exposed on west side of old road from Silvis Canyon, NW1/4 NW1/4 sec. 2, T. 17 S., R. 31 E., Seneca 15-min. quad., Grant County, Oreg. Snowshoe Formation.</td>
</tr>
</tbody>
</table>

**Geographic Distribution**

<table>
<thead>
<tr>
<th>Loc. No.</th>
<th>Geological Survey Mesozoic localities</th>
<th>Collector’s field numbers</th>
<th>Collector, year of collection, description of locality, and stratigraphic assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>127</td>
<td>186-7-10A</td>
<td>W. O. Ross, 1906</td>
<td>Same place as Mesozoic loc. 2822 and probably same as Lupher’s loc. 6, NW1/4 sec. 3, T. 17 S., R. 31 E., Seneca 15-min. quad., Grant County, Oreg. Snowshoe Formation.</td>
</tr>
<tr>
<td>128</td>
<td>L28</td>
<td>A. K. Guard, 1927</td>
<td>Float from middle (7) part of conglomerate exposed at Lupher's loc. 5.</td>
</tr>
<tr>
<td>129</td>
<td>L136</td>
<td>R. L. Lupher, 1927</td>
<td>Float from middle (7) part of conglomerate exposed at Lupher's loc. 5.</td>
</tr>
<tr>
<td>130</td>
<td>L136</td>
<td>R. L. Lupher, 1927</td>
<td>Float from middle (7) part of conglomerate exposed at Lupher's loc. 5.</td>
</tr>
<tr>
<td>131</td>
<td>L55</td>
<td>R. L. Lupher, 1927</td>
<td>Same place as Mesozoic loc. 2822 and probably same as Lupher’s loc. 6, NW1/4 sec. 3, T. 17 S., R. 31 E., Seneca 15-min. quad., Grant County, Oreg. Snowshoe Formation.</td>
</tr>
<tr>
<td>132</td>
<td>L28</td>
<td>A. K. Guard, 1927</td>
<td>Conglomerate sandstone about 40 ft thick on ridge northeast of road above slopes of Lupher's loc. 28 at north edge of Soda Valley. Most fossils collected from talus between outcrop of conglomerate and road. All fossils belong to the Mesozoic. NE1/4 NW1/4 sec. 2, T. 17 S., R. 31 E., Seneca 15-min. quad., Grant County, Oreg. Snowshoe Formation.</td>
</tr>
</tbody>
</table>
except the Izee area. Bajocian ammonites occur in the lowest 125 feet, which is of Toarcian age, or in the Suplee area, which is farthest west, Bajocian times.


SUMMARY OF RESULTS

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

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

The middle Bajocian is well represented in many areas. Beds equivalent to the _Hyperlioceras discites_ subzone at the base of the _Sonninia sovrenyi_ zone include such ammonites as _Sonninia_ (Euhoplloceras), _Sonninia_ (Papilliceras), _Asthenoceeras_, _Endemoceras_, _Fontannesia_, _Hbetozites_, _Praestrigites_, _Strigoceras_, _Pelekodites_, and _Docidoceras_. Most of this assemblage has been found only in the Weberg Member of the Snowshoe Formation in the Suplee area. It comprises two faunas of which the upper may be distinguished from the lower by the presence of _S. (Euhoplloceras) adica_ (Waagen), _S. (E.) crassispinata_ Buckman, _Docidoceras lapheri_ Imlay, n. sp., and _Witchellia_ (Latiwitchellia) new subgenus. Beds of the same general age, identified by the presence of _Fontannesia_, occur also farther east in Oregon in the Clover Creek and the Juniper Mountain areas.

This ammonite assemblage, corresponding to the basal part of the _Sonninia sovrenyi_ zone, has much more in common with ammonites of the same age in Europe than in Alaska. Thus eastern Oregon and Europe contain the same highly variable species, or subspecies of _Sonninia_ (Euhoplloceras). Other species in common probably include most of those ammonites that are herein compared with European species of _Fontannesia_, _Endemoceras_, _Praestrigites_, _Strigoceras_, _Hbetozites_ and _Docidoceras_. Differences with Europe consist mainly of the absence of _Hyperlioceras_ and the presence of _Latiwitchellia_, n. subgen., _Asthenoceeras_, and _Papilliceras_. Resemblances with Alaska include the presence of similar, or possibly identical, species of _Endemoceras_, _Hbetozites_, _Asthenoceeras_, and _Pelekodites_. Differences with Alaska include the absence of _Fontannesia_, _Latiwitchellia_, _Papilliceras_, _Strigoceras_, and _Praestrigites_ and the absence in Oregon of _Pseudolioceras_, _Alaskoceras_, and _Pseudodocidoceras_. Part of these differences may reflect collecting failure, but part probably reflects facies or environmental differences related to the much greater amount of calcium carbonate deposited in Oregon at that time than in Alaska.

Beds equivalent to the _Shirburnia trigonalis_ and _Witchellia laurina_ subzones of the _Sonninia sovrenyi_ zone have been identified only in the Suplee area in the topmost beds of the Weberg Member and in the lower part of the Warm Springs Member of the Snowshoe Formation. These beds are characterized through-
out by the presence of *Witchellia connata* (Buckman), *Soninium* (*Papilliceras*) *stantoni* (Crickmay), *Asthenoceras delicatum* Imlay, n. sp., and *Stephanoceras* spp. In addition the basal beds of the Warm Springs Member contain *Fontannesia intermedia* Imlay, n. sp. The highest beds in the Weberc Member contain that species as well as *Stephanoceras juhlei* Imlay, S. cf. *S. dolichoceras* (Buckman), S. aff. *S. nodosum* (Quenstedt), *Soninium* (*Papilliceras*) *stantoni* (Crickmay), and apparently also *Soninium* (*Euhoploceras*) sp., and *Witchellia* (*Latwitchellia*) *evoluta* Imlay, n. sp. at the top of their range.

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

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

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

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

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

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

Beds equivalent to the lower part of the upper Bajocian of Europe contain the ammonites *Leptosphinctes*, *L. (Prorsisphinctes?)*, *Spiriceras*, *Sphaeroceras*, *Normannites*, *Stephanoceras*, *Teloceras*? *Zemistephanus*?, the new genus *Lupherites*, and probably *Megasphaeroceras*. This faunule occurs (1) at and near the top of the Snowshoe Formation west and immediately south of Seneca and (2) much farther east in unnamed beds in the Juniper Mountains south of Brogan, and (3) in the Huntington area. It bears stronger affinities with upper Bajocian ammonites of Europe than of Alaska. Species in common with Europe include *Spiriceras bifurcatum* (Quenstedt) and *S. annulatum* (Deshayes).
Species closely similar to species in Europe include *Sphaerocras* cf. *S. bronquiat* (J. de C. Sowerby), *Normannites* aff. *N. orbignyi* Buckman, and *Leptosphinctes* cf. *L. leptus* Buckman. Species identical with Alaskan species includes only *Megasphaerocras rotundum* Imlay but probably includes *Leptosphinctes* cf. *L. evolutus* Imlay. The upper Bajocian ammonites from eastern Oregon differ from those in Europe in lacking any species of the *Parkinsoniidae* and in having *Megasphaerocras*. They differ from those in Alaska in having different species of *Normannites* and *Sphaerocras*, in lacking representatives of *Lissoceras* and *Oppelia* (Liraxyites) and in having a fair abundance of *Spiroceras* which genus is questionably represented in Alaska.

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

Bajocian ammonites from eastern Oregon are assigned to 12 families and 42 genera and subgenera. The *Sominiidae*, *Hildoceratidae*, and *Stephanoceratidae* are the dominant families, constituting 53 percent of the specimens and 52 percent of the genera and subgenera present. The six most common genera in decreasing order of abundance are *Asthenoceeras*, *Sominiia*, *Dorsetensia*, *Stephanoceras*, *Pelekolithes*, and *Timetoceras*. One new genus *Lupherites* resembles *Polyplectites*. One new subgenus *Witchellia* (Latiwitchellia) resembles "Zugophorites" Buckman. Eighteen new species are described.

**SYSTEMATIC DESCRIPTIONS**

**Family PHYLLOCERATIDAE** Zittel, 1884

**Genus PHYLLOCERAS** Sowerby, 1865

*Phylloceras* spp.

Plate 1, figures 17, plate 2, figure 9

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

*Figured specimens.*—USNM 168490 and CAS 13327.

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

**Genus CALLIPHYLLOCERAS** Spath, 1927

*Calliphylloceras* sp.

Plate 1, figures 1, 2

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

*Figured specimen.*—Stanford University Museum Paleontology 10006.

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

**Genus HOLCOPHYLLOCERAS** Spath, 1927

*Holophylloceras* sp.

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

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

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

*Figured specimens.*—CAS 13328–13330.

*Occurrence.*—Snowshoe Formation, Weberg Member at USGS Mesozoic locs. 21611, 26768, 27735, Lupher’s locs. 210, 228N, and 313, and Vigrass’ loc. 155; Warm Springs Member at Mesozoic locs. 26767, 29239, Lupher’s locs. 206, 211, 235, 237, 476, 561, 566, and Vigrass’ locs. 10 and 149; Basey Member at Mesozoic locs. 26769 and 29818; lower member at Mesozoic loc. 29237 and Lupher’s loc. 75; middle member at Mesozoic loc. 26773. Also present in unnamed beds in the Juniper Mountain area of Malheur County at Mesozoic loc.
The species is represented by 6 specimens from the Weberg Member, 35 from the Warm Springs Member, 3 from the lower member, and 1 from each of the other members or units listed.

Family SPIROCERATIDAE Hyatt, 1900
Genus SPIROCEAE Quenstedt, 1858

Spiroceras bifurcatum (Quenstedt)
Plate 1, figures 3-8.

Hamites bifurcatum Quenstedt, 1858, pl. 55, figs. 1-12.
Hamites bifurcatum Quenstedt, 1886, pl. 70, figs. 27-44.
Ancyloceras tenue Douville (not d'Orbigny), 1916, pl. 3, figs. 12a, b.

Spiroceras bispinatum (Baugier and Sauzé), Roman and Petournaud, 1927, pl. 3, figs. 13-20, pl. 4, figs. 1-13, pl. 5, figs. 7-11.

Spiroceras bifurcatum (Quenstedt). Potonie, 1929, pl. 17, figs. 4-8, pl. 18, figs. 26-28.

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

Types.—Hypotypes, USNM 168491-168495.

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

Spiroceras annulatum (Deshayes)
Plate 1, figures 9-16.

Ancyloceras annulatum Deshayes, d'Orbigny, 1850, p. 576, pl. 225, figs. 1-7.
Ancyloceras tenue Douville (not d'Orbigny), 1916, pl. 3, figs. 11a, b, 13a, b.

Ancyloceras toxozonicum Buckman, 1924, Type Ammonites, v. 5, pl. 402.

Spiroceras annulatum (Deshayes). Roman and Petournaud, 1927, p. 33, pl. 3, fig. 21, pl. 5, fig. 15-19.


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

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

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

Family HILDOCERATIDAE Hyatt, 1867
Genus ASTHENOCERAS Buckman, 1899

Asthenoceras delicatum Imlay, n. sp.
Plate 3, figures 1-32, plate 4, figures 3-6

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

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

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

The finely ribbed septate whorls are characterized by fine, dense, gently falcoid unforked ribs and striae that extend from the umbilical seam to the keel, become slightly stronger ventrally, and project forward on the margins of the venter. In addition, these septate whors generally bear low broad radial swellings or undulations on the lower parts of their flanks. Adorally on the penultimate whorl and on the body chamber of the finely ribbed specimens, the ribs gradually become a little stronger, more widely spaced, more falcoid; some bifurcate near the middle of the flanks, and some arise on the flanks as continuations of striae.
The moderately to coarsely ribbed variant differs from the finely ribbed variant in having coarser and more widely spaced ribs and more distinct rib furcation, and in lacking radial swellings on their septate whorls. Ten of these specimens (pl. 3, figs. 1-11) in particular have so much coarser ribbing than the finely ribbed specimens that they would normally be assigned to a different species except for the presence of a number of transitional forms (pl. 3, figs. 12-14).

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

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

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Diameter</th>
<th>Whorl</th>
<th>Whorl</th>
<th>Umbilical</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>width</td>
<td>height</td>
<td>thickness</td>
</tr>
<tr>
<td>Holotype (pl. 3, figs. 19, 20)</td>
<td>27</td>
<td>9.5(0.35)</td>
<td>7.5(0.26)</td>
<td>11(0.41)</td>
</tr>
<tr>
<td>Paratype (pl. 3, fig. 20)</td>
<td>20</td>
<td>8 (0.36)</td>
<td>6.5(0.32)</td>
<td>7 (0.35)</td>
</tr>
<tr>
<td>Paratype (pl. 3, fig. 27)</td>
<td>21</td>
<td>8 (0.36)</td>
<td>6 (0.26)</td>
<td>8.2 (0.38)</td>
</tr>
<tr>
<td>Paratype (pl. 3, figs. 5, 6)</td>
<td>25</td>
<td>11 (0.40)</td>
<td>10.5(0.37)</td>
<td>10 (0.41)</td>
</tr>
<tr>
<td>Paratype (pl. 3, fig. 7)</td>
<td>28</td>
<td>9 (0.37)</td>
<td>7.5 (0.27)</td>
<td>12 (0.43)</td>
</tr>
<tr>
<td>Paratype (pl. 3, figs. 5, 6)</td>
<td>32</td>
<td>11.5 (0.46)</td>
<td>9 (0.36)</td>
<td>18 (0.44)</td>
</tr>
</tbody>
</table>

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

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

Occurrence.—Snowshoe Formation, Webberg Member at Lusher's pools. 228, 228N, 305, 306, 313, 474, and 609, Vigrass' locs. 15, 16, and 112, USGS Mesozoic locs. 21611, 26768, 27735, 29827, 29828; Warm Springs Member at Lusher's pools. 116, 206, 232, 298, 316, 482, 560, and 561, Vigrass' locs. 10, 18, 166, and 403, USGS Mesozoic locs. 29239 and 29240; lower member near Ize at Mesozoic locs. 26756 and 26758; Snowshoe Formation undifferentiated at Lusher's loc. 490 in Silvies Canyon; basal beds of Basey Member at Dickinson's loc. 100; unnamed beds at USGS Mesozoic locs. 28831 and 28837 on Juniper Mountain in the Brogan quadrangle, Malheur County.

This species in the Suplee area ranges from the middle part of the Webberg Member into the basal part of the Basey Member. This range, on the basis of associated ammonites, corresponds with the European Soninna icsonbiy zone and the Otoites sauei zone. It occurs higher, therefore, than A. nannodes (Buckman) from the Ludwigia murchisoniæ zone of England (Buckman, 1889, p. 214).

**Asthenoceras? sp.**

Plate 35, figure 10

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

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

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

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

**Figure specimen.—USNM 168505.**

Occurrence.—Snowshoe Formation, upper part of Webberg Member at USGS Mesozoic loc. 21611.
Genus **Fontannesia** Buckman, 1902

Fontannesia costula Imlay, n. sp.

Plate 4, figures 16-26

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

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

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

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

In its smooth appearance, this species resembles some specimens of *Fontannesia whitehousei* Arkell (1934, p. 566, pl. 29, figs. 3, 6, 8) from western Australia. That species, however, has strongly ribbed inner septate whors and completely smooth outer whors, whereas on the Oregon species the ribs are faint to weak on all whors and are strongest on the body chamber.

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

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

**Occurences.**—Snowshoe Formation, Weberg Member at Luphr's locs. 228, 228N, 370 and 584, Viggrass' locs. 8 and 241, and USGS Mesozoic loc. 29828.

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

Fontannesia intermedia Imlay, n. sp.

Plate 4, figures 7-15

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

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

**Fontannesia intermedia** Imlay, n. sp. differs from *F. luculentula* Buckman (1905, p. CLXXXIX; 1902, pl. 46, figs. 4, 5, 8, pl. 47, figs. 10–12) from England and from the Oregon specimens herein compared with that species in having finer, denser ribbing, a distinctly higher keel, more evolute coiling, and a more compressed shell. Compared with species from western Australia, it shows some resemblance to the densely ribbed variety of *F. clarkei* (Crick) figured by Arkell (1934, pl. 29, figs. 1, 2, pl. 30, fig. 2) but differs by having finer ribbing on its inner whors, and much coarser ribbing on its outer whors. It is more evolute and has much finer ribbing on its inner whors than some specimens of *Fontannesia* from New Guinea described by Westermann and Getty (1970, p. 238–244, pls. 48, 49).

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

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

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

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

*Fontannesia cf. F. luculenta* Buckman

Plate 5, figures 14-19

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

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

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

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

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

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

*Figured specimens.*—CAS 13355 and 13356.

*Fontannesia cf. F. carinata* Buckman

Plate 5, figures 4-13


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

The ribs are strongly falcoid, fairly coarse and moderately spaced. On septate specimens the ribs begin weakly on the umbilical wall, become strong on the flanks, are strongest on the margins of the venter, and then fade out rather abruptly before reaching the keel. Most ribs remain simple, but a few bifurcate a little below the middle of the flanks. Adorally on the body chamber the ribs fade out on the umbilical wall, become less falcoid but stronger on the flanks, and are projected across the venter as broad low swellings.
The suture line has a moderately broad, bifid first lateral saddle, an equally broad trifid first lateral lobe that is a little longer than the ventral and second lateral lobes.

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

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

*Figured specimens.*—CAS 13357–13361.

*Occurrence.*—Snowshoe Formation, middle and upper parts of Weber Member at USGS Mesozoic locs. 26768 and 29824; Lpher's loc. 226, 228, 228X, 355; and Vigrass' loc. V121a.

*Fontannesia* cf. *P. evoluta* (Buckman)

Plate 5, figures 1–3

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

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

*Figured specimen.*—Stanford University Museum of Paleontology 10018.

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

**Genus TMETOCERAS** Buckman, 1892

*Tmetoceras scissum* (Benecke)

Plate 2, figures 1–6

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

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

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

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

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

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

*Occurrence.*—Snowshoe Formation. (1) from 125 to 200 feet above base of lower member at USGS Mesozoic locs. 26752, 26753, and 26755; (2) from Weber Member at Vigrass' locs. 3, 121a, 155 and 158, Lpher's locs. 207, 208, 366, 411, 466, 467 and 583, and USGS Mesozoic locs. 26764, 27374, 29820, 29821 and 29822; (3) questionably from basal bed of *Warm Spring* Member at Vigrass' loc. 18; (4) unnamed beds in Juniper Mountain area of the Brogan quadrangle, Malheur County, at USGS Mesozoic locs. 28373 and 28374; (5) unnamed beds in the Huntington quadrangle, Baker County, at USGS Mesozoic loc. 29784; and (6) probably represented in the Bridgeport quadrangle, Malheur County, at Mesozoic loc. 27583.
Eudmetoceras (Euaptetoceras) cf. E. (E.) hauthali (Burckhardt)  
Plate 6, figures 6–9

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

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

_figured specimens._—USNM 168506.  
Occurrence.—Snowshoe Formation, highest part of Weberg Member at USGS Mesozoic loc. 29400 near the eastern pinchout of the member.

Eudmetoceras (Euaptetoceras) cf. E. (E.) klimakomphalum (Vacek)  
Plate 6, figures 10–18

cf. Harpoceras klimakomphalum Vacek, 1886, p. 81, pl. 8, figs. 16a, b, 17a, b.  
cf. Eudmetoceras (Euaptetoceras) klimakomphalum (Vacek). Seyed-Emami, 1967, p. 94, pl. 3, figs. 9 and 10; pl. 11, fig. 5.  
cf. Hammatoceras (Pseudaptetoceras) klimakomphalum (Vacek). Geczy, 1968, p. 78, pl. 19, fig. 2, pl. 40, fig. 11.  
Eudmetoceras (Euaptetoceras) klimakomphalum (Vacek). See Westermann, 1969, p. 74, 75 for additional references to species.

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

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

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

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

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

_figured specimens._—USNM 168507, 168508.  
Occurrence.—Snowshoe Formation, highest part of Weberg Member at USGS Mesozoic locs. 29817 and 29400 near the eastern pinchout of the Weberg Member.

Eudmetoceras (Euaptetoceras) cf. E. (E.) amaltheiforme (Vacek)  
Plate 6, figures 1–5

cf. Harpoceras amaltheiforme Vacek, 1886, p. 81, pl. 9, figs. 1–4.  
cf. Hammatoceras (Pseudaptetoceras) amaltheiforme (Vacek). Geczy, 1968, p. 82, pl. 21, fig. 5.  
cf. Eudmetoceras (Euaptetoceras) amaltheiforme (Vacek). Bremer, 1965, p. 156, pl. 15, figs. 2a,b.  
cf. Eudmetoceras (Euaptetoceras) amaltheiforme (Vacek). Seyed-Emami, 1967, p. 91–94, pl. 3, fig. 8, pl. 11, figs. 1a,b, 2a,b.

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

The specimen at a diameter of 64 mm has a whorl height of 20 mm, a whorl thickness of 16 mm, and an umbilical width of 15 mm. The suture line has a broad, deep and trifid first lateral lobe that is nearly twice as long as the second lateral lobe and slightly longer than the ventral lobe. The suspensive lobe trends nearly straight to the umbilical seam.

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

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

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

*Figured specimen.—CAS 13364.*

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

**Genus PLANAMMATOCERAS** Buckman, 1922

*Planammatoceras* sp.

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

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

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

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

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

*Figured specimens.—USNM 168509–168511.*

*Occurrence.—Snowshoe Formation, lower member at USGS Mesozoic locs. 26753 and 26755. At these localities *Planammatoceras*? is associated with *Tmetoceras scissum* (Benecke) in dark siltstone from 125–200 feet above the base of the Snowshoe Formation. Their lowest occurrence is about 50 feet above beds containing *Haugia* of late Toarcian age (Imlay, 1968, p. C14, C46, pl. 9, figs. 14, 15, 17, 18).
Family **SONNINIIDAE** Buckman, 1892  
Genus **SONNINIA** Bayle, 1879  
**Soninia** cf. *S. nodatipinguis* (Buckman)  
Plate 13, figures 1-4

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

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

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

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

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

**Figured specimens.**—CAS 13365–13368.

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

**Subgenus EUHOPLOCERAS** Buckman, 1913  
**Soninia** (Euhoploceras) *modesta* Buckman  
Plates 7–10

*Soninia modesta* Buckman, 1892, p. 325, pl. 68, pl. 70, fig. 5; 1894, pl. 95, figs. 3–5 (holotype).  
*Soninia simplex* Buckman, 1892, p. 326, pl. 70, figs. 2–4.  
*Soninia substratiata* Buckman, 1892, p. 330, pl. 70, figs. 6, 7, pl. 71, figs. 6–8.  
*Soninia parcwestata* Buckman, 1892, p. 339, pl. 75, figs. 3–5.  
*Soninia nuda* Buckman, 1893, p. 352, pl. 82, figs. 3, 4.  
*Soninia inaequa* Buckman, 1894, p. 400, pl. 101, figs. 4–6.  
*Soninia modesta* Buckman, 1894, p. 422, pl. 95, figs. 3–5; pl. 96, figs. 1, 2.  
*Soninia sub simplex* Buckman, 1894, p. 427, pl. 95, figs. 6–8.  
*Soninia modesta* Buckman. Hiltermann, 1939, p. 153, pl. 10, figs. 5, 6, pl. 11, fig. 1.

*Soninia modesta modesta* Buckman. Oechsle, 1958, p. 111, pl. 13, fig. 7, pl. 14, fig. 8, pl. 16, fig. 5.  
*Soninia modesta substratiata* Buckman. Oechsle, 1958, p. 111, pl. 13, fig. 6, pl. 14, fig. 7, pl. 19, fig. 3.  
*Soninia modesta nodingensis* Oechsle, 1958, p. 111, pl. 13, fig. 5, pl. 14, fig. 6, pl. 18, fig. 1.

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

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

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

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

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

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

<table>
<thead>
<tr>
<th>Specimens</th>
<th>Diameter</th>
<th>Whorl height</th>
<th>Whorl thickness</th>
<th>Umbilical width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypotype (pl. 7, fig. 5)</td>
<td>153</td>
<td>68 (0.44)</td>
<td>48 (0.31)</td>
<td>59 (0.37)</td>
</tr>
<tr>
<td>Hypotype (pl. 7, figs. 1, 4)</td>
<td>84</td>
<td>45 (0.48)</td>
<td>32 (0.34)</td>
<td>25 (0.25)</td>
</tr>
<tr>
<td>Hypotype (pl. 8, figs. 3, 5)</td>
<td>75</td>
<td>37 (0.50)</td>
<td>24 (0.22)</td>
<td>16 (0.21)</td>
</tr>
</tbody>
</table>

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

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

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

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

*Types.*—Hypotypes CAS 13369–13375, 13467; Stanford University Museum Paleontology 10020; USNM 165512–165513.

*Occurrences.*—Snowshoe Formation, Webber Member at Lupher’s locs. 108, 116A, 228, 228W, 228N, 228X, 229, 238, 306, 351, 355, 371, 372, 373, 407, 580, 584, and 610; Vigrass’ locs. 8, 14, 20b, 120, 121a, 152, and 241; USGS Mesozoic locs. 20763, 20824, 20825, 20827, and 20828.

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

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

Sonninia (Euhoploceras) dominans Buckman

Plates 11 and 12

Sonninia dominans Buckman, 1892, p. 322, pl. 66 (holotype), pl. 67, figs. 1, 2, pl. 69.

Sonninia subcostata Buckman, 1892, p. 330, pl. 71, figs. 4, 5.

Sonninia obtusifornis Buckman, 1892, p. 333, pl. 72, figs. 3–5.

Sonninia costata Buckman, 1892, p. 334, pl. 74, fig. 1, pl. 75, figs. 1–2.

Sonninia papilionacea Buckman, 1893, p. 367, pl. 90, figs. 1–3.

Sonninia eurornphalica Buckman, 1893, p. 362, pl. 85, figs. 1–3.

Sonninia omphalita Buckman, 1893, p. 363, pl. 85, figs. 5–9.

Sonninia palmata Buckman, 1893, p. 372, pl. 90, figs. 7–9.

Sonninia scalpta Buckman, 1893, p. 376, pl. 87, figs. 1–3.

Sonninia dominatrix Buckman, 1894, p. 392, pl. 94, figs. 3, 4, pl. 95, fig. 2.

Sonninia umbilicata Buckman, 1894, p. 397, pl. 84, figs. 1–3.

Sonninia camura Buckman, 1894, p. 403, pl. 99, figs. 4–6.

Sonninia dominata Buckman, 1894, p. 408, pl. 97, figs. 1–3.

Sonninia multicostata Buckman, 1894, p. 410, pl. 86, figs. 1–3.

Sonninia costigerata Buckman, 1894, p. 428, pl. 102, figs. 1–3.

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

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

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

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

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

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

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

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

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

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

In England Sonninia dominans Buckman, as herein described, occurs mostly in the Hyperlioceras discites subzone in the basal part of the Sonninia soberbyi zone, but has been recorded also (1893, pl. 79, figs. 7–9) under the name S. palmata Buckman from the top of the Graphoceras concarum zone. In Scotland it occurs with Graphoceras spp. probably near the top of the G. concarum zone (Morton, 1965, p. 99).

Sonninia (Enthoploceras) polyacantha (Waagen)

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

Ammonites polyacanthus Waagen, 1867, p. 592, pl. 20, figs. 1a, b.

Sonninia polyacantha (Waagen). Buckman, 1894, p. 433, pl. 98, figs. 1–3.

Sonninia polyacantha (Waagen). Dorn, 1935, p. 44, pl. 9, fig. 1, pl. 17, fig. 1, text fig. on pl. 4, fig. 2.

Sonninia polyacantha (Waagen). Dorn, 1935, p. 40, pl. 4, fig. 1.

Sonninia polyacantha (Waagen). Oechsle, 1958, p. 88, pl. 11, fig. 1, pl. 18, fig. 2.

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

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

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

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

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

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

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

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

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

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

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

Soninia (Euhoplcoceras) adicra (Waagen)

Plate 13, figures 5–12; plate 14–17

Ammonites adicra Waagen, 1867, p. 591, pl. 25, figs. 1a, b.
Soninia acaentodes Buckman, 1889, p. 658, 659, pl. 22, figs. 6, 7, 22, 23.
Soninia acaentodes Buckman, 1892, p. 319, pls. 58–60.
Soninia irregularis Buckman, 1892, p. 320, pl. 61.
Soninia marginata Buckman, 1892, p. 321, pl. 62, pl. 63, fig. 2, pl. 64, pl. 65, figs. 1, 2.
Soninia submarginata Buckman, 1892, p. 329, pl. 71, figs. 1–3.
Soninia cymatera Buckman, 1892, p. 332, pl. 73, figs. 2, 3, pl. 100, figs. 5–7.
Soninia spinicostata Buckman, 1892, p. 337, pl. 73, figs. 4–6.
Soninia magnispinata Buckman, 1892, pl. 82, figs. 1, 2.
Soninia semispinata Buckman, 1892, p. 348; 1893, pl. 77, figs. 1–2.
Soninia biplicata Buckman, 1893, p. 345, pl. 78.
Soninia crassicostata Buckman, 1893, p. 345, pl. 78, figs. 1–6.
Soninia crassicosta Buckman, 1893, p. 350, pl. 82, figs. 1, 2.
Soninia crassispinata Buckman, 1893, p. 353, pl. 80, figs. 1–3.
Soninia nodata Buckman, 1893, pl. 369, pl. 89, figs. 1–3.
Soninia paucinodata Buckman, 1893, p. 370, pl. 91, figs. 7–9.
Soninia triactyla Buckman, 1894, p. 393, pl. 101, figs. 1–5.
Soninia regularis Buckman, 1894, p. 395, pl. 96, figs. 3–5.
Soninia spinosa Buckman, 1894, pl. 405, pl. 56, figs. 4–6.
Soninia dominica Buckman, 1894, p. 410; 1895, pl. 69.
Soninia mutans Buckman, 1894, p. 414, pl. 91, figs. 4–6.
Soninia subirregularis Buckman, 1894, p. 426, pl. 98, figs. 4, 5; 1895, pl. 77, figs. 6–9, pl. 88, fig. 4.
Sonния locuples Buckman, 1894, p. 431, pl. 92, figs. 1-4, pl. 163, fig. 4; 1892, pl. 50, figs. 16-18.
Sonния reformata Buckman, 1894, p. 434, pl. 89, figs. 6-8.
Sherborneites projectifer Buckman, 1923, v. 4, pl. 441.
Sherborneites adicra (Waagen). Buckman, 1926, v. 6, pl. 669.
Sonния adicra (Waagen). Dorn, 1935, p. 37, pl. 3, figs. 1, 2, pl. 6, fig. 1, pl. 10, figs. 1, 7.
Sonния adicra (Waagen). Hiltermann, 1939, p. 150, pl. 10, figs. 3-4, text figs. 20-24.
Sonния adicra (Waagen). Oechsle, 1958, p. 85, pl. 10, figs. 5-9, pl. 11, fig. 2, pl. 18, figs. 3-4.

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

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

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

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

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

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

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

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

Types.—Hypotypes, CAS 13387-13393, 13395, 13397; USNM 168515. The small specimens compared with the inner whorls of S. (E.) adicra (Waagen) (pl. 13, figs. 5-9) are assigned the numbers, CAS 13394 and 13396 and USNM 168498.
**Occurrences.**—Snowshoe Formation, upper part of Weberg Member at Lupher's locs. 228, 228N, 228W, 315, 491; USGS Mesozoic locs. 26765, 29403; probably present also at Lupher's loc. 290.

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

*Sonninia (Euhoploceras) crassispinata* Buckman

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

*Sonninia crassispinata* Buckman, 1892, p. 317, pl. 57, figs. 1, 2, pl. 65, fig. 5; 1894, pl. 93, fig. 7.

*Sonninia reclinans* Buckman, 1894, p. 421, pl. 98, fig. 7, pl. 103, fig. 21; 1892, pl. 48, figs. 16, 17, pl. 65, figs. 34.

*Sonninia gibbera* Buckman, 1894, p. 421; 1893, pl. 87, figs. 4, 5, pl. 88, figs. 1–3.

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

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

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

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

The specimen shown on plate 23, figures 2–4 at a diameter of 130 mm has a whorl height of 46 mm, a whorl thickness of 26 mm between the spines, and an umbilical width of 46 mm. On the smaller specimen shown on plate 25, figures 18 and 19, the same dimensions are 98, 38, 37, and 34 mm, respectively.

The suture line cannot be traced.

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

**Types.**—Hypotypes, CAS 13398; 13399, 13401–13403; USNM 185516, 185517.

**Occurrences.**—Snowshoe Formation, upper part of Weberg Member at Lupher’s locs. 228N, 353, 361, 370, 578, 605, Vigurs’ loc. 20b, USGS Mesozoic locs. 2612, 26762, and 26766.

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

*Sonninia crassispinata* Buckman is recorded in England from the *Hyperlioceras discites* subzone in the basal part of the *Sonninia sowerbyi* zone (Buckman, 1892, p. 317; 1894, p. 421), in Scotland from the next younger *Shirburnia trigonalis* subzone (Morton, 1965, p. 199), in the southern part of European USSR from beds containing *Sonninia sowerbyi* and *Hyperlioceras discites*.
(Sasanov, 1964, table 2 on p. 794), and in Turkey from beds containing Docidoceras, Fontannesia, Euadniceras (Euapetoceras), and Bradfordia (Bremer, 1966, p. 161).

Soninia (Euhoploceras) cf. S. (E.) crassispinata Buckman
Plate 22, figure 3; plate 24, figure 5
Two internal molds from Oregon differ from S. crassispinata (Buckman), as described herein, in lacking spines on their small whorls at diameters between 15 to 45 mm. Instead, those whorls bear ribs that are flexuous, closely spaced, and in part paired. The succeeding whorl bears widely spaced spines that are separated by four to eight gently flexuous to nearly radial ribs. The largest preserved septate whorl bears prominent spines as in the Oregon specimens of S. crassispinata. Overall, the appearance of these molds suggests that they represent a variant of that species.

_Figured specimens._—CAS 13400; Stanford University Museum Paleontology 10092.

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

Subgenus PAPILLICERAS Buckman, 1930
Soninia (Papilliceras) stantoni (Crickmay)
Plate 26, figures 1–10, 12, 13
_Papilliceras stantoni_ Crickmay, 1933, p. 910, pl. 29, figs. 1, 2, pl. 32, fig. 1.
_Papilliceras stantoni_ Crickmay. Lupher, 1941, p. 262.

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

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

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

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

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

This species was compared by Crickmay (1933, p. 911) with _Papilliceras acantherum_ Buckman (1921, pls. 205 A, B) from the _Otoites sausei_ zone of England. It differs, however, by having sharper and more closely spaced ribs at comparable sizes. Its inner whorls resemble those of _P. papillatum_ Buckman (1929, pl. 150 A, B), but its outer whorls bear sparser and stronger ribs and spines. Its outer whorls bear much stronger ribs and spines than on _S. mesacantha_ (Waagen) (1867, p. 594, pl. 28, figs. 1a, b; Dorn, 1935, pl. 8, figs. 1, 4).

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

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

Soninia (Papilliceras) cf. S. (P.) arenata (Quenstedt)
Plate 26, figure 11
cf. _Ammonites arenatus_ Quenstedt, 1886, pl. 60, fig. 10.
cf. _Soninia arenata_ Quenstedt. Dorn, 1935, p. 38, pl. 7, figs. 1, 2. 
cf. _Soninia blackweideri_ Crickmay, 1933, p. 911, pl. 30, figs. 1–4.

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

_Figured specimens._—USNM 168522.

_Occurrence._—Snowshoe Formation, upper part of Warm Springs Member at USGS Mesozoic loc. 29241.
Sonninia (Papilliceras) cf. P. (S.) juramontana (Crickmay)
Plate 27, figure 1


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

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

*Figured specimen.*—CAS 13412.

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

Sonninia (Papilliceras) cf. S. (P.) espinazitensis Tornquist
Plate 27, figures 4–6


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

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

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

*Figured specimens.*—USNM 168523; CAS 13413.

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

**Genus WITCHELLIA** Buckman, 1889

Witchellia connata (Buckman)
Plate 20, figure 4; plate 21, figures 1–7, 10, 11

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

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

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

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

*Types.*—Hypotypes, USNM 168524–168529; CAS 13413, 13414; Stanford University Museum Paleontology 10023.
OLDEST KNOWN EUROPEAN REPRESENTATIVES OF LAMINATE Ammonite GENERA AND SPECIES THAT OCCUR IN BEING TUBERCLES ON THE FLANKS. IT DIFFERS FROM IN Bearing TBURCLES ON THE FLANKS. IT DIF- FERS FROM AMMONITES FROM EASTERN OREGON}

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

**Witchelli a sp.**

**Plate 20, figures 2, 3**

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

**Figured specimen.—Stanford University Museum of Paleontology 10024.**

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

**Subgenus LATIWI TCHELLIA Imlay, n. subgen.**

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

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

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

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

**Witchella (Latwitchellia) evoluta Imlay, n. sp.**

**Plates 31-33**

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

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

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

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

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

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

The finely ribbed variant (pl. 33) differs from typical specimens in its ribs being much weaker, lower and more widely spaced. On the body chamber of the largest adult whorls the ribs are irregularly spaced, that rounds abruptly into the flanks, and a single keel that is not bordered by furrows. The whorls overlap about one-third of the preceding whorls. The ribs on the flanks of the inner whorls are thin, cross the flanks nearly radially, curve forward near the venter, and arise singly or in pairs near the umbilicus. Adorally the ribs become broader, lower and more widely spaced. On the largest whorls the ribs are irregularly spaced, very low, and in part are replaced by striae.

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

Figured specimens.—USNM 168534; CAS 13429.

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

Dorsetenia cf. D. pulchra Buckman
Plate 28, figures 1–7; plate 29, figure 7

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

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

Figured specimens.—USNM 168535, 168536; CAS 13430, 13431.
Dorsetensia cf. D. complanata Buckman
Plate 29, figures 5, 6
cf. Dorsetensia complanata Buckman, 1892, p. 306. pl. 53, figs. 1–10, pl. 54, figs. 1. 2.

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

Figured specimen.—USNM 168537.

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

Dorsetensia aff. D. edouardiana (d’Orbigny)
Plate 30, figures 9–12

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

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

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

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

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

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

Dorsetensia sp. undet.
Plate 30, figures 5, 6

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

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

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

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

Figured specimen.—CAS 13442.

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

Dorsetensia oregonensis Imlay, n. sp.
Plate 29, figures 1–4

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

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

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

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

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

**Types.**—Holotype, CAS 13432; paratypes, CAS 13433-13435.

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

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

**Dorsetensia diversistrata** Imlay, n. sp.

Plate 29, figures 8-14

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

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

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

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

*Dorsetensia diversistrata* is characterized by its variably fine ribbing and by the development of abundant striae on its whorls of intermediate and large sizes. In this respect as well as in coiling it shows considerable resemblance to *Dorsetensia hyalina* (Buckman) (1924, pl. 519) from the Otoites sauzei zone of England, but differs in developing stronger and much less flexuous ribbing on its outer whorls. It differs from *D. liostraca* Buckman (1892, p. 310, pl. 53, figs. 11-16, pl. 55, figs. 3-5, pl. 56, fig. 1; Dorn, 1925, pl. 11, fig. 5) in being more evolute and in developing stronger and more variable ribbing. *Witchellia simulans* (Buckman) (1926, pl. 631) has a higher keel, a rounder umbilical wall, and weaker, less variable ribbing.

**Types.**—Holotype, CAS 13436, paratypes, CAS 13437-13441.

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

**Genus PELEKODITES** Buckman, 1923

**Pelekodites webergi** Imlay, n. sp.

Plate 34, figures 19-34

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

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

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

The specimen shown on plate 34, figures 32 and 33, appears to be only slightly compressed. At a diameter of 26 mm, it has a whorl height of 8 mm, a whorl thickness of 6.4 mm, and an umbilical width of 10.5 mm.

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

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

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

Occurrences.—Snowshoe Formation, middle and upper part of Weberg Member at USGS Mesozoic loc. 21612, 26761, 26763, and 29828; Lpher's locs. 229, 370, 474, and 506; Vigrass' loc. 205.

Pelekodites silviesensis Imlay n. sp.

Plate 34, figures 5-18

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

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

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

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

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

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

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

Pelekodites dossenensis Imlay, n. sp.

Plate 34, figures 1-4

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

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

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

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

Genus POECILOMORPHUS Buckman, 1889

Poecilomorphus varius Imlay, n. sp.

Plate 25, figures 1–16

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

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

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

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

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

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

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

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

Family STRIGOCERATIDAE Buckman, 1924

Genus PRAESTRIGITITES Buckman, 1924

Praestrigites cf. P. deltotus (Buckman)

Plate 35, figures 1–9, 11–14

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

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

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

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

The suture line is imperfectly preserved. The first lateral saddle is moderately broad. The first lateral lobe is trifid and slightly longer than the ventral lobe. The body chamber has a diameter of 88 mm, a whorl height of 66 mm, and an umbilical width of 4 mm.

The species ranges throughout the Lower Bajocian of Oregon and Washington. Some of the specimens bear a faint, broad spiral fluting near the middle of the flanks, then curve backward a little above the middle of the flanks, then curve forward on the ventral margin, and fade out on the venter. Some of the specimens bear a faint, broad spiral ridge near the middle of the flanks.

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

The suture line has moderately broad lobes and saddle. The first lateral lobe is much longer than the second lateral lobe. The ribs on the lower part of the flanks are nearly straight and incline slightly forward. They curve backward a little above the middle of the flanks, then curve forward on the ventral margin, and fade out on the venter. Some of the specimens bear a faint, broad spiral ridge near the middle of the flanks.

The umbilical whorl is incompletely preserved but nearly fade out on the adoral part of the largest septate whorl.

The umbilical ridge near the middle of the flanks is strongly compressed, and have a minute umbilicus and a hollow floored keel. The body chamber is incomplete and is represented on the largest specimen by about one-fifth of a whorl.

The ribs incline gently and nearly disappear on the adoral part of the largest septate whorl.

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

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

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

The suture line is imperfectly preserved. The first lateral saddle is moderately broad. The first lateral lobe is trifid and slightly longer than the ventral lobe. The body chamber has a diameter of 88 mm, a whorl height of 66 mm, and an umbilical width of 4 mm.

The species ranges throughout the Lower Bajocian of Oregon and Washington. Some of the specimens bear a faint, broad spiral fluting near the middle of the flanks, then curve backward a little above the middle of the flanks, then curve forward on the ventral margin, and fade out on the venter. Some of the specimens bear a faint, broad spiral ridge near the middle of the flanks.

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

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

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

**Figured specimens.**—CAS 13473, 13474.

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

Family HAPLOCERATIDAE Zittel, 1884

**Genus Lissoceras** Bayley, 1879

*Lissoceras hydei* Imlay, n. sp.

Plate 40, figures 24–33

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

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

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

*Lissoceras hydei* Imlay, n. sp. is characterized by a moderately involute compressed shell, sharp backwardly inclined ribbing, a smooth midventral area, and an evenly rounded umbilical edge. Its general appearance is similar to that of *Bradfordia heleneae* (Renz) (1925, p. 28, pl. 2, figs. 3, 4) and *B. inclusa* Buckman (1910, pl. 9, figs. 2, 3), but it differs from all described species of *Bradfordia* in its umbilical wall rounding evenly into the flanks instead of forming a sharp or raised edge. In this feature, as well as in the others listed, it greatly resembles *Lissoceras semicoastulatum* Buckman (1923, pl. 400) from the Sominia sowerbyi zone of England but differs in having much coarser ribbing. It differs from an Alaskan species, described as *L. cf. L. semicoastulatum* (Buckman) (Inlay, 1964a, p. 238, pl. 4, figs. 7, 8) in having much sharper ribbing that inclines backward more strongly. Overall, its characteristics appear to be intermediate between those of *Lissoceras* and *Bradfordia*, which genera are closely related, according to Arkell (in Arkell and others, 1957, p. L274, L275).

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

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

**Occurrences.**—Snowshoe Formation undifferentiated in Seneca area at Lupher's loc. 57 and USGS Mesozoic locs. 21617 and 28027; near middle of lower member near Izee at Lupher's loc. 73, Dickinson's loc. 108 and Mesozoic loc. 29230; Warm Springs Member at Mesozoic loc. 29241.

*Lissoceras?* sp.

Plate 36, figures 5–7, 11, 12

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

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

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

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

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

**Figured specimen.**—USNM 168558.
Occurrence.—Snowshoe Formation, upper part of Weberg Member at USGS Mesozoic loc. 21610.

Family OPPELIIDAE Bonarelli, 1894
Genus OPPelia Waagen, 1869
Oppelia cf. O. subradiata (J. de C. Sowerby)
Plate 40, figure 13

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

Figured specimen.—CAS 13483.

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

Family OTOITIDAE Mascke, 1907
Genus Docidoceras Buckman, 1919
Docidoceras luphei Imlay, n. sp.
Plate 38, figures 8, 9, 12, 14–17

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

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

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

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

The suture line cannot be traced.

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

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

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

Types.—Holotype, CAS 13484; paratypes, CAS 13483, 13486; paratype, USNM 168559.

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

Docidoceras warmingsense Imlay, n. sp.
Plate 38, figures 1–7, 13

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

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

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

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

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

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

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

Docidoceras sparsicostatum Imlay, n. sp.

Plate 37, figures 1–3, 5–12, 15, 16

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

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

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

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

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

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

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

Occurrences.—Snowshoe Formation, Weberg Member, at USGS Mesozoic locs. 26760, 27581 and 29925; Lupher’s locs. 212, 214, 224, 226 and 368, and Viggrass’ locs. 11, 86, and 87. The species ranges throughout the upper two-thirds of the Weberg Member above beds characterized by Tmetoceras.

Docidoceras cf. D. liebi Maubeuge

Plate 37, figures 4, 13, 14

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

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

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

The largest Oregon specimen at a diameter of 77 mm, has a whorl height of 26 mm, a whorl thickness about 40 mm, and an umbilical width of 35 mm. The suture line cannot be traced accurately. All specimens are too crushed to make meaningful measurements.

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

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

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

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

Emileia sp. undet.

Plate 39, figures 5, 12, 14

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

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

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

During subsequent growth the swellings disappear, the primary ribs extend across the lower third of the flanks, and the secondary ribs arise in bundles of three to four and become much weaker relative to the primary ribs. Adorally on the body chamber all ribs become inclined forward and become much weaker, and near the aperture are replaced by striae of irregular strength.
The suture line cannot be traced.

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

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

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

Genus OTITES Mascke, 1907

Otoites contractus (J. de C. Sowerby)

Plate 39, figures 1-4, 6, 7

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

The species is represented in eastern Oregon by 30 molds that show different growth stages and some variation in ribbing. Most of these specimens of Otoites contractus (J. de C. Sowerby) have very coarse ribbing similar to that on the holotype (Buckman, 1920, pl. 158) from England and on some of the specimens from Germany illustrated by Westermann (1954, pl. 1, fig. 5).

They also closely resemble a specimen from Argentina (Gott sche, 1878, pl. 2, figs. 4a, b) that Westermann (1954, p. 94) considers to belong to a subspecies of E. contractus. Some of the specimens are a little finer ribbed than the others but resemble a specimen from Germany that has been assigned to E. contractus by Westermann (1954, pl. 2, fig. 1).

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

Types.—Hypotypes, USNM 168567–168572.

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

Family SPHAEROCERATIDAE Buckman, 1920

Genus CHONDROCERAS Mascke, 1907

Chondroceras allani (McLearn)

Plate 40, figures 11, 12

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

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

The few specimens of Chondroceras defontii that also incline forward. Some primary ribs remain undivided, and some secondary ribs arise freely near the middle of the flanks. Secondary ribs outnumber primary ribs slightly more than 2 to 1. Adorally the ribbing becomes higher, sharper, and more widely spaced. The suture line cannot be traced accurately.

Chondroceras n. sp. undet. bears a general resemblance to some small adult specimens of Chondroceras from Europe described as C. orbignyanum crusicostatum Westermann (1956a, p. 70, pl. 5, fig. 8a–d, pl. 6, figs. 3–5), but differs in being much more tightly coiled and in its ribs branching higher on the flanks.

Figured specimens.—CAS 13494–13496.

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

Genus SPHAEROGERAS Bayle, 1878

Sphaeroererat cf. S. brongniartii (J. de C. Sowerby)

Plate 40, figures 17–23

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

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

The suture line cannot be traced accurately.

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

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

_Figured specimens._—USNM 168575-168577; CAS 13497.

_Occurrences._—Snowshoe Formation undifferentiated near Seneca at Lupher’s loc. 8 and at USGS Mesozoic locs. 29817, 29818, and 29826. At the last three localities it is associated with *Spiroceras*.

*Sphaeroceras* sp.

_Plate 40, figures 14-16_

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

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

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

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

_Figured specimens._—USNM 168578, 168579.

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

**Genus MEGASPHAEROCERAS** Imlay, 1962

_Megasphaeroceras rotundum* Imlay

_Plate 40, figures 4-7_


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

_Types._—Hypotypes CAS 13498-13501.

_Occurrence._—Snowshoe Formation undifferentiated near Seneca at Lupher’s loc. 28.

**Family STEPHANO Ceratidae** Neumayr, 1875

**Genus NORMANNITES** Munier-Chalmas, 1892

_Normannites* (Normannites) orbignyi Buckman

_Plate 41, figures 9, 10, 18, 20_

_Normannites orbignyi* Buckman, 1927, v. 7, pl. 734, figs. 1-3.

_N. (N.) orbignyi* Buckman, Westermann, 1954, p. 138, pl. 5, figs. 3, 4, pl. 6, fig. 1.

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

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

*Figured specimens.*—USNM 168580–168583.

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

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

Plate 41, figures 14–16

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

*Figured specimens.*—USNM 168664, 168585.

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

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

Plate 41, figure 17

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

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

*Figured specimen.*—CAS 13502.

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

*Normannites (Normannites) cf. N. (N.) quemstedti* Roche

Plate 41, figures 11–13

*cf. Ammonites braikenridgii* Sowerby. Quenstedt, 1886, v. 2, p. 325, pl. 65, fig. 5.


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

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

*Figured specimens.*—CAS 13503 and 13549.

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

*Subgenus ITINSAITES* McLearn, 1927

*Normannites (Itinsaites) crickmayi* (McLearn)

Plate 41, figures 2–5

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

This species is represented in eastern Oregon by 32 laterally crushed specimens, of which 5 show parts of the lateral lappets of adults. The specimens have a fairly wide umbilicus, which on the largest specimen widens near the aperture owing to contraction of the body chamber. The ribbing is fairly coarse and widely spaced. The primary ribs are appreciably stronger than the secondary ribs, curve slightly forward on the lower
two-fifths of the flanks, and terminate in acute tubercles. From the tubercles pass two or three secondary ribs that incline gently forward on the flanks. Some secondary ribs arise freely along the zone of furcation. Secondary ribs outnumber primary ribs about \( \frac{3}{2} \) to 1 on the septate whorls and on the adapical part of the body chamber. Near the aperture there are about two secondary ribs for each primary rib.

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

Types.—Hypotypes, USNM 168586–168589.

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

*Normannites (Itinsaites) formosus* (Buckman)

Plate 41, figure 19

*Epalxites formosus* Buckman, 1929, v. 3, pl. 151, figs. 1–3.

*Itinsaites formosus* (Buckman). Westermann, 1954, p. 260, pl. 22, fig. 4, pl. 25, figs. 1a–c.

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

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

Type.—Hypotype, USNM 168590.

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

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

Plate 41, figure 21

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

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

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

Figured specimen.—USNM 168591.

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

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

Plate 41, figures 6–8

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

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

Figured specimen.—CAS 13504–13506.

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

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

Plate 41, figure 1

*cf. Ammonites contractus anceps* Quenstedt, 1886, v. 2, p. 521, pl. 64, fig. 20.

*cf. Epalxites anceps* (Quenstedt). Westermann, 1954, p. 297, pl. 27, figs. 4a–c, pl. 28, figs. 1–3.

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

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

*Figured specimen.*—USNM 168592.

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

**Subgenus MASCKEITES** Buckman, 1920

**Normannites** (Masckeites!) *cf. N. (M.1) densus* (Buckman)

*Plate 40, figures 1, 2*


*cf. Masckeites densus* Buckman, Westermann, 1964, p. 332, pl. 32, figs. 1a–c.

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

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

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

*Figured specimens.*—USNM 168593.

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

**Normannites kialagvikensis** Imlay

*Plate 40, figure 3*

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

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

*Types.*—Hypotype, CAS 13507.

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

**Genus STEPHANOCEERAS** Waagen, 1869

**Stephanoceras** *mowichense* Imlay, n. sp.

*Plate 45, figures 5–7*

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

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

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

*Types.*—Holotype, USNM 168594; para-types USNM 168595, 168596.

*Occurrence.*—Snowshoe Formation, near top of Warm Springs Member at USGS Mesozoic loc. 29395 and Lupher's loc. 109.
**Stephanoceras sp. A**

Plate 45, figure 10

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

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

*Figured specimen.*—USNM 168597.

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

**Stephanoceras sp. B**

Plate 45, figure 9

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

*Figured specimen.*—CAS 13548.

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

**Stephanoceras sp. C**

Plate 44, figures 1-6

This species is represented by 25 molds of which most are crushed. It has moderately involute coiling, by high, sharp, widely spaced ribs, and by weak, radially elongate lateral tubercles at the furcation points of the ribs. On the four smallest preserved whorls the primary ribs incline backwards on the umbilical wall and then incline gently forward to the middle of the flanks where most of them divide into pairs of slightly weaker secondary ribs. A few primary ribs remain simple. A few secondary ribs arise freely near the middle of the flanks. All secondary ribs incline forward on the flanks and arch gently forward on the venter. Secondary ribs outnumber primary ribs about two to one.

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

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

*Figured specimens.*—USNM 168599, 168600.

*Occurrence.*—Snowshoe Formation undifferentiated in the Seneca area at USGS Mesozoic loc. 28020. Unnamed beds in Juniper Mountain area, Malheur County.
at Mesozoic loc. 28649. *Stephanoceras* sp. D at Mesozoic loc. 28620 is associated with *Normannites* and is several hundred feet higher stratigraphically than beds containing *Spiroceras* at Mesozoic locs. 28018, 28022, and 29232. At Mesozoic loc. 28649 *Stephanoceras* sp. D is associated with *Spiroceras?* and *Normannites* in beds that are 150 feet northwest along the strike from Mesozoic loc. 28650 which has furnished *Spiroceras bifurcatum* (Quenstedt).

**Stephanoceras** cf. *nodosum* (Quenstedt)

Plate 44, figures 7–11
cf. *Ammonites nodosus* Quenstedt, 1858, p. 400, pl. 54, fig. 4.
cf. *Ammonites humphriesianus nodosus* Quenstedt, 1866, p. 532, pl. 65, fig. 17.
cf. *Stephanoceras nodosum* (Quenstedt). Weisert, 1932, p. 136, pl. 15, figs. 1, 2.

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

**Figured specimen.—**Stanford University Museum Paleontology 10030.

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

Subgenus *SKIRROCERAS* Mascke, 1907

**Stephanoceras** (Skirroceras) *kirschneri* Imlay

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

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

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

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

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

**Occurrence.—**Snowshoe Formation undifferentiated in the Emigrant Creek area at USGS Mesozoic locs. 26770, 26772, and 29140; in the Seneca area at Lupher's locs. 55, 272 and Mesozoic loc. 29790; near base of middle member at Mesozoic loc. 26776; near middle of Basey Member at USGS Mesozoic locs. 27377, 27737,
Stephanoceras (Skirroceras) juhlei Imlay
Plate 43, figures 1-7, 15

Stephanoceras (Skirroceras) juhlei Imlay, 1964a, p. B47, pl. 16, fgs. 1, 3-6, pl. 17.

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

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

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

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

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

Stephanoceras (Skirroceras) aff. S. (S.) juhlei Imlay
Plate 48, figures 8, 9

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

Figured specimen.—USNM 168609.

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

Stephanoceras (Skirroceras) cf. S. (S.) leptogyrale (Buckman)
Plate 46, figure 15

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

Figured specimen.—USNM 168610.

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

Stephanoceras (Skirroceras) cf. S. (S.) dolichococcus (Buckman)
Plate 45, figures 8, 11

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

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

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

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

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

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

**Subgenus PHAULOSTEPHANUS** Buckman, 1927

*Stephanoceras* (*Phaulostephanus*) *oregonense* McLearn, n. sp.

Plate 45, figures 1–4

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

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

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

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

This species greatly resembles *Stephanoceras* (*Phaulostephanus*) *paululus* (Buckman) (1927, pl. 754, figs. 1–3) but differs in being more evolute, nearly twice as large, finer ribbed, and perhaps in bearing weak tubercules on its small septate whorls. That species is reported to be nontuberculate (Arkell and others, 1957, p. L280); but, as illustrated, the swollen ventral ends of its primary ribs resemble the swollen rib ends of the Oregon species.

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

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

**Genus STEMMATOCERAS** Mascke, 1907

*StemmatoCeras* aff. *S. albertense* McLearn

Plate 46, figures 1–9

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

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

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

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

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

The Oregon specimens of *StemmatoCeras* show some resemblance to immature specimens of *S. albertense* McLearn from Alberta, Canada, as illustrated by Frobold (1957, pl. 21, figs. 2a, b, pl. 23, figs. 1b, c) but have much more closely spaced primary ribs and fewer secondary ribs per primary. They show more resemblance to *S. n. sp. aff. S. albertense* McLearn from the western interior region of the United States (Imlay, 1967, pl. 10, pl. 16, figs. 5–7) but apparently have a more depressed
venter, denser and longer primary ribs, and fewer secondary ribs per primary rib.

*Figured specimens.—CAS 13521–13524.

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

**Genus** **TELOCERAS** **Mascke, 1907**

*Teloceras itinsae* **McLearn**

*Plate 46, figures 10, 11, 13*

*Teloceras itinsae* **McLearn**, 1932, p. 51, pl. 10 figs. 1, 2.

*Teloceras itinsae* **McLearn**, **Imlay**, 1964a, p. 150, pl. 23, figs. 9, 10, pl. 24, figs. 1–5, 7.

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

*Types.—Hypotypes, USNM 168614–168616.*

*Occurrence.—Snowshoe Formation undifferentiated near Emigrant Creek at USGS Mesozoic locs. 29410 and 29410.*

**Genus** **ZEMISTEPHANUS** **McLearn, 1927**

*Zemistephanus? cf. Z. richardsoni* **(Whiteaves)**

*Plate 46, figures 12, 14*

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

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

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

*Figured specimens.—USNM 168617; CAS 13525.*

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

**Genus** **LUPHERITES** **Imlay, n. gen.**

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

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

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

*Lupherites senecaensis* **Imlay, n. sp.**

*Plate 47, figures 1–20*

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

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

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

On the body chamber the primary ribs are sharp, high, and widely spaced and incline forward on the flanks. Some remain simple, and some divide on the middle third of the flanks into pairs of sharp but slightly weaker secondary ribs. Some furcation points are swollen, some are weakly tuberculate, and some are merely sharpened. Most pairs of forked ribs are separated by a secondary rib that arises freely on the upper third of the flanks. All ribs cross the venter transversely.

Dimensions cannot be measured accurately because all the specimens are deformed.

The suture line, fairly well exposed on one specimen, has moderately broad saddles and lobes. The first lateral lobe is irregularly trifid, slightly shorter than the ventral lobe, and much longer and broader than the second lateral lobe. The second lateral saddle is much smaller than the first lateral saddle.

*Leptosphinctes senecaensis* Imlay, n. sp. bears a general resemblance to species of *Polyplectites* as discussed under the definition of the genus.

*Types.*—Holotype CAS 13526; paratypes, CAS 13527–13540; paratypes, USNM 168618, 168619.

*Occurrence.*—Snowshoe Formation undifferentiated near Seneca at Lupher's locs. 8 and 30. Unnamed beds in the Huntington quadrangle at USGS Mesozoic loc. 29111.

**Family PERISPHINCTIDAE Steinmann, 1890**

**Genus LEPTOSPHINCTES Buckman, 1920**

*Leptosphinctes cf. L. leptus* Buckman

Plate 47, figure 25

One laterally crushed, evolute ammonite, represented by both internal and external molds, shows parts of five whorls of which four are septate. The outermost whorl apparently overlaps about one-third of the next inner whorl. The venter is not exposed. The ornamentation consists of thin widely spaced, nearly radial or slightly prorsiradiate primary ribs, of which nearly half bifurcate at about two-thirds of the height of the flanks. Some of the secondary ribs are indistinctly connected with the primary ribs. The furcation points are not swollen or tuberculate. Constrictions are not present.

The suture line cannot be traced accurately but appears to be similar to that of *L. delicatus* Imlay (1962, pl. 5, fig. 8) from Alaska.

The Oregon species resembles the septate whorls of *L. leptus* Buckman (1920, pl. 160) in fineness of ribbing, but is probably more evolute.

**Figured specimen.**—CAS 13541.

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

*Leptosphinctes cf. L. evolutus* Imlay

Plate 47, figures 21–23, 26, 27


One species of *Leptosphinctes* from eastern Oregon, represented by four fragmentary crushed molds, is characterized by highly evolute coiling and coarse widely spaced ribs. The smallest specimens bear very high, sharp, widely spaced primary ribs that incline forward on the flanks and terminate in swellings or weak tubercles on the margins of the venter. From these tubercles pass one or two lower and broader secondary ribs that arch gently forward on the venter and, at least on one specimen, are clearly not interrupted by a midventral furrow. One of these small specimens also bears a deep constriction.

On the two large fragments the primary ribs are even higher and more widely spaced, incline forward on the flanks, curve strongly forward on the margins of the venter and then fade out or become very weak on the venter. Most ribs remain simple, but one primary rib divides indistinctly into two secondary ribs. The venter of these large specimens is poorly exposed but appears to be nearly smooth and without a ventral furrow, such as occurs in similarly coarsely ribbed species of *Parkinsonia*.

This species of *Leptosphinctes* from eastern Oregon closely resembles the most coarsely ribbed paratype of *L. evolutus* Imlay (1964a, pl. 28, fig. 5) from the Talkeetna Mountains, Alaska. It may differ by having slightly higher ribs and fewer forked ribs on its outer whorls. None of the described European species of *Leptosphinctes* are nearly as evolute or as coarsely ribbed.

**Figured specimens.**—CAS 13542–13545.

**Occurrence.**—Near top of Snowshoe Formation undifferentiated near Seneca at Lupher's loc. 30.

*Leptosphinctes sp.*

Plate 47, figure 24

One fragment of a whorl bears sharp, strong primary ribs that incline slightly forward on the flanks and divide at about three-fifths of the height of the flanks into pairs of broader and lower secondary ribs. One primary rib remains simple and a few secondary ribs are indistinctly connected with primary ribs.

The ribbing is sharper and higher than in most species of *Leptosphinctes* but is comparable in coarseness with that on *L. (Prorsisphinctes) pseudomartinsi* (Siemiradzki) (Arkell and others, 1957, p. L314, fig. 395). That species differs by having more forwardly inclined ribbing on its venter.
Figured specimen.—USNM 168620.

Occurrence.—Snowshoe Formation, near base of upper member, at USGS Mesozoic loc. 26775.

Subgenus PRORSISPINICTES Buckman, 1921
Leptosphinctes (Prorsispinctes) spp. juv.
Plate 47, figures 28–30

The subgenus Prorsispinctes is probably represented by seven immature molds. These specimens have highly evolute coiling, forwardly inclined ribbing and some constrictions. Most primary ribs pass into pairs of slightly weaker secondary ribs at or a little above the middle of the flanks. The secondary ribs continue to incline forward on the upper parts of the flanks and arch weakly forward on the venter. Five of the specimens (pl. 47, fig. 29) from Lupher’s loc. 30 represent a fairly coarsely ribbed species comparable to the inner whorls of L. (P.) phanerus (Buckman) (1921, pl. 211) or L. (P.) meseres (Buckman) (1923, pl. 446; 1927, pl. 446A). The other two specimens (pl. 47, figs. 28, 30) represent a finely ribbed species comparable to the inner whorls of L. (P.) stomphus (Buckman) (1921, pl. 247). Their ribs also resemble those on Leptosphinctes leptus Buckman (1920, pl. 160) except for being more forwardly inclined.

Figured specimens.—USNM 168621, 168622; CAS 13546.

Occurrence.—Snowshoe Formation undifferentiated near Seneca at Lupher’s loc. 30. Unnamed beds in the Juniper Mountain area, Brogan quadrangle, at USGS Mesozoic localities 28649 and 28650.

Genus PARABIGOTITES Imlay, 1961
Parabigotites crassicostatus Imlay
Plate 47, figures 31–38

Dactylioceras sp. A, Kellum, Daviess and Swinney, 1945, figs. 5A–B (not C–E).

Parabigotites crassicostatus Imlay, 1961, p. 472–473, pl. 64, figs. 4–10.

Parabigotites crassicostatus Imlay, 1964a, p. B54, pl. 29, figs. 1–10.

This species is represented in eastern Oregon by six specimens that show the same characteristics and range of variation as the type specimens from Alaska. The largest specimen is finer ribbed than most of the illustrated Alaskan specimens but is similar in that respect to certain small specimens (Imlay, 1964a, pl. 29, figs. 11, 13). It matches closely also with a finely ribbed variant (see pl. 47, fig. 34) that occurs in Alaska in the Kialagvik Formation (USGS Mesozoic locs. 19773 and 21258), in association with the typical coarsely ribbed variant.

The microconch equivalent of this species could be Normannites kialagvikensis Imlay (1964a, p. B43, pl. 18), as once suggested by G. E. G. Westermann (written commun., Nov. 30, 1964).

Types.—Hypotypes, USNM 168623; CAS 13547; Stanford University Museum Paleontology 10034–10036.

Occurrences.—Snowshoe Formation, middle to upper parts of Warm Springs Member at Lupher’s loc. 211, Dickinson’s locs. 94, 96 and 98, and USGS Mesozoic loc. 29805. The species is probably represented also in the lower member of the Snowshoe Formation at USGS Mesozoic loc. 27356.

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MIDDLE JURASSIC (BAJOCIAN) AMMONITES FROM EASTERN OREGON


Quenstedt, F. A. von, 1858, Der Jura: Tubingen, 842 p., atlas of 100 pls.


1964b. Sexual-Dimorphismus bei Ammonoiden und seine Bedeutung für die Taxonomie der Otoitidae (einschließlich Sphaeroceratinae; Ammonitina, m. Jura) : Palaeontographica, v. 124, Abt. A, p. 33-73, pls. 6-9, 13 text figs.


Wilson, Vernon, Welch, F. B. A., Robbie, J. A., and Green, G. W., 1958, Geology of the country around Bridport and Yeovil (explanation of sheets 327 and 312) : Great Britain Geol. Survey Mem., England and Wales, 239 p., 7 pls. 27 text figs.
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PLATES 1–47

Contact photographs of the plates in this report are available, at cost, from U.S. Geological Survey Library, Federal Center, Denver, Colorado 80225.
PLATE 1

[All figures natural size unless otherwise indicated. Specimens shown in figs. 3-16 are from the highest beds of the Snowshoe Formation near Seneca]

Figures 1, 2. Calliphyloceras sp. (p. 54).
Lateral and ventral views (× 2) of specimen, Stanford Univ. Mus. Paleontology 10006 from Vigrass' loc. 152, Weberg Member of the Snowshoe Formation.

3-8. Spiroceras bifurcatum (Quenstedt) (p. 55).
3, 4. Ventral and lateral views (× 2) of hypotype, USNM 168491 from USGS Mesozoic loc. 28017.
5. Hypotype, USNM 168493 from USGS Mesozoic loc 28022.
6. Hypotype, USNM 168494 from USGS Mesozoic loc. 29232.
7. Ventro-lateral view of hypotype, USNM 168495 from USGS Mesozoic loc. 29232. Shows ventral groove.
8. Hypotype, USNM 168492 from USGS Mesozoic loc. 29232. Shows weak lateral and strong ventral tubercles.

9, 10. Ventral and lateral views of hypotype, USNM 168502 from USGS Mesozoic loc. 28650.
11. Hypotype, USNM 168500 from USGS Mesozoic loc. 29232.
12, 13. Ventral and lateral view of hypotype, USNM 168499 from USGS Mesozoic loc. 29232.
14. Hypotype, USNM 168501 from USGS Mesozoic loc. 28018.
15. Hypotype, USNM 168496 from USGS Mesozoic loc. 29232.
16. Hypotype, USNM 168497 from USGS Mesozoic loc. 29232.

17. Phylloceras sp. (p. 54).
Specimen, USNM 168490 from USGS Mesozoic loc. 29790 in middle part of Snowshoe Formation near Seneca.

18-21. Holophylloceras sp. (p. 54).
18. Specimen, CAS 13328 from Lupher's loc. 221.
19-21. Lateral and ventral views (× 2) of specimen, CAS 13329 from Lupher's loc. 221 in the Warm Springs Member of the Snowshoe Formation.
CALLIPHYLLOCERAS, SPIROCERAS, PHYLLOCERAS, AND HOLCOPHYLLOCERAS
PLATE 2

[All figures are natural size. All specimens shown in figs. 1-6 and 9 from the Weberg Member of the Snowshoe Formation]

1, 2. Ventral and lateral views of hypotype, CAS 13362 from Lupher's loc. 207.
3, 4. Lateral and ventral views of hypotype, CAS 13363 from Lupher's loc. 207.

7, 8. *Holophylloceras* sp. (p. 54).
Apertural and lateral views of specimen, CAS 13330 from Lupher's loc. 235 in the Warm Springs Member of the Snowshoe Formation.

9. *Phylloceras* sp. (p. 54).
Crushed internal mold bearing some shell material.
Specimen CAS 13327 from Lupher's loc. 468.
TMETOCERAS, HOLCOPHYLLOCERAS, AND PHYLLOCERAS
PLATE 3

[All figures natural size unless otherwise indicated]

FIGURES 1–32. Asthenoceras delicatum Imlay, n. sp. (p. 55).

Within the species those specimens shown in figures 1–11 are the most coarsely-ribbed; in figures 12–14 are moderately-ribbed; and in figures 16–32 are the most finely ribbed. Specimens shown in figures 1, 2, 4–7, 9–11, 15–17 and 22–25 are from the Weberg Member. All others are from the Warm Springs Member of the Snowshoe Formation.

1. Paratype, CAS 13344 from Lupher's loc. 306.
2. Paratype, CAS 13345 from Lupher's loc. 306.
3. Paratype, CAS 13338 from Lupher's loc. 232.
4. Paratype, CAS 13334 from Lupher's loc. 228N.
5–7. Paratype, CAS 13336 from Lupher's loc. 228N. Note lateral lappet on fig. 5.
8. Paratype, CAS 13333 from Lupher's loc. 116.
9–11. Ventral and lateral views of paratype, CAS 13335 from Lupher's loc. 228N.
15. Suture line (× 2) (drawn at whorl height of 13 mm) of paratype, Stanford Univ. Mus. Paleontology 10010 from Vigrass' loc. 16.
16, 17. Paratype, CAS 13341 from Lupher's loc. 306.
18. Paratype, USNM 168503 from USGS Mesozoic loc. 29239.
19, 20, 28–30. Holotype, CAS 13331 from Lupher's loc. 116 (figures 28–30 are × 2).
22. Paratype, CAS 13337 from Lupher's loc. 228N.
23. Paratype, CAS 13343 from Lupher's loc. 306.
24. Paratype, CAS 13342 from Lupher's loc. 306.
25. Paratype, CAS 13340 from Lupher's loc. 305.
26. Paratype (× 2), CAS 13346 from Lupher's loc. 560. Note swellings on flanks.
27. Paratype (× 2), CAS 13347 from Lupher's loc. 561.
32. Paratype (× 2), Stanford Univ. Mus. Paleontology 10007 from Vigrass' loc. 10. Note lateral lappet.
PLATE 4

[All figures natural size unless otherwise indicated. Specimen shown in figs. 5 and 6 is from the Warm Springs Member. All others are from the Weberg Member of the Snowshoe Formation]

FIGURES 1, 2. Asthenoceras cf. A. delicatum Imlay, n. sp. (p. 33).
Ventral and lateral views of specimen, USNM 168504 from USGS Mesozoic loc. 24137 in the basal sandstone of the Tuxedni Formation, 0.53 mile S 74.5° E of mouth of Pass Creek, Talkeetna Mountains, Alaska. Specimen resembles the coarsely ribbed variant of A. delicatum Imlay.

3–6. Asthenoceras delicatum Imlay, n. sp. (p. 55).
3. Suture line (× 2) (drawn at whorl height of 10 mm). Paratype, Stanford Univ. Mus. Paleontology 10011 from Vigrass' loc. 16.
4. Paratype, Stanford Univ. Mus. Paleontology 10009 from Vigrass' loc. 16. Shows change from fine to coarse ribbing.
5, 6. Paratype, CAS 13339 from Lupher's loc. 232. This specimen is much stouter than average and shows marked change from fine to coarse ribbing.

7–15. Fontannesia intermedia Imlay, n. sp. (p. 57).
7. Rubber imprint of external mold. Paratype, CAS 13354 from Lupher's loc. 239.
10, 11, 15. Lateral and apertural views (× 1) and suture line (× 2). Holotype, CAS 13332 from Lupher's loc. 228W.
12–14. Lateral, apertural, and ventral views. Paratype, CAS 13353 from Lupher's loc. 228X.

16. Paratype, CAS 13349 from Lupher's loc. 228.
17. Paratype, CAS 13350 from Lupher's loc. 228.
21, 26. Holotype, CAS 13348 from Lupher's loc. 228N. About three-fourths of outer whorl is body chamber.
22–24. Ventral and lateral views (× 1) and suture line (× 2) (drawn at whorl height of 13 mm). Paratype, Stanford Univ. Mus. Paleontology 10015 from Vigrass' loc. 8.
25. Paratype, CAS 13351 from Lupher's loc. 370.
ASTHENOCERAS AND FONTANNESIA
PLATE 5

[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation]

**Figures 1–3. Fontannesia cf. F. evoluta** (Buckman) (p. 59).
Specimen, Stanford Univ. Mus. Paleontology 10018 from Viggras' loc. 121a.

**Figures 4–13. Fontannesia cf. F. carinata** Buckman (p. 58).
4, 5. Specimen, CAS 13361 from Lupher's loc. 355.
6, 12. Suture line (× 2) and lateral view of specimen, CAS 13357 from Lupher's loc. 226.
7, 8. Specimen, CAS 13359 from Lupher's loc. 355. About three-fourths of outer whorl represents body chamber.
9, 11. Partial body chamber of specimen, CAS 13358 from Lupher's loc. 228X.
10, 13. Immature specimen, CAS 13360 from Lupher's loc. 355.

**Figures 14–19. Fontannesia cf. F. luculenta** Buckman (p. 58).
14–17. Suture line (× 2) (drawn at whorl height of 18.5 mm), lateral, ventral, and apertural views of specimen, CAS 13356 from Lupher's loc. 355. Figure 16 shows ventral elongation of shell.
18, 19. Specimen, CAS 13355 from Lupher's loc. 355.
PLATE 6

[All figures natural size unless otherwise indicated. All specimens shown are from the Weber Member of the Showshoe Formation]

Apertural, lateral, and ventral views (× 1) and suture line (× 2) of specimen, CAS 13364 from Lupher's loc. 1701.

6–9. *Eudmetoceras (Euaptoceras) sp. juv. cf. E. (E.) hauthali* (Burekhardt)
(p. 60).
7, 8. Specimen, USNM 168506b.
9. Specimen, USNM 168506c. All from USGS Mesozoic loc. 29400.

11, 16, 18. Lateral views of three crushed immature specimens, USNM 168508a–c from USGS Mesozoic loc. 29817.
10, 12, 13, 17. Lateral views of four crushed immature specimens. USNM 168507a–d from USGS Mesozoic loc. 29400.
14, 15. Lateral view and cross section of fairly large specimen, USNM 168507e from USGS Mesozoic loc. 29400. About one-fourth of outer whorl is nonseptate.
EUDMETOCERAS (EUAPTEOCERAS)
PLATE 7

[All figures are natural size. All specimens shown are from the Weberg Member of the Snowshoe Formation]

Figures 1-5. *Soninia (Euhoplaceras) modesta* Buckman (p. 62).

1, 4. Septate hypotype, CAS 13370 from Lupher's loc. 228N. Note abrupt umbilical edge and change in coiling from moderately involute to moderately evolute. Represents a stout and fairly coarsely ribbed variant.

2, 3. Immature septate hypotype, CAS 13374 from Lupher's loc. 373. Has fairly fine ribbing.

5. Moderately large septate hypotype, CAS 13375 from Lupher's loc. 584. Note vertical umbilical wall, fairly abrupt umbilical edge, fairly stout whorl section, and moderately coarse ribbing. See cross section on pl. 9, fig. 4. Specimen develops slightly stronger and sparser ribbing than *Soninia subcostata* Buckman (1892, pl. 86, fig. 1) or *S. multicoslata* Buckman (1893, pl. 86, fig. 1), but closely resembles *S. inaequa* Buckman (1894, pl. 101, figs. 4, 5).
SONNINIA (EUHOPLOCERAS)
PLATE 8

[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation]


1, 2, 6, 7. Hypotype, USNM 168512 from USGS Mesozoic loc. 29828. Shows weakly-ribbed septate whorls (figs. 1, 2) and moderately-ribbed outer nonseptate whorl (figs. 6, 7) similar to those on specimen of *Sonninia modesta* Buckman (1892, pl. 68) from England. Note abrupt umbilical edge and change in amount of involution.

3–5. Suture line (× 2) and lateral and apertural views of immature septate hypotype, CAS 13373 from Lupher's loc. 306. It is moderately compressed and has fairly fine ribbing.
SONNINIA (EUHOPLOCERAS)
PLATE 9

[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation]


2. Suture line of hypotype, CAS 13369 from Lupher's loc. 228. Drawn at whorl height of 60 mm.
3. Suture line of hypotype, CAS 13372 from Lupher's loc. 228W. Drawn at whorl height of 48 mm.
4. Cross-section of hypotype, CAS 13375, shown on pl. 7, fig. 5.
5, 6. Hypotype, CAS 13371 from Lupher's loc. 228W. Shows change in ribbing from fairly weak on septate whorls to fairly strong on body chamber. Resembles *Sonninia subcostata* Buckman (1892, pl. 71, fig. 4) at a comparable size. Develops slightly coarser ribbing at an earlier growth stage than on a certain paratype of *S. modesta* Buckman (1892, pl. 68).
7. Small septate whorl (X 2) of hypotype, USNM 168513 from USGS Mesozoic loc. 29828. Shows nearly smooth nucleus followed by development of weak flexuous ribs.
PLATE 10

[Figure about four-fifths natural size]

FIGURE 1. *Sonninia (Euholoploceas) modesta* Buckman (p. 62).

Lateral view of large laterally crushed hypotype, CAS 13467 from Lupher's loc. 610 in Weberg Member of Snowshoe Formation. Adoral fifth or outer whorl is nonseptate and presumably represents part of the adult body chamber. Note vertical umbilical wall, abrupt umbilical edge, widening of umbilicus during growth, general smoothness of internal mold, and presence of broad radial undulations. Weathering accounts for some of the smoothness on the adapical part of the outer whorl. Note resemblance to *S. simplex* Buckman (1892, pl. 70, figs. 2-4), *S. substriata* Buckman (1892, pl. 71, fig. 6), *S. parvicostata* Buckman (1892, pl. 75, figs. 3-5), *S. modesta* Buckman (1892, pl. 68), and *S. nuda* Buckman (1893, pl. 82, figs. 3, 4).
SONNINIA (EUHOPLOCERAS)
Figures 1–4. Sonninia (Euhoploceras) dominans Buckman (p. 63).

1, 4. Hypotype, CAS 13378 from Lupher’s loc. 228. Whorl section drawn at diameter of 180 mm. Resembles Sonninia costigera Buckman (1894, pl. 102) and S. obtusiformis Buckman (1892, pl. 72, figs. 3–5).

2. Small, immature septate hypotype, CAS 13380 from Lupher’s loc. 306.

3. Suture line drawn at whorl height of 42 mm on hypotype, CAS 13377 from Lupher’s loc. 226. Specimen bears ribbing comparable with that present near the adoral end of the specimen shown on pl. 12, fig. 5.
SONNINIA (EUHOPLOCERAS)
PLATE 12

[All figures are natural size. All specimens shown are from the Weberg Member of the Snowshoe Formation]

3. Hypotype, CAS 13376 from Lupher's loc. 108. Resembles *Sonninia omphalica* Buckman (1893, pl. 83, figs. 5, 6) and *S. dominatrix* Buckman (1894, pl. 94, fig. 3).
5. Hypotype, CAS 13379 from Lupher's loc. 228N. Resembles *Sonninia multicostata* Buckman (1894, pl. 86, figs. 1, 2).
PLATE 13

[All figures natural size unless otherwise indicated. Specimens shown in figs. 1-4 are from lowest exposed bed of Snowshoe Formation near Seneca, Oreg.; other specimens are from the Weberg Member of the Snowshoe Formation in the Supplee area, Oreg.]


All from Luperh's loc. 272.
1. Specimen, CAS 13366. About three-fifths of outer whorl is nonseptate. Note tubercles on inner whorl.
2. Rubber imprint of external mold, CAS 13365. Note strong radial-trending ribs that fade out on venter.
3. Septate and partially corroded internal mold, CAS 13368.
4. Small corroded internal mold (X 2), CAS 13367. Note tubercles on inner whorls.

5, 6. Sonninia (Euhoploceras) sp. juv. (p. 65).
5, 6. Specimen, USNM 168498 from USGS loc. 21612. Shows prominent tubercles characteristic of inner whorls of species of Sonninia (Euhoploceras) adicra (Waagen) or S. (E.) crassispinata Buckman, as described herein.

7, 8. Internal mold with some adhering shelly material, CAS 13394 from Luperh's loc. 228N.
9. Internal mold showing strong tubercles and ribs, CAS 13396 from Luperh's loc. 407.

10-12. Sonninia (Euhoploceras) adicra (Waagen) (p. 65).
10. Laterally crushed internal mold of hypotype, CAS 13397 from Luperh's loc. 491. Shows strong spines characteristic of inner and intermediate whorls. Resembles inner whorls of S. acanthodes Buckman (1892, pl. 50, figs. 16, 17; 1894, pl. 92, figs. 1, 2).
11, 12. Hypotype, CAS 13392 from Luperh's loc. L228N.
PLATE 14

[All figures are natural size]

Figures 1–6. Sonninia (Euhoploceras) adicra (Waagen) (p. 65).

From the Weberg Member of the Snowshoe Formation.
1. Hypotype, USNM 168315 from USGS Mesozoic loc. 26765. Change from tuberculate to nontuberculate ribs occurs at an earlier growth than in some specimens.
2, 5. Hypotype, CAS 13395 from Lusher's loc. 228W. Cross section was drawn near adoral end. About one-fourth of outer whorl is nonseptate.
3, 4, 6. Hypotype, CAS 13393 from Lusher's loc. 228N. Shows tubercles on inner septate whorls similar to those shown on pl. 13, figs. 10, 11.
Figures 1–5. Sonninia (Euhaploceras) adicra (Waagen) (p. 65).

From the Weberg Member of the Snowshoe Formation.

1, 2. Lateral and ventral views of a stout hypotype, CAS 13390 from Lupher’s loc. 228N. This specimen differs from other Oregon specimens assigned to *S. adicra* in its ribs fading out on the venter as on the holotype of that species (Dorn, 1935, pl. 10, fig. 7).

3, 5. Hypotype, CAS 13391 from Lupher’s loc. 228N. Represents a coarsely ribbed variant of average stoutness. Resembles *S. cymaterea* Buckman (1892, pl. 73, figs. 2, 3), *S. spinicostata* Buckman (1892, pl. 73, figs. 4–6), and *S. locuples* Buckman (1894, pl. 92, figs. 5–7).

4. Laterally crushed hypotype, CAS 13389 from Lupher’s loc. 228N. Shows loss of tuberculation at a fairly early growth stage.
SONNINIA (EUHOPLOCERAS)
Figure 1. Sonninia (Euhaploceras) adicra (Waagen) (p. 65).
Laterally crushed hypotype, CAS 13388 from Lupher's loc. 228N. From the Weberg Member of the Snowshoe Formation. About three-fifths of outer whorl is nonseptate and probably represents most of body chamber. Resembles S. (E.) acanthodes Buckman (1892, pls. 58–60).
SONNINIA (EUHOPLOCERAS)
PLATE 17

(Figure is about four-fifths natural size)

Figure 1. *Soninia (Euhoploceras) adiera* (Waagen) (p. 65).

Moderately stout hypotype, CAS 13387 from Luper's loc. 228, upper part of Weberg Member of Snowshoe Formation. As slightly less than one-fourth of the outer whorl is nonseptate, the complete adult shell must have had a diameter of at least 350 mm. This specimen is nearly identical in appearance with the large adult specimens of *Soninia marginala* Buckman (1892, pls. 62 and 64).
SONNINIA (EUHOPLOCERAS)
Figures 1–3. Sonninia (Euhoploceras) polyacantha (Waagen) (p. 64).

Hypotype, CAS 13385 from Lupher's loc. 573. From Weberg Member of the Snowshoe Formation. Suture line drawn at whorl height of 70 mm. Figure 3 represents inner septate whorls of the specimen shown on plate 19 at reduced size. The cross section ($\times$ 3/5) represents the outer two whorls of the complete specimen shown on plate 19.
SONNINIA (EUHOPLOCERAS)
Figure 1. *Sonnia (Euhoploceras) polyacantha* (Waagen) (p. 64).

Hypotype CAS 13385 from Lupher's loc. 573. Same specimen shown on plate 18. The outermost whorl is nonseptate and presumably represents part of the body chamber.
PLATE 20

[All figures are natural size. Specimens shown in figs. 1, 5-7, are from the Weberg Member of the Snowshoe Formation; other specimens are from the Warm Springs Member]

FIGURES 1, 5-7. *Sonninia (Euhoploceras) polyacantha* (Waagen) (p. 64).
1, 5. Hypotype, CAS 13382 from Lupher's loc. 361.
6. Hypotype, CAS 13384 from Lupher's loc. 373.
7. Hypotype, CAS 13383 from Lupher's loc. 383.

2, 3. *Witchellia sp.* (p. 70).

Hypotype, CAS 13413 from Lupher's loc. 116.
SONNINIA (EUHOPLOCERAS) AND WITCHELLIA

1. 2. Hypotype, Stanford Univ. Mus. Paleontology 10023 from Dickinson's loc. 94 (= V4)
3. Hypotype, USNM 168528 from USGS Mesozoic loc. 29808.
4. Hypotype, USNM 168527 from USGS Mesozoic loc. 29395.
5. Hypotype (× 2), USNM 168529 from USGS Mesozoic loc. 29807.
6. Hypotype, USNM 168526 from USGS Mesozoic loc. 29395.
7. Hypotype, USNM 168525 from USGS Mesozoic loc. 29395.
10. Hypotype, CAS 13414 from Lupher's loc. 57.
11. Hypotype, USNM 168524 from USGS Mesozoic loc. 29395.

8, 9. *Sonninia* (*Euhaploceras*) *polyacantha* (Waagen) (p. 64).
8. Hypotype, USNM 168514 from USGS Mesozoic loc. 29828.
9. Hypotype, CAS 13386 from Lupher's loc. 581.
SONNINIA (EUHOPLOCERAS) AND WITCHELLIA
PLATE 22

[All figures are natural size. All specimens are from the Weber Member of the Snowshoe Formation]

Figures 1, 2, 4. *Sonninia (Europloceras) crassispinata* Buckman (p. 67).

1, 2. Lateral views of hypotype, USNM 168516 from USGS Mesozoic loc. 26766.

4. Compressed hypotype, CAS 13403 from Lpher’s loc. 605. Outer whorl is nonseptate and probably represents part of adult body chamber.


Specimen, Stanford Univ. Mus. Paleontology 10022 from Vigrass’ loc. 8. Note absence of spines on innermost exposed whorl at diameter between 15 to 45 mm.
SONNINIA (EUHOPLOCERAS)
Figures 1–4. Sonninia (Euhoploceras) crassispinata Buckman (p. 67).
From the Weberg Member of the Snowshoe Formation.
1. Hypotype, USNM 168517 from USGS Mesozoic loc. 21612. About one-third of outer whorl is nonseptate.
2–4. Cross section and lateral views of hypotype, CAS 13402 from Lupher's loc. 361.
SONNINIA (EUPHOCERAS)
PLATE 24

[All figures are natural size. Specimens shown in figs. 1, 4, and 5 are from the Weberg Member of the Snowshoe Formation; the other specimens are from the lower member of the Snowshoe Formation in the Izee area.]

FIGURES 1, 4. *Soninina (Euhoploceras) crassispinata* Buckman (p. 67).
1, 4. Hypotype, CAS 13398 from Lupher's loc. 228N. One-third of outer whorl is nonseptate.

2. Crushed fragment of inner whorls of specimen USNM 168509 from USGS Mesozoic loc. 26755.
3. Crushed fragment of outer whorl of specimen USNM 168510 from USGS Mesozoic loc. 26753.

Specimen, CAS 13400 from Lupher's loc. 228X. Note absence of spines on innermost exposed whorls.
SONNINIA (EUHOPLOCERAS) AND PLANAMMATOCERAS?
PLATE 25

All figures natural size unless otherwise indicated. Specimens shown in figs. 1-10 and 12-14 are from the middle part of the Snowshoe Formation in a large shale exposure east of highway and 0.6 mile south of Seneca, Ore. Specimens shown in figs. 11 and 15 are from lower part of middle member of Snowshoe Formation in the Izzi area. Specimens shown in figs. 17-19 are from the Weber Member of the Snowshoe Formation. Figs. 1, 3, 6, 12, 14, and 16 are from rubber imprints of external molds.

FIGURES 1-16. *Poecilomorphus varius* Imlay, n. sp. (p. 75).

All specimens except those shown in figures 11, 15, and 16 are from Lupher's loc. 28.

1. Paratype, CAS 13466.
2. Paratype, CAS 13465. Shows keel.
3. Paratype, CAS 13464. Shown with larger whorl at bottom.
4. Paratype, CAS 13461.
5. Paratype, CAS 13458.
6. Paratype, CAS 13460.
7. Paratype, CAS 13462.
8. Paratype, CAS 13459.
10. Paratype, CAS 13457.

11. Paratype, USNM 168553 from USGS Mesozoic loc. 27363.
12. Paratype (X 2), CAS 13456.
13, 16. Holotype (X 1 and X 2), CAS 13454. Figure 16 (X 2) is from a rubber imprint.
14. Paratype (X 2), CAS 13455.
15. Paratype, USNM 168554 from USGS Mesozoic loc. 27363.


17. Much weathered hypotype, CAS 13401 from Lupher's loc. 353.
18, 19. Hypotype, CAS 13399 from Lupher's loc. 228N. Cross section drawn from near adoral end.
POECILOMORPHUS AND SONNINIA (EUHOPLOCERAS)
PLATE 26

[All figures are natural size. Specimens shown in figs. 1, 11, and 12 are from the Warm Springs Member and in fig. 10 from the Weberg Member of the Snowshoe Formation in the Supplee area. All others are from the middle part of the Snowshoe Formation in the Seneca area, Ore. Figs. 2, 5, 7-9, 12, and 13 are from rubber imprints of external molds]

FIGURES 1–10, 12, 13. Sonninia (Papilliceras) stanloni (Crickmay) (p. 68).

Specimens shown in figures 4–9, 13 are from Luper’s loc. 57.
1. Hypotype, USNM 168518 from USGS Mesozoic loc. 29241.
2. Hypotype, USNM 168521 from USGS Mesozoic loc. 21617.
3. Hypotype, CAS 13407 from Luper’s loc. 311.
4. Hypotype, CAS 13405.
5. Hypotype, CAS 13404.
6. Hypotype, CAS 13410.
8. Hypotype, CAS 13411.
10. Hypotype, USNM 168520 from USGS Mesozoic loc. 21611.
12. Hypotype, USNM 168519 from USGS Mesozoic loc. 29241.
13. Hypotype, CAS 13406.
11. Sonninia (Papilliceras) cf. S. (P.) arenata (Quenstedt) (p. 68).
Specimen, USNM 168552 from USGS Mesozoic loc. 29241.
   Specimen, CAS 13412 from Lupher's loc. 206.

2, 3. *Planammatoceras?* spp. (Buckman) (p. 61).
   2. Rubber imprint of external mold of specimen USNM 168511a from USGS Mesozoic loc. 26753.
   3. Internal mold of specimen, USNM 168511b from USGS Mesozoic loc. 26753.

   4. Specimen, USNM 168523 from USGS Mesozoic loc. 26783.
   5, 6. Specimen, CAS 13413 from Lupher's loc. 360.
SONNINIA (PAPILLCERAS) AND PLANAMMATOCERAS?
PLATE 28

[All figures are natural size. Specimens shown in figs. 1 and 2 are from Warm Springs Member; in figs. 3, 4, and 6 from the lower part of the Basay Member; and in figs. 5 and 7 from the lower member of the Snowshoe Formation]


1, 2. Lateral and apertural views of specimen, USNM 168536 from USGS Mesozoic loc. 29239. See other view on pl. 29, fig. 7.
3. Rubber imprint of external mold, USNM 168535a from USGS Mesozoic loc. 29812.
4. Rubber imprint of external mold, USNM 168535b from USGS Mesozoic loc. 29812.
5. External mold, CAS 13430 from Lapher’s loc. 75. Outer whorl is nonseptate.
6. Internal mold bearing some shell material, USNM 168535c from USGS Mesozoic loc. 29812.
7. Crushed internal mold bearing some shell material, CAS 13431 from Lapher’s loc. 75.
DORSETENSIA
[All figures are natural size. Specimens shown in figs. 1-4 and 8-14 are from the lower exposed part of the Snowshoe Formation near Seneca. Those shown in figs. 5-7 are from the Warm Springs Member of the Snowshoe Formation]


All specimens are from Lupher’s loc. 272.

1. Paratype, CAS 13435.
2. Rubber imprint of external mold of paratype, CAS 13434.
3. Rubber imprint of external mold of paratype, CAS 13433.
4. Rubber imprint of external mold of holotype, CAS 13432.


External molds, USNM 168537 a, b from USGS Mesozoic loc. 29396.


Specimen, USNM 168536 from USGS Mesozoic loc. 29239. See other views on pl. 28, figs. 1, 2.


All specimens are from Lupher’s loc. 57.

8. Rubber imprint of external mold of paratype, CAS 13440.
9, 11. Rubber imprint of external mold of paratype, CAS 13438.
10. Paratype, CAS 13441.
12. Rubber imprint of external mold of paratype, CAS 13437.
13. Paratype, CAS 13439.
[All figures are natural size. Specimens shown in figs. 1-4, 7-9, and 11 are from near the top of the Warm Springs Member of the Snowshoe Formation in the Suplee area; in figs. 5 and 6 from 60 feet below the top of the middle member of the Snowshoe Formation in the Izie area; in figs. 10 and 12 from the lower 300 feet of the Basey Member of the Snowshoe Formation in the Suplee area. Specimen shown in fig. 13 is described below.]


1–3, 7, 8. Laterally crushed specimens, USNM 168534a–c from USGS Mesozoic loc. 29241. Figures 1 and 3 are rubber imprints of external molds.

4. Rubber imprint of external mold, CAS 13429 from Lupher’s loc. 109.

5, 6. *Dorsetensia* sp. undet. (p. 72).

Undeformed internal mold with some shell adhering. Specimen, CAS 13442 from Lupher’s loc. 128.


10, 12. Small internal whorls, USNM 168538a, b from USGS Mesozoic loc. 29812.


13. *Stephanoceras* (Skirrowceras) *kirschneri* Imlay (p. 87).

Rubber imprint of hypotype, 168663 from USGS Mesozoic loc. 20017 in the Fitz Creek Siltstone, 1.08 miles N. 84.4° W. from mouth of Fitz Creek, Iniskin Peninsula, Alaska. Included for comparative purposes.
DORSETENSIA AND STEPHANOCEAS (SKIRROCEAS)
PLATE 31

[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation and represent a coarsely ribbed, tuberculate variant of the species]

Figures 1–12. Witchellia (Latiwitchellia) evoluta Imlay, n. sp. (p. 70).

1–3. Ventral and lateral views and suture line of internal mold. Paratype, CAS 13419 from Lupher’s loc. 228N. Suture line (X 2) drawn at whorl height of 21 mm near adapical end of specimen and of body chamber. Note ventral swellings on some ribs.

4, 5. Internal mold of paratype, CAS 13425 from Lupher’s loc. 355. One spirally elongate tubercle present at adapical end.

6, 10, 11. Suture lines (X 2) and lateral and ventral views of septate whorls. Paratype, CAS 13426 from Lupher’s loc. 361. Some ribs terminate in ventral swellings.

7, 8. Internal mold of paratype, CAS 13424 from Lupher’s loc. 307. Note spirally elongate swelling near ventral ends of backwardly inclined ribs.

9, 12. Internal mold of adult. Paratype, CAS 13420 from Lupher’s loc. 228N. Note that aperture is constricted on flanks and prolonged on the venter.
WITCHELLIA (LATIWITCHELLIA)
PLATE 32

(All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation, bear ribbing of intermediate strength for the species, and do not bear tubercles.)

Figures 1–11. Witchellia (Latitwitchellia) evoluta Imlay, n. sp. (p. 70).

1, 2, 5, 6. Ventral, lateral, and apertural views and suture line (× 2) of adult. Holotype, USNM 168530 from USGS Mesozoic loc. 29828.

Holotype is mostly an internal mold but includes some shelly material. Suture line drawn from adapical end of body chamber which occupies about three-fifths of a whorl.

3. Small septate paratype, USNM 168531 from USGS Mesozoic loc. 29828.

4. Slightly larger septate paratype, CAS 13421 from Lupher’s loc. 228N.

7, 11. Laterally compressed internal mold shows apertural constriction. Paratype, CAS 13427 from Lupher’s loc. 563.

8. Internal mold of small septate specimen retaining some shell material. Paratype, CAS 13416 from Lupher’s loc. 228.

9, 10. Internal mold of adult retaining some shell material. Note apertural prolongation on venter. Paratype, CAS 13423 from Lupher’s loc. 228W.
WITCHELLIA (LATIWITCHELLIA)
PLATE 33

[All figures are natural size. All specimens are from the Weberg Member of the Snowshoe Formation and represent a finely ribbed variant of the species. The specimens shown in figs. 4, 5, 7, and 8 become coarser ribbed rather abruptly, whereas the other specimens become coarser ribbed more gradually]

FIGURES 1–12. Witchellia (Latiwitchellia) etolata Imlay, n. sp. (p. 70).

1, 2. Immature internal mold retaining considerable shell material. Paratype, USNM 168553 from USGS Mesozoic loc. 26766.

3. Internal mold retaining considerable shell material. Paratype, CAS 13417 from Luper's loc. 228.

4, 5. Internal mold of paratype, CAS 13422 from Luper's loc. 228N.

6, 10. Internal mold retaining considerable shell material. Paratype, CAS 13428 from Luper's loc. 584. Note apertural constriction.

7, 8. Internal mold of paratype, CAS 13418 from Luper's loc. 228.

9, 11, 12. Apertural and lateral views of adult internal mold retaining much shell material. Paratype, USNM 168532 from USGS Mesozoic loc. 29828.
WITCHELLIA (LATIWITCHELLIA)
PLATE 34

[All figures natural size unless otherwise indicated. Specimens shown in figs. 1-4, 10, 11, and 15-17 are from the Bazy Member of the Snowshoe Formation; in figs. 5-9, 12, 14, and 18 from the lower exposed part of the Snowshoe Formation south of Seneca; in fig. 13 from the lower member of the Snowshoe Formation near Iizer; and in figs. 19-34 from the Weberg Member of the Snowshoe Formation in the Supplee area]


1. Rubber imprint of compressed external mold of paratype, USNM 168552.
2. Rubber imprint of compressed external mold of paratype, USNM 168550.
3. Paratype, USNM 168551.
4. Rubber imprint of compressed external mold of holotype, USNM 168549.

5-18. *Pelecodites silviesensis* Imlay, n. sp. (p. 74).

Specimens in figures 5-8 are from Lupher's loc. 272.
5. Holotype, CAS 13446. Note lateral lappet.
6. Rubber imprint of external mold of paratype, CAS 13450.
7. Rubber imprint of external mold of paratype, CAS 13448.
9. Paratype, CAS 13453 from Lupher's loc. 57.
10. Paratype, USNM 168547 from USGS Mesozoic loc. 29812.
11. Paratype, USNM 168548 from USGS Mesozoic loc. 29812.
12. Paratype, CAS 13452 from Lupher's loc. 57.
14. Paratype, CAS 13451 from Lupher's loc. 57. Note lateral lappet.
15, 16. Rubber imprint of external mold showing lateral lappet and internal mold (fig. 16) of paratype, USNM 168545 from USGS Mesozoic loc. 29818.
17. Rubber imprint of external mold showing lateral lappet. Paratype, USNM 168546 from USGS Mesozoic loc. 29812.
18. Rubber imprint of external mold showing part of lateral lappet. Paratype, CAS 13449 from Lupher's loc. 272.

19-34. *Pelecodites webergi* Imlay, n. sp. (p. 73).

20. Paratype, USNM 168543 from USGS Mesozoic loc. 26766.
21, 30. Fragment of body chamber showing high, narrow keel. Paratype, USNM 168542 from USGS Mesozoic loc. 26766.
22, 23. Compressed internal mold bearing much shell material. Paratype, CAS 13444 from Lupher's loc. 370.
24. Internal mold (× 2) bearing some shell material. Paratype, USNM 168540 from USGS Mesozoic loc. 26766.
25-27. Suture line (× 2) from adoral end of internal mold shown on figures 26 and 27 (also × 2). Paratype, CAS 13445 from Lupher's loc. 74.
28, 29, 31. Ventral and lateral views (× 2 and × 1) of holotype, CAS 13443 from Lupher's loc. 370. Figure 29 shows distinct lateral lappet. Specimen retains much shell material.
32, 33. Internal mold (× 2) retaining much shell material except for body chamber. Paratype, USNM 168539 from USGS Mesozoic loc. 21012. Note lateral lappet.
34. Internal mold retaining some shell material and bears lateral lappet. Paratype, USNM 168541 from USGS Mesozoic loc. 26766.
PLATE 35

All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation.


1, 2. Immature specimen (X 2) retaining much shell material, USNM 168555a from USGS Mesozoic loc. 21610.

3, 5–7. Suture line (X 2), ventral, lateral, and apertural views of septate internal mold, CAS 13460 from Lupher’s loc. 228N. Suture line drawn from near adoral end at whorl height of 47 mm.

4, 8, 9. Fairly small specimen retaining much shell material, USNM 168555b from USGS Mesozoic loc. 21610. Shows characteristic ribbing where shell is present.

11, 12, 14. Apertural, lateral, and ventral views of mostly septate internal mold, CAS 13470 from Lupher’s loc. 228N. Note broad, faint ribs that fade out adorally. Incomplete body chamber probably represented near crushed adoral end.

13. Small weathered internal mold, CAS 13468 from Lupher’s loc. 207.

10. *Asthenceras*? sp. (p. 56).

Specimen, USNM 168505 from USGS Mesozoic loc. 21611. Note lateral lappet and change from fine to coarse ribbing near beginning of body chamber.
PRAESTRIGITES AND ASTHENOCERAS?
PLATE 36

[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation]


1–4. Septate internal mold retaining some shell material, CAS 13474 from Lupher’s loc. 475.

8–10. Suture line (× 2) and ventral and lateral views of internal mold, CAS 13473 from Lupher’s loc. 225. In figure 9 the adoral end is pointed downward.


Lateral, apertural, and ventral views and suture line (all views × 2) of specimen, USNM 168558 from USGS Mesozoic loc. 21610. About one-eighth of whorl is nonseptate. Suture line drawn at whorl height of 8.5 mm near adapical end of outer whorl.


17. Lateral view of fragment of internal mold, CAS 13471 from Lupher’s loc. 371.

18–20. Lateral and apertural views of weathered internal mold, CAS 13472 from Lupher’s loc. 460.


Lateral and ventral views of internal mold, USNM 168556 from USGS Mesozoic loc. 26766. In figure 15 the adoral end is pointed downward.
HEBETOXYITES, LISSOCERAS?, AND STRIGOCERAS
PLATE 37

[All figures natural size unless otherwise indicated. All specimens shown are from the Weberg Member of the Snowshoe Formation]


1–3. Septate internal mold. Paratype, CAS 13491 from Lupher’s loc. 368.

5–7. Holotype, Stanford Univ. Mus. Paleontology 10028 from Vigrass’ loc. 87. Body chamber represents only one-fourth of outer whorl shown in figure 6, but most of that chamber is fragmentary and is not illustrated.

8, 9, 11, 12. Paratype, USNM 168560 from USGS Mesozoic loc. 26760. Nearly half of the outer whorl shown in figure 8 is nonseptate.

10, 15, 16. Suture line (× 2) and lateral and ventral views of paratype, CAS 13490 from Lupher’s loc. 212. Suture line drawn at whorl height of 16 mm about three-fourths whorl from adoral end of specimen.


4. Specimen, CAS 13493 from Lupher’s loc. 575. Shows fine ribbing on small septate whorl.

13, 14. Specimen, CAS 13492 from Lupher’s loc. 575. Shows fairly fine ribbing and stoutness of outer septate whorl. The specimen also includes a fragment of the body whorl which is not illustrated.
DOCIDOCERAS
PLATE 38

[All figures natural size unless otherwise indicated. All specimens shown except figs. 10 and 11 are from the Weberg Member of the Snowshoe Formation]


1-3, 13. Crushed adult internal mold. Paratype, CAS 13488 from Lupher's loc. 228N. Suture line (× 2) drawn near adapical end of outer whorl. Note apertural constriction.

4, 5. Partly crushed adult internal mold. Holotype, CAS 13487 from Lupher's loc. 228N. Note apertural constriction followed by swelling.

6, 7. Paratype, CAS 13489 from Lupher's loc. 352.

8, 9, 12, 14-17. *Docidoceras lupheri* Imlay, n. sp. (p. 78).

8, 12. Small septate paratype, CAS 13486 from Lupher's loc. 228.

9. Paratype, USNM 168559 from USGS Mesozoic loc. 29528. Internal mold retains much shell material that shows details of ornamentation on inner whorl. About half of outer whorl is non-septate.

14, 15, 17. Holotype, CAS 13484 from Lupher's loc. 228N. Complete body chamber occupies almost an entire whorl.

16. Deformed paratype, CAS 13485 from Lupher's loc. 103.


Rubber imprint of external mold of specimen, USNM 168561 from USGS Mesozoic loc. 21293, 1200 feet below top of Red Glacier Formation and 1.35 miles N. 52° W. of mouth of Fitz Creek, Iniskin Peninsula, Alaska. Discussed under *Comparisons With Other Faunas.*
DOCIDOCERAS AND DOCIDOCERAS?
PLATE 39

[All figures are natural size. All specimens shown are from the Warm Spring Member of the Snowshoe Formation]

Figures 1–4, 6, 7. *Otoites contractus* (J. de C. Sowerby) (p. 81).

Specimens except those in figures 3 and 4 are from USGS Mesozoic loc. 29241.
1. Rubber imprint of external mold of hypotype, USNM 168570. Represents a finely ribbed variant.
2. Rubber imprint of external mold of hypotype, USNM 168569.
3. Rubber imprint of external mold of hypotype, USNM 168572 from USGS Mesozoic loc. 29395.
4. Hypotype, USNM 168571 from USGS Mesozoic loc. 29395.
6. Rubber imprint of external mold of hypotype, USNM 168568.

5, 12, 14. *Emileia* sp. undet. (p. 80).
5. Rubber imprint of external mold of adult, USNM 168566a from USGS Mesozoic loc. 29241. Note apertural constriction.
12. Immature specimen, Stanford Univ. Mus. Palaeontology 10029 from Dickinson's loc. 94.

8–11, 13, 15. *Emileia buddenhagensi* Imlay, n. sp. (p. 80).
10, 11. Rubber imprint of internal mold and external mold (fig. 11) USNM 168563.
13. Paratype, USNM 168565
15. Rubber imprint of external mold of paratype, USNM 168564.
OTOITES AND EMILEIA
PLATE 40

[All figures natural size unless otherwise indicated. Specimens shown in figs. 1 and 2 are from the Warm Springs Member of Snowshoe Formation; in figs. 3, 24-33 from the lower part of the Snowshoe Formation south of Seneca; in figs. 4-19 from the top of the middle part of the Snowshoe Formation south of Seneca; in figs. 11, 14-16 from the Basey Member of the Snowshoe Formation; in fig. 15 from Snowshoe Formation near Emigrant Creek in beds equivalent to middle part of Snowshoe Formation of Seneca area; and in figs. 13, 17-23 from highest part of Snowshoe Formation near Seneca.]

Figures 1, 2. Normannites (Massekites?) cf. N. (M.? densus (Buckman) (p. 85).
From USGS Mesozoic loc. 29241.
1. Rubber imprint of external mold, USNM 168593a. Outer whorl is nonseptate.
2. Rubber imprint of external mold of adoral part of body chamber. Specimen, USNM 168593b.
Rubber imprint of internal mold of hypotype, CAS 13507 from Lupher's loc. 57. Note lateral lappet.

4–7. Megasphaeroceras rotundum Imlay (p. 82).
From Lupher's loc. 28.
4. Lateral view of septate whorl, CAS 13301.
5. Lateral view of septate whorl, CAS 13499.
6. Rubber imprint of external mold, CAS 13500.
7. Ventral view of crushed internal mold, CAS 13498.

8–10. Chondroceras n. sp. undet. (p. 82).
From Lupher's loc. 28.
8. Adult specimen, CAS 13496.
9. Adult specimen, CAS 13494.
10. Crushed body chamber, CAS 13495.

11, 12. Chondroceras allani (McLearn) (p. 81).
11. Adult hypotype, USNM 168574 from USGS Mesozoic loc. 28384.
12. Adult hypotype, USNM 168573 from USGS Mesozoic loc. 20770.

Rubber imprint of external mold, CAS 13483 from Lupher's loc. 8.

14–16. Sphaeroceras sp. (p. 82).
14. Internal mold showing most of body chamber. Specimen, USNM 168579a from USGS Mesozoic loc. 29816.
15. Internal mold of adult, USNM 168579b from USGS Mesozoic loc. 29816. Note flared collar.
16. Internal mold of adult, USNM 168578 from USGS Mesozoic loc. 29813. Note flared collar.

17. Rubber imprint of external mold showing most of body chamber. Specimen, USNM 168577 from USGS Mesozoic loc. 29817.
18. Ventral view of adoral part of body chamber. Specimen, USNM 168576 from USGS Mesozoic loc. 29236.
19–22. Lateral, ventral, and apertural views of unfomed internal mold of adult specimen, CAS 13497 from Lupher's loc. 8. Figures 20–22 (X 2). Figure 22 shows same view as figure 19.
23. Lateral view of adult body chamber. Specimen, USNM 168575 from USGS Mesozoic loc. 28018.

24–33. Lithoceras hypell Imlay, n. sp. (p. 77).
Specimens shown, except in figure 29, are from Lupher's loc. 57.
24. Lateral view of small septate paratype, CAS 13478.
25. Lateral view of small fragment of internal mold showing smooth area along venter. Paratype, CAS 13481.
26. Ventral view of fragment showing smooth area along venter. Paratype, CAS 13482.
27. Lateral view showing smooth midventral area. Paratype, CAS 13480.
28. Lateral view of part of body whorl. Paratype, CAS 13479.
29. Internal mold retaining much shell material and representing most of adult body whorl. Paratype, USNM 168557 from USGS Mesozoic loc. 21617.
30, 31. Internal mold (fig. 30) and rubber imprint of external mold of adult body whorl. Holotype, CAS 13475.
32. Crushed internal and external molds of paratype, CAS 13476.
33. Rubber imprint of external mold of paratype, CAS 13477.
PLATE 41

[All figures are natural size. Specimens shown in figs. 1 and 18 are from the middle part of the Snowshoe Formation south of Seneca; in figs. 2-5, 9, 20, and 21 from equivalent beds near Emigrant Creek; in figs. 6-8, 17, and 19 from the lower part of the Snowshoe Formation south of Seneca; in fig. 16 from the Basey Member of the Snowshoe Formation; and in figs. 11-16 from the highest part of the Snowshoe Formation near Seneca.]

FIGURE 1. *Normannites* (Epalxites) cf. *N. (E.) anceps* (Quenstedt) (p. 84).

[Specimen, USNM 168592 from USGS Mesozoic loc. 29413.]


[Specimen, USNM 168589 from USGS Mesozoic loc. 29410.]

[Specimen, USNM 168587.]

[Specimen, USNM 168588.]

[Specimen, USNM 168586.]


[Specimen, USNM 168581 from USGS Mesozoic loc. 27579.]

[Specimen, USNM 168583 from USGS Mesozoic loc. 29815.]

[Specimen, USNM 168582 from USGS Mesozoic loc. 29415.]

[Specimen, USNM 168580 from USGS Mesozoic loc. 20772.]


[Specimen, CAS 13503 from Lpher’s loc. 8.]

[Specimen, CAS 13504. Note lateral lappet.]

[Specimen, CAS 13505. Outer half whorl is nonseptate.]

[Specimen, CAS 13506.]

9, 10, 18, 20. *Normannites* (Normannites) *orbignyi* Buckman (p. 82).

[Specimen, USNM 168581 from USGS Mesozoic loc. 27579.]

[Specimen, USNM 168583 from USGS Mesozoic loc. 29815.]

[Specimen, USNM 168582 from USGS Mesozoic loc. 29415.]

[Specimen, USNM 168580 from USGS Mesozoic loc. 20772.]


[Specimen, USNM 168584 from USGS Mesozoic loc. 29232.]

[Note lateral lappet.]

[Specimen, USNM 168585 from USGS Mesozoic loc. 29231.]


[Specimen, CAS 13502 from Lpher’s loc. 57. Note lateral lappet.]

19. *Normannites* (Itinsaites) *formosus* (Buckman) (p. 84).

[Specimen, USNM 168590 from USGS Mesozoic loc. 21617.]


[Specimen, USNM 168591 from USGS Mesozoic loc. 28029.]
NORMANNITES (EPALXITES), N. (ITINSAITES), AND N. (NORMANNITES)
FIGURES 1–10. Stephanoceras (Skirroceras) kirschneri Imlay (p. 87).

1. Rubber imprint of small external mold. Hypotype, CAS 13510 from Lpher's loc. 55.
2. Small inner whorls. Hypotype, USNM 168604 from USGS Mesozoic loc. 29813.
3, 4. Parts of a single specimen. Hypotype, USNM 168605 from USGS Mesozoic loc. 26770.
6. Hypotype, USNM 168606 from USGS Mesozoic loc. 26772.

2. Hypotype, CAS 13517 from Lupher’s loc. 272.
5. Hypotype, CAS 13520 from Lupher’s loc. 311.
8. Compressed hypotype, USNM 168608 from USGS Mesozoic loc. 28028.


Rubber imprint of external mold and internal whorls of same specimen. USNM 168609 from USGS Mesozoic loc. 29413.

10. Rubber imprint of external mold, USNM 168599a from USGS Mesozoic loc. 28649.
11. Rubber imprint of external mold, USNM 168599b from USGS Mesozoic loc. 28649.
12. Specimen, USNM 168599c from USGS Mesozoic loc. 28649.
13. Rubber imprint of external mold, USNM 168599d from USGS Mesozoic loc. 28649.
14. Rubber imprint of external mold, USNM 168600 from USGS Mesozoic loc. 28020.
STEPHANOCERAS (SKIRROCERAS) AND STEPHANOCERAS
PLATE 44

[All figures natural size unless otherwise indicated. Specimens shown in figs. 1-6 are from the highest part of the Snowshoe Formation near Seneca; in fig. 9 from the Snowshoe Formation undifferentiated in the Seneca area; in fig. 7 from upper part of Basey Member of Snowshoe Formation; in figs. 8 and 10 from basal part of middle member of the Snowshoe Formation in the loe area; on fig. 11 from near top of middle part of Snowshoe Formation south of Seneca; and in figs. 12 and 13 from upper part of Weberg Member of Snowshoe Formation]


From USGS Mesozoic loc. 29231.
1, 2, 5, 6. Ventral and lateral views (X 1) and suture line (X 2) of specimen, USNM 168598a. Figure 5 is from a rubber imprint of an external mold.
3. Specimen, USNM 168598b.
4. Specimen, USNM 168598c.


7. Rubber imprint of external mold of fairly large septate specimen, USNM 168602 from USGS Mesozoic loc. 23834.
8, 10. Small whorls of specimen, USNM 168601 from USGS Mesozoic loc. 27363. Figure 10 is a rubber imprint of an external mold.
9. Rubber imprint of an external mold showing small whorls of specimen, CAS 13508 from Lupher's loc. 57.
11. Specimen, CAS 13509 from Lupher's loc. 28.


Lateral and ventral views of specimen, Stanford Univ. Mus. Paleontology 10030 from Vigrass' loc. 162.
STEPHANOCERAS (SKIROCERAS) AND STEPHANOCERAS
[All figures are natural size. Specimens shown in figs. 1-7 are from the Warm Springs Member of the Snowshoe Formation; in figs. 8 and 11 from the Weber Member; and in figs. 9 and 10 from the lower part of the Snowshoe Formation south of Seneca]

**Figures 1-4.** *Stephanoceras (Phaulostephanus?) oregonense* Imlay, n. sp. (p. 89).

1,2. Crushed internal mold and rubber imprint of external mold. Holotype, USNM 168611 from USGS Mesozoic loc. 29241. Figure 1 shows complete body chamber that occupies slightly more than one whorl. Figure 2 is oriented in same position as figure 1 and lacks about two-fifths of body chamber.


4. Rubber imprint of external mold. Paratype, USNM 168613 from USGS Mesozoic loc. 29395.


5. Rubber imprint of external mold. Paratype, USNM 168596.


8,11. *Stephanoceras (Skirroceras) cf. S. (S.) dalichoecus* (Buckman) (p. 88).

8. Internal mold retaining some shell and showing inner whorls. Specimen, Stanford Univ. Mus. Paleontology 10033 from Vigrass' loc. 162.

11. Internal mold showing adoral part of body chamber. Specimen, Stanford Univ. Mus. Paleontology 10032 from Vigrass' loc. 16.


Rubber imprint of external mold. Specimen, CAS 13548 from Lupher's loc. 57.


Rubber imprint of external mold. Specimen, USNM 168597 from USGS Mesozoic loc. 25818.
STEPHANOCCERAS (PHAULOSTEPHANUS?), S. (SKIRROCERAS), AND STEPHANOCCERAS
PLATE 46

[All figures natural size unless otherwise indicated. Specimens shown in figs. 1-9 and 12 are from the upper part of the Snowshoe Formation near Seneca; in figs. 10, 11, 13, and 14 from the Snowshoe Formation near Emigrant Creek; and in fig. 15 from the Warm Springs Member of the Snowshoe Formation in the SUPLEE area]

   From Lupher's loc. 8
   1, 2. Specimen, CAS 13522.
   3-5. Lateral and ventral views (×1) and suture line (×2) of largest available specimen. CAS 13521.
   6, 7. Specimen, CAS 13524.
   8, 9. Specimen, CAS 13523.

10, 11, 13. Teloceras itinense McLearn (p.90).
   10. Rubber imprint of external mold. Specimen, USNM 168614 from USGS Mesozoic loc. 29410.
   11. Specimen, USNM 268616 from USGS Mesozoic loc. 26770.

   12. Rubber imprint of small whorl. Specimen, CAS 13255 from Lupher's loc. 30.

15. Stephanoceras (Skirroceras) cf. S. (S.) leptogyrale (Birman) (p. 88).
   Fairly complete internal mold, USNM 168610 from USGS Mesozoic loc. 29241.
STEMMATOCERAS, TELOCERAS, ZEMISTEPHANUS?, AND STEPHANOCERAS (SKIRROCERAS)
PLATE 47

[All figures natural size unless otherwise indicated. Specimens shown in figs. 1-9, 12-23, and 26-30 are from the highest part of the Snowshoe Formation near Seneca; in figs. 10 and 11 from near top of unnamed Jurassic sequence in the Huntington area; in fig. 24 from the base of the upper member in the Suplee area; in fig. 25 from near the top of the middle part of the Snowshoe Formation near Seneca; in fig. 26 from unnamed Jurassic beds on Juniper Mountain, Malheur County; and in figs. 21-23, 25, and 26 from the Warm Springs Member of the Snowshoe Formation in the Suplee area. Specimens shown in figs. 1, 2, 6, 7, 9-11, 19, 25, 28-30, and 30 are rubber imprints of external molds.]

Figures 1-20. _Lupherites senecaensis_ Imlay, n. sp. (p. 90).
Specimens shown, except in figures 10 and 11, are from Lupher's loc. 30.

1. Paratype, CAS 13532.
2. Paratype, CAS 13531.
3. Paratype, CAS 13536.
4. 5. Lateral and ventral views of paratype, CAS 13535.
6. Paratype, CAS 13529.
7. Paratype, CAS 13540.
8. Paratype, CAS 13537. Note presence of weak swellings on ventral ends of primary ribs on nonseptate part of outer whorl.
9. Paratype, CAS 13527.
10. Paratype, USNM 168619 from USGS Mesozoic loc. 29111.
11. Paratype, USNM 168618 from USGS Mesozoic loc. 29111.
12. 13. Paratype, CAS 1350. Note change in ribbing from septate inner whorl to nonseptate outer whorl.
14. Holotype, CAS 13526. Note change in rib density from septate inner whorl to nonseptate outer whorl.
15. Suture line (X 2) drawn at whorl height of about 19 mm. Paratype, CAS 13528.
17. Paratype, CAS 13533. Only right hand margin is septate.

21-23, 26-27. _Leptosphinctes cf. L. evolutus_ Imlay (p. 91)

From Lupher's loc. 30.

21. Specimen, CAS 13543.
22. 23. Ventral and lateral views of specimen, CAS 13545.
26. Specimen, CAS 13542.
27. Specimen, CAS 13544.

24. _Leptosphinctes_ sp. (p. 91).
Specimen, USNM 168620 from USGS Mesozoic loc. 26775.

25. _Leptosphinctes cf. L. leptus_ Buckman (p. 91).
Specimen, CAS 13541 from Lupher's loc. 28.

28-30. _Leptosphinctes_ (Prorsisphinctes?) spp. juv. (p. 92).

28. Specimen, USNM 168622 from USGS Mesozoic loc. 28649.
29. Specimen, CAS 13546 from Lupher's loc. 30.
30. Specimen, USNM 168621 from USGS Mesozoic loc. 28650.

31-36. _Parabigoliles crassicoostatus_ Imlay (p. 92).

31, 32. Lateral views (X 2 and X 1). Hypotype, CAS 13547 from Lupher's loc. 211.
34. Hypotype, USNM 168623 from USGS Mesozoic loc. 19773 from Kialagvik Formation on Alaska Peninsula.
LUPHERITES, LEPTOSPHINCTES, L. (PRORSISPHINCTES?), AND PARABIGOTITES