Studies of the Mowry Shale (Cretaceous) and Contemporary Formations in the United States and Canada

GEOLOGICAL SURVEY PROFESSIONAL PAPER 355

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By JOHN B. REESIDE, Jr., *and* WILLIAM A. COBBAN

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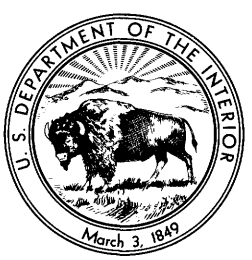
A stratigraphic and paleontologic study of five large assemblages of gastroplitine cephalopods interpreted as five species of Neogastroplites *having an unusual degree of variability*



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STUDIES OF THE MOWRY SHALE (CRETACEOUS) AND CONTEMPORARY FORMATIONS IN THE UNITED STATES AND CANADA

By JOHN B. REESIDE, JR., and WILLIAM A. COBBAN

ABSTRACT

A series of five faunal assemblages is found in the beds that constitute (a) the Mowry and Aspen shales and strata on Leeds Creek of the central part of the Western Interior of the United States, (b) part of the Colorado shale of Montana and Alberta, and (c) part of the Fort St. John group of Alberta and British Columbia. In the United States the deposits are largely the product of a long series of volcanic eruptions that are now represented by porcelanite, porcelanitic shale and sandstone, and bentonite distributed over the central and northern parts of the Western Interior. The Mowry and contemporary formations have yielded a flora, fresh-water invertebrates, marine invertebrates, an enormous amount of disarticulated fish remains, and a few bones of a variety of reptiles. Some of the marine invertebrates are the subject of the present paper. The fossils, except for the fish remains, are generally rare and poorly preserved, but at a few places calcareous concretions have furnished considerable numbers of well-preserved specimens, particularly ammonites. The speculation is offered that these assemblages of ammonites are fecal accumulations of a carnivore. Associated specimens of ammonites display a seemingly unusual range of variation in form and ornamentation and are interpreted as representing a small number of diversified species rather than a larger number of genera and species. Five such species are accepted in the genus *Neogastroplites* and are considered to mark five faunal zones. The age of the deposits is accepted as latest Albian (latest Early Cretaceous), with the reservation that they may possibly belong to the earliest Cenomanian (earliest Late Cretaceous). Detailed description of representative stratigraphic sections and a list of all the localities that yielded fossils considered in the paper are given.

Five species of gastroplitine ammonities are recognized as marking five discrete assemblages and are assigned to *Neogastroplites*: in ascending order, *haasi* Reeside and Cobban, n. sp.; *cornutus* (Whiteaves); *muelleri* Reeside and Cobban, n. sp.; *americanus* (Reeside and Weymouth); and *maclearni* Reeside and Cobban, n. sp. Faunal connection between the horizons of these assemblages cannot now be shown and inferences as to development are purely theoretical. In each species the wide range of form is broadly classified as including compressed costate, stout nodose, and subglobose spinose shells, though the relative amounts of each morphologic variety differ from level to level. The subglobose spinose portion is predominant in the oldest assemblage, the stout nodose portion in the second, and the compressed costate, *Gastroplites*-like portion, in the third and fourth, and the subglobose spinose appears strongly again in the fifth. Within each species 5 to 7 subordinate morphologic units are recognized as infrasubspecific variants and designated by letter. Each variant and some connecting forms are described and illustrated to show ontogenetic development as well as mature stages. As the genus *Neogastroplites* was based on a few moderately large shells of stout nodose morphology, the generic diagnosis has to be expanded to include the compressed costate variants, which attain large size, and the subglobose spinose variants, which remain relatively small. McLearn's interpretation that *Ncogastroplites* descended from *Gastroplites* by development of nodes is accepted.

INTRODUCTION AND ACKNOWLEDGMENTS

The primary purpose of this work is to describe, illustrate, and interpret certain invertebrate fossils of the Mowry shale and approximately contemporaneous formations in the Western Interior of the United States and their continuation northward into Canada. For a satisfactory understanding of the fauna, it is desirable to record, in addition to the taxonomic data, details of geographic distribution, stratigraphic occurrence, association, and various other features of the fossils, as well as character and thickness of the enclosing rocks.

The Mowry and Aspen shales have long been known for their unusual lithologic content, particularly the highly siliceous rocks now called porcelanites, for their abundant content of disarticulated fish remains, and for the general scarcity of other fossils. Ammonites had been found at a few places, but were in the main completely flattened molds that were difficult to interpret and were completely misunderstood. A few unflattened specimens had actually been collected, but most of them had been attributed to false horizons by the collectors and the small remainder had not been critically examined. Collections made by Cobban in the 1940's had shown that at least some of the unflattened material came from Mowry horizons and suggested that the fauna would be worth investigation. In the fall of 1949, Dr. T. C. Yen and Mr. H. R. Christner brought in a few specimens of well-preserved ammonites from a locality on the Winnecook

Ranch, Wheatland County, Montana, which led to a field investigation of this and other localities in 1950 and thus launched the present undertaking.

In the work on which this paper is based the writers have had much help for which acknowledgement is due. Mr. Oscar O. Mueller, of Lewistown, Montana, discovered and collected the fossils from the localities near Teigen, Montana. Dr. Otto H. Haas, of the American Museum of Natural History, and Dr. Keith Young, of the University of Texas, lent material collected by them from a locality near Limestone, Montana, and Dr. Young presented to the U. S. National Museum the specimens from his collection figured in this paper. The Geological Survey of Canada, through the kind offices of Dr. J. A. Jeletzky, gave casts of Canadian specimens and lent material from localities in Alberta. Other friends have given or lent specimens from numerous localities and the collections of the U. S. Geological Survey, made by present and former members of the Survey, have supplied a number, for all of which the writers are grateful. The names of these many collectors are recorded in the locality data on a later page; their efforts have provided a widespread record of the occurrences of the fauna.

Dr. F. H. McLearn and Dr. J. A. Jeletzky, of the Geological Survey of Canada, have kindly read parts of the manuscript and offered helpful suggestions.

The writers have visited many of the localities cited in this paper. In the summers of 1950, 1951, and 1953 Mr. H. R. Christner assisted in the field-work. In 1953 Messrs. Alejandro Calderón García, Eduardo Rodríguez Santana, M. V. A. Sastry, and Dwight W. Taylor also assisted. These gentlemen contributed materially to the success of the field operations.

In order to save space certain symbols and abbreviations are used, as follows:

AMNH American Museum of Natural History
BM British Museum (Natural History)
GSC Geological Survey of Canada
Loc. Locality
Mes. Mesozoic
USGS United States Geological Survey
USNM United States National Museum
UT University of Texas
YPM Yale Peabody Museum

STRATIGRAPHY AND HISTORICAL BACKGROUND

FORMATIONS IN THE WESTERN INTERIOR OF THE UNITED STATES

The collections of fossils from the United States here discussed have come from the Mowry shale, uppermost part of the Thermopolis shale, Aspen shale, strata on Leeds Creek, and from equivalents of the Mowry and Aspen in the Colorado shale of Montana. All are from the middle and northern parts of the Western Interior region (fig. 1) and fall within the time span of *Neogastroplites*.

MOWRY SHALE

The Mowry shale (as "the Mowrie beds") was named by Darton (1904, p. 394-401) from exposures on Mowry Creek, northwest of Buffalo, Wyoming, near the northern end of the Bighorn Mountains. It was considered then part of the Benton formation, and it was said to form a

> very characteristic series, about 150 feet thick, of hard, lighter gray shales and thin bedded sandstones which weather to a light gray color and form bare ridges of considerable prominence * * * most of its beds contain large numbers of fish scales and occasional fish teeth and bones.

The Mowry at its type locality is underlain by dark shales, unnamed in 1904 but subsequently named the Thermopolis shale (Lupton, 1916) and including near the middle a Muddy sandstone member. These in turn are underlain by a sandy formation called Cloverly sandstone by Darton. The Mowry is overlain by dark shales, also unnamed in 1904 but included in recent years in the Frontier formation.

In the same publication Darton (1904, p. 391) described as a part of the Graneros shale in the Black Hills

> a very distinctive series of hard sandy shales, from 50 to 300 feet thick, which extends entirely around the uplift. These shales are characterized by weathering to a dull silver gray color, by containing large numbers of fish scales, and by usually giving rise to a low but distinctive ridge bearing a stunted growth of pines.

These shales are underlain by a few feet of dark shale, unnamed in 1904 but at a later date named the Nefsy shale member of the Graneros shale (Collier, 1922); both units are now included in the Mowry shale. Beneath the Mowry lie in turn a sandstone now called the Newcastle sandstone (Hancock, 1920, p. 39), a dark shale now called the Skull Creek shale (Collier, 1922, p. 79) and forming the base of Darton's Graneros, and a sandstone called by Darton the Dakota sandstone but now called the Fall River sandstone (Russell, 1927, p. 402). The Mowry shale is overlain by several hundred feet of dark shale, unnamed in 1904 but now called the Belle Fourche shale (Collier, 1922, p. 74). In the Black Hills the thickness of the Mowry shale ranges from 180 feet near the southwest margin to 250 feet near the northeast margin.

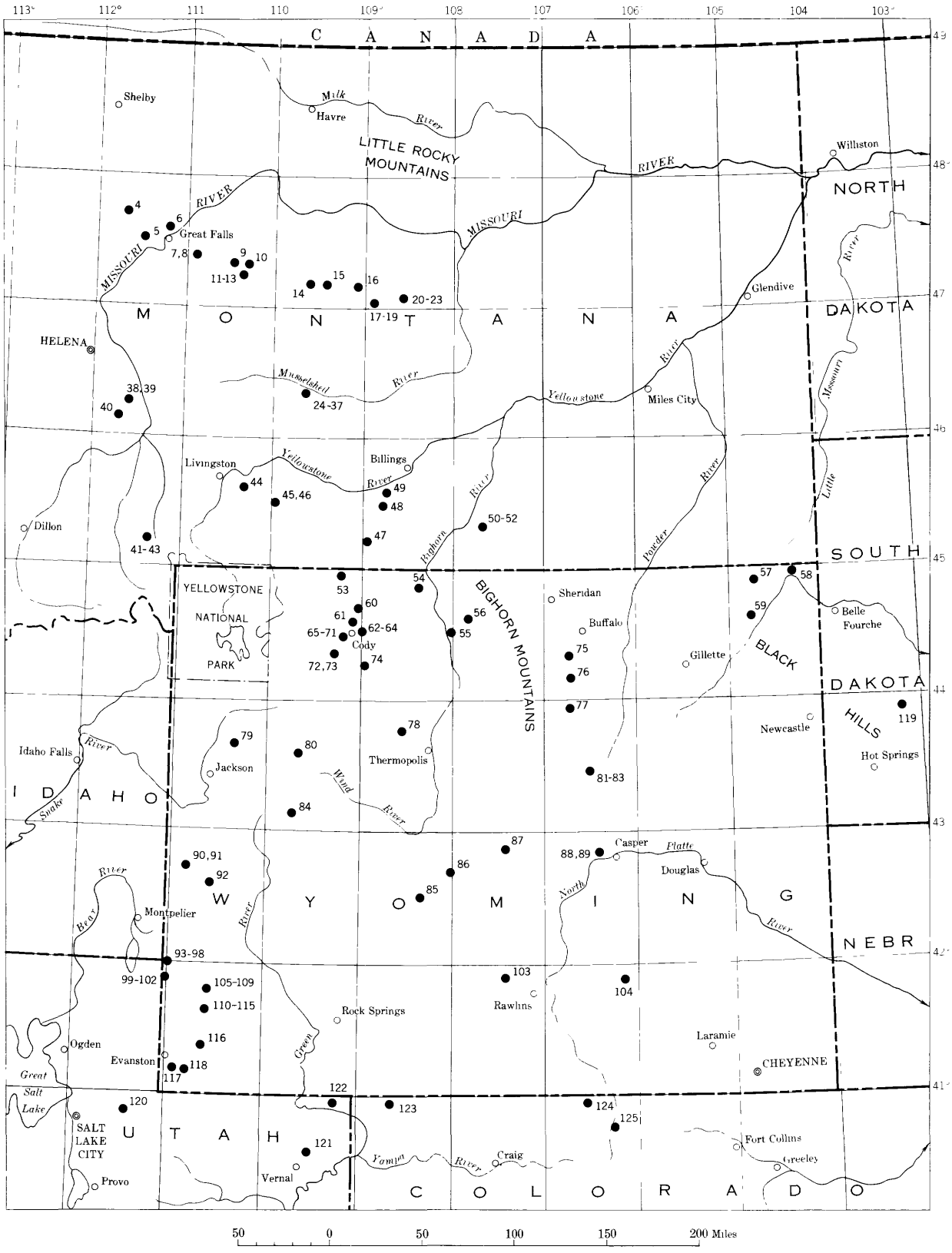


FIGURE 1.—Localities in the Western Interior of the United States of collections from the Mowry shale and contemporary formations. The numbers refer to the list of localities of collections of fossils given on page 21.

Because of the distinctive physical characters of the Mowry shale, the name was taken up and is now used over a large area from northern Colorado across central Wyoming into southern Montana and extending northeastward into the Black Hills. The presence in the formation of conspicuous beds of hard, very fine-grained, dense rock, much of it laminated, dark on fresh surfaces but weathering nearly white and forming resistant light-gray "chips" on the surface, and of yellowish soapy clay that swells when wet, were widely noted, together with the almost invariable presence of numerous scattered fish scales and bones. No convincing explanation of these peculiar features was offered until it was demonstrated that the yellowish clay, to which the name bentonite was given, is an altered volcanic ash (Hewett, 1917) and much later that the hard rocks were more or less silicified and also produced by the alteration of volcanic ash (Rubey, 1929; Bramlette, 1946, p. 44). These hard rocks range from very fine-grained nearly pure silica, usually called porcelanite,[1] to porcelaneous shale and porcelaneous sandstone. The layers of bentonite are unusually numerous; as many as 55 beds have been measured in a single section in a thickness of 191 feet (Heathman, 1939, p. 14). Concretions, isolated or in zones, are usually not common, though they do occur rather widely and may be highly calcareous. Limestones are rare, and for all practical purposes are absent.

The thickness of the Mowry shale in the Bighorn Basin (Pierce and Andrews, 1941, p. 121; Hewett and Lupton, 1917, p. 20) is 160 to 450 feet and in the Wind River Basin (Thompson, Love, and Tourtelot, 1949) is 200 to 700 feet, the greater thickness being in the west. In northwestern Colorado (Reeside, 1955) the Mowry is 155 feet thick and in the Laramie Basin of southeastern Wyoming (Darton and Siebenthal, 1909, p. 33) it is about 100 feet thick.

The underlying formation over much of central Wyoming is the black Thermopolis shale, with a Muddy sandstone member near the middle, and the overlying formation is the Frontier formation, containing in the west numerous sandstones and in the east shales with sandstones chiefly at the top. The underlying unit in the Black Hills, as stated above, is the Newcastle sandstone, below which in turn are the Skull Creek shale and Fall River sandstone; the overlying unit is the Belle Fourche shale. The basal part of the Mowry shale near the eastern flank of the Bighorn Mountains (western margin of the Powder River Basin, Hose, 1955) is a dark shale that rests on a sandstone now called Newcastle sandstone, and this in turn on a dark shale called Skull Creek, and this in turn on a Cloverly formation. West of the mountains, in the Bighorn Basin, the dark shale that forms the base of the Mowry of the east flank is included in the upper part of the Thermopolis shale, the Newcastle sandstone is called the Muddy member, and the Skull Creek shale is the lower shale member of the Thermopolis.

Skolnick (1958b) considers the basal part of the Mowry shale of the Black Hills, the Newcastle sandstone, and the Skull Creek shale to constitute one genetic unit, for which he uses the name Skull Creek, with a discontinuous member, the Newcastle. Only the more distinctive hard siliceous beds are included in the Mowry shale.

The apparent distribution of the volcanic material constituting the Mowry and Aspen shales is discussed in a later part of this paper.

Some difference of opinion has existed, with respect to central and western Wyoming, as to where in the sequence of rocks the boundaries of the Mowry shale should be placed. In this area the Mowry is overlain by the Frontier formation and underlain by the Thermopolis shale. In the original definition of the Thermopolis shale Lupton (1916, p. 168) described a "Muddy sand" near the middle. This later became known as the Muddy sandstone member of the Thermopolis shale, which is the present classification of the United States Geological Survey. Love (1948, p. 106) has pointed out that the part of the Thermopolis shale that overlies the Muddy sandstone member grades upward into the Mowry shale and that a satisfactory boundary cannot be determined either at the outcrops or from well cuttings. Love and associates (Love, 1948, p. 106-108; Thompson, Love, and Tourtelot, 1949; Love, Hose, Weitz, Duncan, and Bergquist, 1951) favor elevating the Muddy sandstone to formation rank and extending the Mowry downward to the top of the Muddy. Foster (1947, p. 1572, 1573, fig. 8) placed the boundary between the Mowry shale and Thermopolis shale still lower and included the Muddy sandstone in the lower part of the Mowry shale.

The upper boundary of the Mowry shale has, likewise, been placed at different levels according to personal opinion. Love and associates (Love, 1948, p. 108; Thompson, Love, and Tourtelot, 1949; Love,

[1] The term porcelanite, as used in this paper, has been applied in the Western Interior region to a form of chert much like the "porcelaneous smooth chert" of the "American Geological Institute Glossary" (Howell, 1957), which is described as having "a smooth fracture surface, hard opaque to translucent, resembling chinaware or glazed porcelain." It is not used in the senses of porcelanite given in the Glossary of "1. A light-colored porcelaneous rock resulting from the contact-metamorphism of marls * * * 2. Fused shales and clay that occur in the roof and floor of burned coal seams."

VERTICAL VIEW OF ALKALI ANTICLINE

Vertical view of Alkali anticline 13 miles southeast of Lovell, Wyo. The photograph includes much of the west half of T. 54 N., R. 95 W., Big Horn County. The Mowry shale crops out as light-gray bare ridges between the dark Thermopolis shale and the sandstone beds of the Frontier formation. Aerial photograph by U.S. Department of Agriculture. Formation contacts by R. L. Rioux, U.S. Geological Survey.

Hose, Weitz, Duncan, and Bergquist, 1951) place the upper boundary in central Wyoming at the base of a gray medium- to coarse-grained soft porous bed of sandstone that contains numerous dark grains. This sandstone is overlain by a widespread unit of white bentonite, tuff, and porcelanite. In southwestern Wyoming a similar white tuffaceous unit lies in the lower part of the Frontier formation at its type locality. In the Jackson Hole area farther north Foster (1947, p. 1574-1577) included this tuffaceous unit in the upper part of the Mowry. It makes little difference for present purposes whether this tuffaceous interval is called Mowry or Frontier. Presumably the tuff represents one of the latest eruptions in the series that contributed to the formation of the Mowry shale, and its assignment depends on the personal opinion as to whether the Mowry shale should include only the main mass of volcanic debris or all of it. Some authors (Towse, 1952, p. 1977; Hunter, 1952, p. 63; Masters, 1952, p. 58) place the top of the Mowry at a lower level than that accepted by Love and his associates.

The sections numbered 1 to 7 in the part of the paper on stratigraphic sections show the composition of the Mowry shale at several localities, and figure 2 presents the data graphically. Illustrations of outcrops of the formation in Wyoming are given in plate 2 and figure 4.

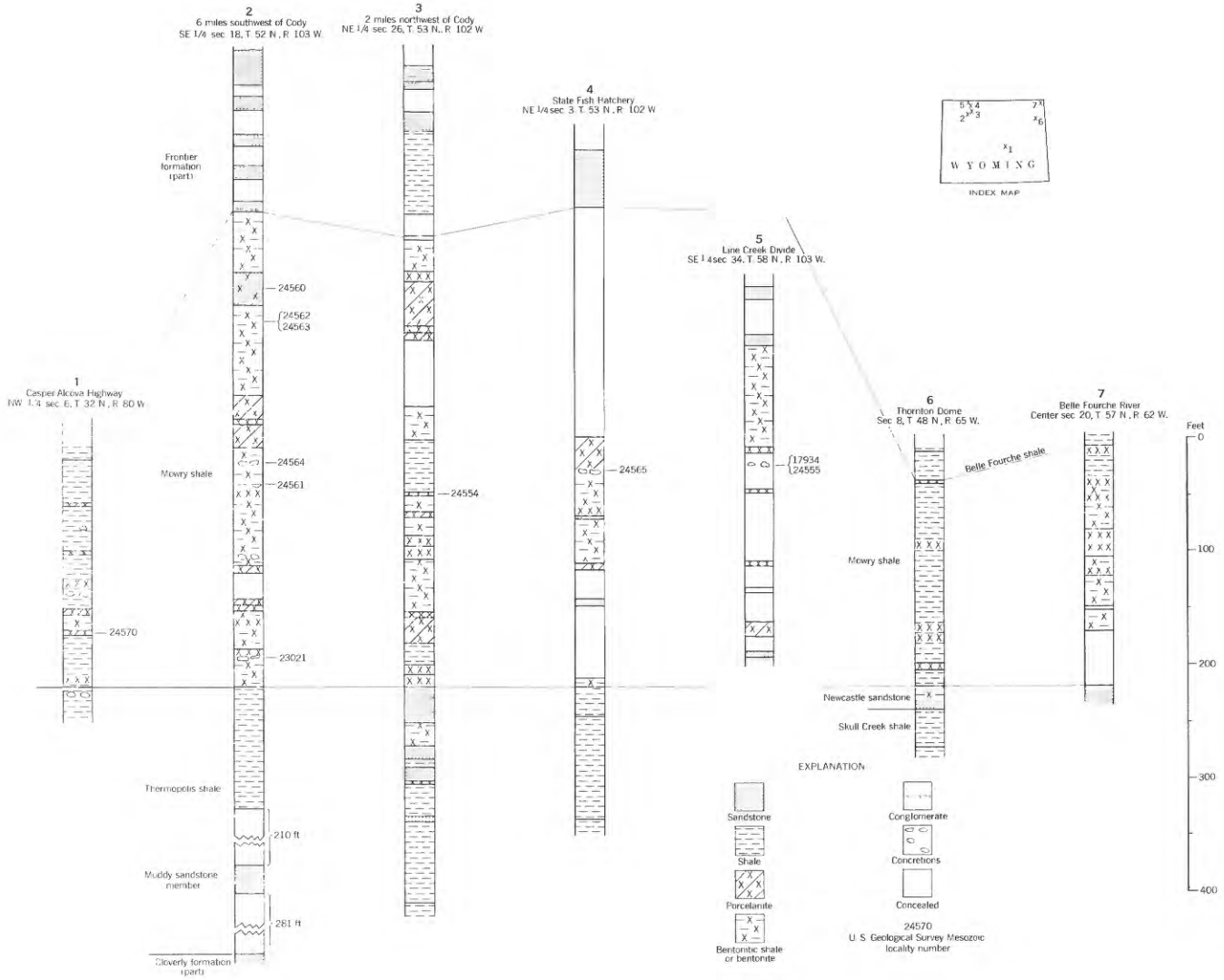


FIGURE 2.—Graphic sections of the Mowry shale of central and eastern Wyoming.

ASPEN SHALE

The Aspen shale was named by Veatch (1907, table opp. p. 50, p. 64) for the former station of Aspen, on a now abandoned alinement of the Union Pacific Railroad. Old Aspen was at the center of sec. 29, T. 14 S., R. 118 W., Uinta County, Wyoming, about 20 miles northeast of the southwest corner of the State. The formation was described as black and gray splintery, somewhat arenaceous shales containing abundant fish scales and often weathering silver-gray. The underlying dark shales, limestones, and sandstones had long been called the Bear River formation and the overlying sandstones and shales, in part coal-bearing, had for some years been called the Frontier formation. The name Aspen was carried by Schultz (1914, p. 59) northward 150 miles to the Snake River and later (1918, p. 28) about 50 miles still farther northwest into Idaho. The name has been applied by some geologists along both flanks of the Uinta Mountains in Utah, but in general has not been carried out of the north-south belt of outcrop in extreme western Wyoming over which Schultz used it. The thickness of the formation in its type area is 700 to 800 feet and in Idaho about 2,000 feet (Gardner, 1947, p. 6).

In general the Aspen shale might be said to contain proportionately more unsilicified shale and sandstone than the Mowry, though the conspicuous porcelanites are said to have less nonvolcanic material than the porcelanites of the Mowry (Rubey, 1931). The gross appearance of the two formations is much the same.

As with the Mowry shale, question might be raised as to the position of the boundary between the Aspen shale and the Frontier formation. Veatch placed in the Frontier several conspicuous beds of white altered tuff, well above the base of his Frontier (Cobban and Reeside, 1952b, p. 1927) and separated from the Aspen shale by sandstones, shales, and coal beds that are Frontier-like. Presumably the tuff here also represents part of the series of eruptions that contributed to both the Aspen and Mowry shales.

The sections numbered 8 and 9 in the part of the paper on stratigraphic sections show the composition of the Aspen shale at several localities, and figure 3, presents the data graphically.

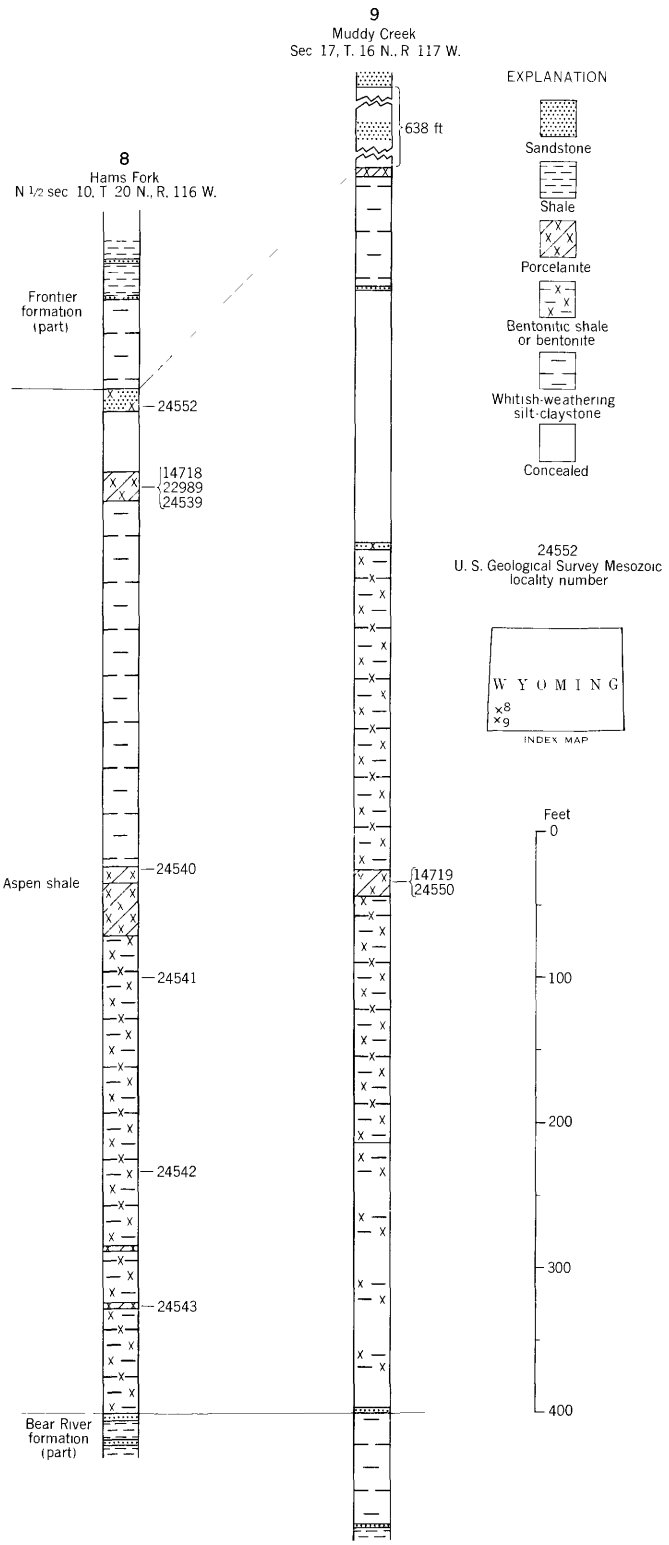


FIGURE 3.—Graphic sections of the Aspen shale of southwestern Wyoming.

STRATA ON LEEDS CREEK, WYOMING

Strata on Leeds Creek, about 15 miles south of Cokeville, Lincoln County, Wyoming, though only 25 miles west of the line of outcrop that contains the typical Aspen shale, form a sequence of rocks so different from the Aspen that the name is not logically applicable. Massive porcelanites and bentonites are present at intervals, but there are also thick light-brown nonporcelaneous sandstones, nonsiliceous shales,

coal beds, and limestones. Parts of the sequence are marine and bear pelecypods and gastropods; parts are nonmarine and bear fossil plants and nonmarine mollusks. The thickness amounts to about 6,000 feet, with the top undetermined because of the overlap of alluvial fill of Bear River Valley. The underlying beds, a sequence of dark shales, sandstones, and limestones, and locally coal beds, constitute the Bear River formation, with its characteristic nonmarine fauna. Erosion has removed any formerly overlying strata and it is not known what their age and composition may have been. It is possible that the sequence includes at the top equivalents of the lower part of the typical Frontier formation. The sequence fits very well what might be expected of a shoreward continuation of the Aspen shale and the strata are believed to extend northwestward into the upper part of the entirely nonmarine Wayan formation of Mansfield (1927, p. 105.)

COLORADO SHALE AND MOWRY SHALE MEMBER OF CENTRAL MONTANA

At its outcrop around the Little Rocky Mountains in the northeastern part of central Montana the Mowry consists of hard siliceous shale that weathers grayish white and contains abundant fish scales, much like the typical Mowry of Wyoming. Here the Mowry was given formational rank by Collier (1918, p. 21-26) and assigned a thickness of 100 feet. Later Collier and Cathcart (1922, p. 172) gave 50 feet as the thickness, used the Wyoming name Thermopolis for the underlying shale, and gave the new name Warm Creek for the overlying shale. At other places, particularly toward the east and north, no distinct member of the Colorado shale has been differentiated as the Mowry member, though equivalent beds are present.

West and south from the Little Rocky Mountains the Mowry becomes sandy. On the western part of the Cat Creek anticline Reeves (1927, p. 46) recognized a Mowry shale member near the middle of the Colorado shale. He gave a thickness of 100 feet and described the member as "grayish-white fissile sandy shale and fine-grained clayey sandstone with thin lamination of dark shale bearing fish scales." Near Teigen (No. 20 on pl. 1), 10 to 15 miles southwest of Reeves' area, the Mowry member consists of a lower light-gray siliceous shale unit 46 feet thick, a medial buff sandy unit 28 feet thick, and an upper light-gray siliceous shale unit 127 feet thick (see South Teigen, section 19, on a later page). Northwestward from Teigen the sandy unit thickens, seemingly at the expense of the adjoining shale units (pl. 1), and near Fort Maginnis the sandy unit is 102 feet thick, which is about half of the total thickness (215 feet) of the Mowry member. Between the Fort Maginnis and Spring Creek Colony sections little change in thickness or lithologic character occurs, but northwestward from Spring Creek Colony the lower and upper shale units thin markedly. At Belt Butte (No. 12 on pl. 1), 110 miles west-northwest of the South Teigen section, the entire Mowry equivalent may be sandy. Rocks equivalent to the Mowry member are sandy and poorly siliceous at their outcrop on the axis of the Sweetgrass arch a few miles north of Great Falls. Farther west along the Rocky Mountain front a sequence of nonmarine gray and green mudstones, siltstone, and sandstone may represent Mowry time.

About 50 feet below the Mowry member in the Teigen area is a 2½-foot bed of bentonite. This bed thickens rapidly northwestward and its top gradually approaches the base of the Mowry member (pl. 1). At Arrow Creek the bentonitic unit is 40 feet thick and consists of bentonite, tuff, and porcelanite. It is overlain directly by the lower shale unit of the Mowry member. This bentonitic unit, which forms a conspicuous white outcrop for 35 miles between Belt Butte and Stanford and is a very useful reference zone, is herein named the Arrow Creek member (Lower Cretaceous) of the Colorado shale. The section on the north side of Arrow Creek in sec. 23, T. 18 N., R. 10 E. (see section 14, on a later page) is selected as the type for the member. The stratigraphic positions of many of the ammonite collections in the Belt-Lewistown area are given in feet above or below the Arrow Creek member.

Rocks equivalent to the Mowry shale crop out on the West and Middle domes of the Shawmut anticline (Bowen, 1918, pl. 25), about 50 miles southwest of Lewistown. Here a conspicuous hogback-forming sandstone, the Big Elk sandstone member of the Colorado shale, grades downward into a sequence of soft shaly siltstone and sandy to nonsandy shale, with here and there a bed of bentonite. Along Timber Coulee near the Winnecook Ranch, on the north flank of Middle dome, a 31-foot bed of greenish-gray glauconitic sandstone lies stratigraphically 270 feet below the base of the cliff of the Big Elk sandstone member. *Neogastroplites* occurs in the upper part of this glauconitic sandstone and at intervals almost up to the base of the cliff.

About 60 miles southwest of the Timber Coulee section in the area near Livingston, Richards (1957, p. 415, pl. 36) described along the Boulder River a sequence of rocks similar to that of the Shawmut anticline and equivalent to all or part of the Mowry

shale. He gave the name Boulder River sandstone member of the Colorado shale to a hogback-forming unit that overlies 115 feet of sandy shale that is in part siliceous and contains *Neogastroplites*.

Near the Limestone School, 17 miles southeast of Richards' Boulder River section, rocks that are equivalent to part or all of the Mowry shale are nearly 200 feet thick (see Limestone, section 10, on a later page). The sequence is composed of porcelanitic sandstone, hard and soft shales that weather light gray, and several beds of bentonite. Beneath these are dark shales like those of the Thermopolis shale.

The sections numbered 10 to 20 in the part of the paper on stratigraphic sections show sequences in the Colorado shale at several localities, and plate 1 and figure 5 present the data graphically. Exposures of the Mowry member and equivalents in the Colorado shale in Montana are shown in figures 4 and 8.

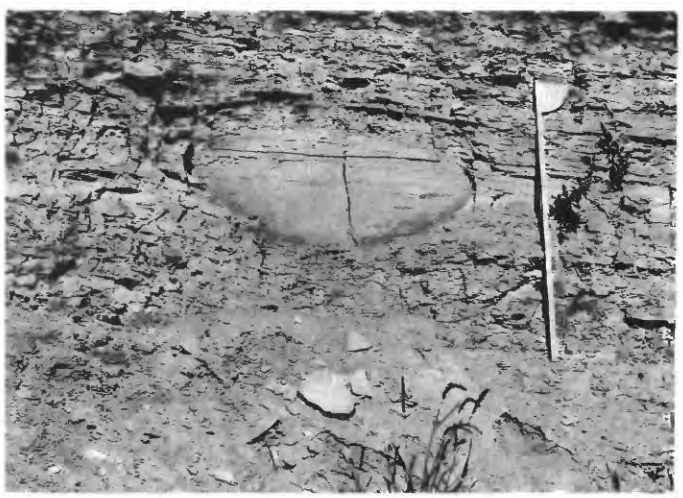
DISTRIBUTION OF MOWRY AND ASPEN SHALES

The peculiar rocks characteristic of the Mowry and Aspen shales — white-weathering porcelanites and hard, often white-weathering or bluish, porcelaneous shales and sandstones, associated at many places with thick bentonites—have been found over a fairly well defined area that extends from northern Utah and Colorado northward into Montana and from western Wyoming eastward to the east side of the Black Hills

A

B

C



D

FIGURE 4.—*A*, Bluff of Mowry shale (*Neogastroplites americanus* zone) near Belle Fourche River in sec. 20, T. 57 N., R. 62 W., Crook County, Wyo. *B*, Ledge-forming Mowry shale overlain by ironstone-bearing basal shale unit of Belle Fourche shale. Man is standing on Clay Spur bentonite bed (dark band) which is considered top of Mowry shale. Near same locality as *A*. *C*, Mowry shale 3 miles southeast of Upton in sec. 7, T. 47 N., R. 64 W., Weston County, Wyo. The very light color, sparseness of grass, and abundance of pine trees is characteristic of outcrops of this formation. *D*, Concretion of sandstone in sandy shale (*Neogastroplites americanus* zone) 172 feet below base of Big Elk sandstone member of Colorado shale in Timber Coulee in the NW¼ sec. 14, T. 7 N., R. 6 E. Wheatland County, Mont. Jacob staff is 5 feet.

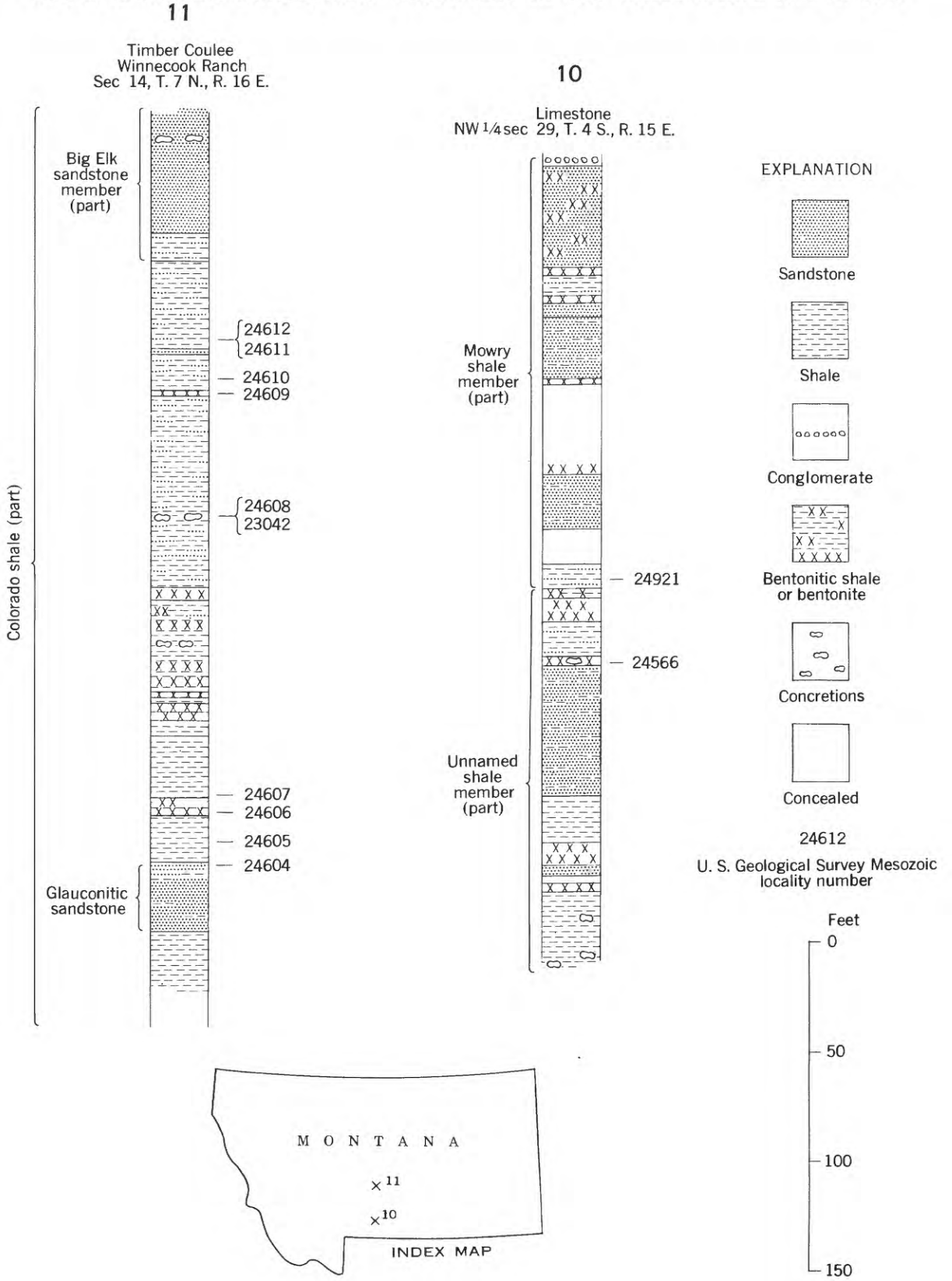


FIGURE 5.—Graphic sections of part of the Colorado shale of south-central and southern Montana.

in South Dakota (Reeside, 1944, map 3; Cobban and Reeside, 1952a, p. 1023; Reeside, 1957, fig. 6) (see fig. 6). In a general way this assemblage of strata is thickest near the center of the western margin of its area and thins progressively toward the southern, eastern, and northern margins. It disappears from the sequence of beds in northern Utah and Colorado, in southeastern Wyoming, at the southern edge of the Black Hills, and across central Montana. Also in a general way it is coarser-grained and the porcelaneous parts have proportionately more altered volcanic debris in them in the western parts of its area than in the remainder. The lithologic peculiarities are attributed to the former presence of volcanic ash that ranged from nearly 100 percent in some of the bentonites to very much less in some of the hard shales and sandstones, and the fossils in the beds over most of the area indicate deposition in sea water. The evidence, therefore, suggests a long series of volcanic eruptions, perhaps in Idaho, from which air-borne ash was carried, mostly eastward, over an inland sea and deposited in it.

As stated on a later page, five faunal assemblages, each believed to represent a brief time interval, are recognized in the Mowry and contemporaneous units. From the facts that in the Mowry shale the *Neogastroplites cornutus* assemblage occurs at a number of places near the base and the *N. americanus* assemblage at about the middle of the formation and that in the Aspen shale the *N. cornutus* assemblage occurs at about the middle and the *N. americanus* at the top of the formation it is suggested that the two units represent different time intervals. Half of the Aspen shale may have been deposited before the deposition of the Mowry shale began, perhaps while the upper part of the Thermopolis shale was being laid down. The upper half of the Mowry shale, on the other hand, may have been deposited during part of the time of deposition of the typical Frontier formation, perhaps the part represented by the rocks up to the white plant-bearing volcanic unit (Cobban and Reeside, 1952b, p. 1927, 1933). The conspicuous rocks of both the Mowry and Aspen shales are so similar to each other and so different from other rocks in the Cretaceous sequence that it is difficult not to believe them the product of one series of events.

Perhaps in the early stages of the series of eruptions the ash, if it came from Idaho, reached the area of the strata on Leeds Creek and the Aspen formation along what is now the Idaho-Wyoming boundary, but did not extend farther eastward in the amounts necessary to make up the Mowry formation. In central Wyoming the dark shales of the upper part of the Thermopolis, including numerous thin bentonite beds, were accumulating and in the Black Hills, the Newcastle sandstone, and overlying dark nonsiliceous part of the Mowry shale (Nefsy shale member of the Graneros shale of Collier, 1922, p. 82). Eventually the volcanic materials reached central Wyoming, and the Aspen and Mowry shales were accumulating simultaneously. After a while the basin in the western area had filled or the land had risen, for the nonmarine conditions of the lower part of the typical Frontier prevailed there, while the deposition of ash into the sea waters continued in the eastern area. Finally in central Wyoming also the sea basin filled or the land rose, for the sands of the Frontier formation succeeded the volcanic detritus. In the Black Hills the sea waters continued but they received the dark muds that are now the Belle Fourche shale.

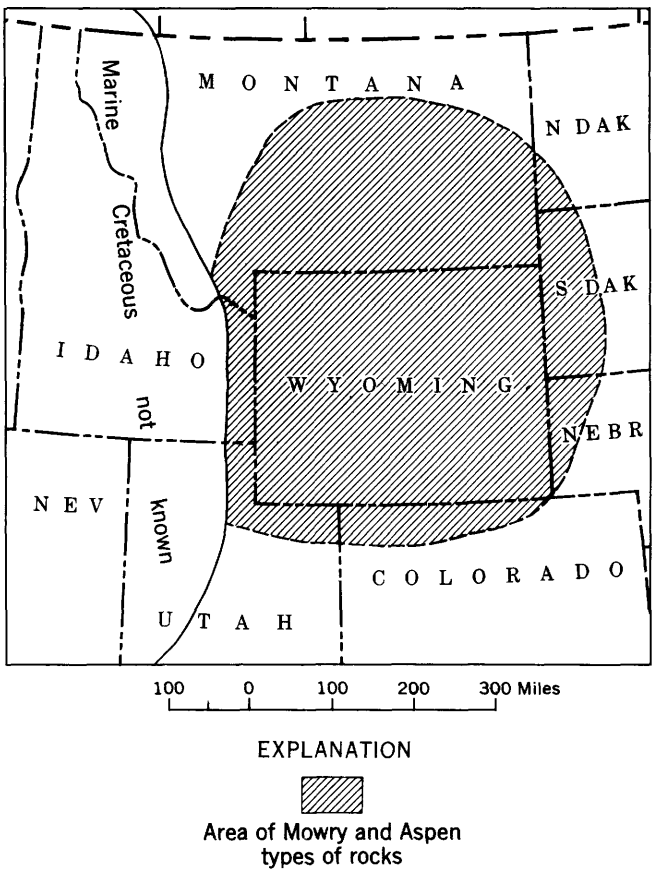


FIGURE 6.—Distribution of volcanic material constituting the Mowry and Aspen shales.

FORMATIONS IN THE WESTERN INTERIOR OF CANADA

The fossils from Canada described in this paper have come from the *Neogastroplites* zone in the upper part of the Fort St. John group and equivalent rocks in Alberta and northeastern British Columbia. Be-

cause of its importance in the general problem of classification and correlation, the older zone of *Gastroplites* is also discussed. The *Gastroplites* fauna has been found in the Peace River, Hasler, Commotion, Scatter, Lepine, and Buckinghorse formations and in the Sans Sault group. The *Neogastroplites* fauna has been found in the Shaftesbury, Goodrich, and Sikanni formations and in the upper part of the undivided Fort St. John group of the Alberta Foothills Belt (fig. 7). Fish-scale-bearing beds of *Neogastroplites* age occur in the Colorado group of southern Alberta. A widely distributed unit of shale, the Joli Fou and equivalent rocks, seems to lie between the levels of *Gastroplites* and *Neogastroplites*. It is included in this discussion because of its value in subsurface correlations.

In the following paragraphs the names that have been used in various areas are given and tentative correlations are recorded. A summary of these is shown in plate 3.

FORT ST. JOHN GROUP

Dawson (1881, p. 115B) gave the name "Fort St. John Shales" to the "Lower Shales" described by Selwyn (1877, p. 72) along the Peace River between Hudson Hope and Fort St. John. The name was applied to the marine rocks exposed along the river below the "Lower sandstone and shales with lignite and true coals (Dunvegan sandstone)." The top of the Fort St. John was well established, but the base was not defined. Dawson correlated the Fort St. John with the Benton shale of the United States and the Upper Greensand of England. Farther east, down the Peace River, McConnell (1893, p. 46D–57D) recognized three formations, a lower dark shale that he named the "Loon River shales" from exposures along the lower part of the Loon River (now Wabiskaw River), a middle sandy unit to which he applied the name "Peace River sandstones," and an upper shale to which he applied Dawson's name "Fort St. John shales." Fossils collected by Selwyn, Dawson, and McConnell were described by Whiteaves (1885, 1889, 1893). From the Fort St. John shales Whiteaves described *Buchiceras? cornutum*, which was later to become the genotype of *Neogastroplites* McLearn (1931, p. 7). Among the ammonites from the Peace River sandstones Whiteaves described *Hoplites canadensis*, which later became the genotype of *Gastroplites* McLearn (1930, p. 7).

McLearn in 1918 described the Cretaceous formations along Peace River. For the eastern area (Peace River-Vermilion Chutes area) he recognized a Loon River formation, a Peace River formation (with a lower sandstone member, a middle shale member, and an upper shale member), and a St. John formation. In the western area (Hudson Hope-Fort St. John area) all the strata between McLearn's "Bull Head Mountain sandstone" and the Dunvegan formation were placed in the St. John formation, which McLearn divided into three members, a lower shale, a middle sandstone, and an upper shale. The middle sandstone was correlated with the lower sandstone member of the Peace River formation. In 1923 McLearn restricted the name St. John formation to the upper shale of the western area. The middle sandstone was named the Gates sandstone and the underlying shale was called the Moosebar formation. Later McLearn (in McLearn and Hume, 1927, p. 244) applied the name St. John formation to all the beds between the "Bull Head Mountain formation" and the Dunvegan formation. The St. John formation was divided into a lower Moosebar shale member, a middle Gates sandstone member, and an upper shale member. In 1932 McLearn (p. 165, 166, fig. 2) again used Moosebar and Gates as formational names and applied to the upper shale the name Fort St. John. Wickenden and Shaw (1943, p. 2, 3) elevated Fort St. John to group status. McLearn and Henderson (1944, p. 2, 3) then revised the eastern Peace River section by placing the Loon River and Peace River formations in the Fort St. John group and giving the new name Shaftesbury to the shale above the Peace River formation that had formerly been called "St. John shale." Shaftesbury was applied tentatively by McLearn (1945, p. 4, fig. 2) to the upper shale formation of the Fort St. John group in the western area.

Beginning in 1945 considerable attention was focused on the Fort St. John group in the eastern Peace River area. McLearn (1945, p. 4) gave the name Cadotte to the upper sandstone of the Peace River formation but left the middle shale member and the lower sandstone member unnamed. Wickenden (1951, p. 5) noted that the Cadotte member of McLearn consisted of two units, a lower marine sandstone and an upper nonmarine sequence of sand, silt, and carbonaceous beds. He restricted the name Cadotte to the lower marine sandstone and called the nonmarine unit the "Continental member" of the Peace River formation. Badgley (1952, p. 7-9) studied the subsurface stratigraphy of the Lower Cretaceous rocks of central Alberta and presented many new names selected by the Alberta Society of Petroleum Geologists' Committee on the Lower Cretaceous of the Peace River area. The Peace River formation was restricted to the "upper sandstone" and "middle shale" of McLearn (1918, p. 15C). The

FIGURE 7.—Localities in Canada of the *Neogastroplites* fauna dealt with in this paper and other localities. The numbers refer to the list of localities given on a later page.

FIGURE 8.—*A*, Locality on the Winnecook ranch of *Neogastroplites americanus*, in Timber Coulee in sec. 14, T. 7 N., R. 16 E., Wheatland County, Mont. A concretion near the contact of the light and dark beds on the slope on the right side of the photograph contained hundreds of ammonites (USGS 23042). Big Elk sandstone member of Colorado shale forms bluff above cottonwood trees. *B*, Upper shale unit (bare of vegetation) overlying ledge-forming sandy unit of Mowry shale member of Colorado shale at the locality (USGS 24065) of the prolific *Neogastroplites muelleri* concretion near Teigen in sec. 4, T. 14, N., R. 25 E., Petroleum County, Mont. *C*, View east along south side of Belt Butte in sec. 30, T. 19 N., R. 7 E., Cascade County, Mont. A concretion crowded with *Neogastroplites cornutus* (USGS 23410) was found just above the top of the 33-foot ledge of porcelanite (Arrow Creek member of Colorado shale). *D*, Locality of *Neogastroplites haasi*, ¾ mile west of Limestone school in sec. 29, T. 4 S., R. 15 E., Stillwater County, Mont. The fossiliferous concretion was found on the hillside near the telephone pole (USGS 24566).

middle shale was given the name Harmon and the "Continental member" of Wickenden, which composed the upper part of the "upper sandstone" or Cadotte member of McLearn, was called the Paddy member. Two formations were defined for the section between the base of the restricted Peace River formation and the top of the Bullhead group. The upper or Spirit River formation included the "lower sandstone" or "basal member" of the Peace River formation of McLearn (1918, p. 16C) and Wickenden (1951, p. 4, 5) and much of the underlying Loon River formation. The Spirit River was divided into a lower Wilrich member, a middle Falher member, and an upper Notikewin member. The lower formation, Bluesky, was described between the Spirit River formation and the top of the Bullhead group. These formations and members were more formally defined later by the Alberta Study Group (Workman, 1954). Gleddie (1954, p. 488–494) noted that the Shaftesbury formation in the western Peace River plains of Alberta consists of a lower part of thinly bedded fissile shales with several fish-scale zones and an upper part of silty and sandy shale with few fish scales. He referred to these units as "Lower Shaftesbury formation" and "Upper Shaftesbury formation." Stelck and Wall (1955, fig. 5, p. 18) showed that, owing to interfingering with the Dunvegan formation, the top of the Shaftesbury becomes younger eastward.

In the Peace and Pine River areas west and south of Hudson Hope the beds above the Moosebar forma-

tion change character to such an extent that new names were needed. Wickenden and Shaw (1943, p. 2–10) proposed that the Fort St. John group be divided into the following formations: Moosebar, Commotion, Hasler, Goodrich, and Cruiser. They found *Inoceramus* of *Gastroplites* age in the Commotion formation and *Inoceramus* of *Neogastroplites* age in the Goodrich formation. Along Peace River west of Hudson Hope, Beach and Spivak (1944, p. 2, 6–10) recognized the following sequence of formations for the Fort St. John group: Moosebar, Gates, Hasler, Goodrich, and Cruiser.

Along the foothills southeast of the Pine River area, at least as far as Smoky River, the Fort St. John group is mapped as a unit and not divided into formations. Only the *Neogastroplites* fauna has been recorded (McLearn and Henderson, 1944, p. 3; Thorsteinson, 1952, p. 6, 30, 31; Greiner, 1955, p. 4).

Along the Sikanni Chief River north of Hudson Hope the Fort St. John group was divided by Hage (1944, p. 3, 9–12) into two formations, Buckinghorse at the base and Sikanni at the top. The Sikanni was divided into a lower sandy unit and an upper shale unit. The sand unit was further subdivided into four sandstone members (First, Second, Third, and Fourth). Hage records *Neogastroplites* from the upper part of the Buckinghorse and from the Second sandstone member of the Sikanni. McLearn (1944b, fig. 1) at first correlated the First and Second sandstone members with the upper part of the Hasler formation and the Third and Fourth sandstone members with the Goodrich formation, but later he (1945, fig. 1) correlated all four sandstones with the Goodrich. The shale member of the Sikanni was correlated with the Cruiser formation. Henderson (1954, p. 2281) referred to the sandy unit as the "Four-Sandstone member."

Farther north, in the Tetsa River valley west of Fort Nelson, Williams (1944, p. 23, 24) referred to a series of sandstones and shales to the Fort St. John group, but subdivision into named formations was not attempted. He noted a fauna of *Neogastroplites* age in a unit of sandstone and shale. Henderson (1954, p. 2282–2284) applied the names Buckinghorse and Sikanni to the Fort St. John group of Hage.

In the Liard River area centering around Nelson Forks northwest of Fort Nelson, Kindle (1944, p. 4, 10–13) defined three new formations, Garbutt, Scatter, and Lépine, which he considered equivalent to the Fort St. John group. Fossils diagnostic of the *Gastroplites* zone were found in the Scatter formation and Whiteaves' *Placenticeras liardense* was found in the Lépine formation.

Near Fort Liard at the mouth of the Petitot River Hage (1945, p. 4, 19, 20) mapped a "Fort St. John group" without subdivision into formations. He records *Neogastroplites cornutus*? from the lower part.

The *Neogastroplites* fauna has not been recorded north of Fort Liard. Marine rocks of Cretaceous age crop out far to the north along the Mackenzie River. In the Norman Wells area Hume and Link (1945, p. 5, 39–44) divided the Cretaceous rocks into a "Division A", consisting of glauconitic sandstone and gray sandy shale, a "Division B" of dark shale with some sandy beds, a "Division C" of sandstone and shale and some coal, and a "Division D" of gray shale. They record *Beudanticeras*, *Gastroplites*, and *Hoplites* from their division A, and a Turonian *Inoceramus labiatus* fauna from their division C. Fossils were not observed in division B, which may well be in part of *Neogastroplites* age. Stewart (1945, p. 3, 6–8) gave the name Sans Sault group to division A of Hume and Link and considered this to include all the rocks of Early Cretaceous age. Hume and Link's divisions B to D were given formational rank and named Slater River, Little Bear, and East Fork. A "fish-scale horizon" was noted in the Slater River formation.

COLORADO GROUP

Rocks in central and east-central Alberta that may contain the *Neogastroplites* fauna have been placed in the Colorado group by some authors and in the Fort St. John group by others. Along the lower part of the Athabasca River above Fort McMurray McConnell (1893, p. 27D–32D, 53D, 57D–59D) recognized the following sequence of Cretaceous rocks, from oldest to youngest: "Tar sands," Clearwater shale, Grand Rapids sandstone, Pelican shale, Pelican sandstone, and La Biche shales. From the Clearwater shale McConnell recorded *Hoplites* [=*Lemuroceras*] *mcconnelli* Whiteaves and *Desmoceras* [=*Beudanticeras*] *affine* Whiteaves, of middle Albian age. The "Tar sands" were later named the McMurray formation by McLearn (1917, p. 146), who at a much later date (1944b, fig. 1) placed the overlying Clearwater formation, Grand Rapids formation, and Pelican shale in the Fort St. John group. McLearn correlated the Grand Rapids formation with the Peace River formation, which contains *Gastroplites* in the upper part and *Beudanticeras* in the lower part. Wickenden (McLearn, 1945, p. 12) found *Haplophragmoides gigas* Cushman in the Pelican shale above the Grand Rapids formation. This species marks a widely distributed microfaunal zone of middle Albian age. Inasmuch as Pelican should not be used for two formations, Wickenden (1949, p. 3, 12–

21) restricted that name to the Pelican sandstone of McConnell and gave the new name Joli Fou to the Pelican shale. Wickenden referred the rocks above the Pelican formation to the Colorado group.

Farther south, in the Vermilion area of east-central Alberta, Nauss (1945, p. 1608–1618) gave the name Mannville formation to about 500 feet of sandy marine and fresh-water beds of Early Cretaceous age, and divided the formation into six named members. The Mannville is overlain by about 750 feet of dark marine shale called Lloydminster by Nauss. A Late Cretaceous age was assigned this shale. Wickenden (1948, p. 2) studied the subsurface geology of the Lloydminster area east of Vermilion and noted the presence of the *Haplophragmoides gigas* microfauna in the basal part of Nauss' Lloydminster shale. Badgley (1952) reported on subsurface investigations of the Lower Cretaceous rocks of a large part of central Alberta from Peace River on the northwest to Lloydminster on the southeast. He proposed for the entire area the recognition of Mannville as a group composed of the McMurray, Clearwater, and Grand Rapids formation. Above his Mannville group Badgley would have a Colorado group consisting of a Joli Fou formation at the base, followed by the Pelican formation, and that by an unnamed unit. Stelck and others (1956, p. 8) grouped the rocks in a different manner and used mostly other names. They suggest for east-central Alberta a Fort St. John group consisting of, in ascending order, the Mannville, Joli Fou, Viking (in place of Pelican), and Colorado or Lloydminster formations. Stelck and others (1956, p. 18) indicate a middle Albian age for all the Joli Fou and an early late Albian age for the shale overlying the Pelican or Viking sandstones. Beds equivalent to the Joli Fou extend far to the east into Saskatchewan, where Wickenden (1932) has recognized the *Haplophragmoides gigas* microfauna in many wells. Farther east, in southeastern Saskatchewan and southwestern Manitoba, the lower part of the Ashville formation may be of Albian age, inasmuch as it contains a microfauna and "seems to be more closely related to the Shaftesbury formation in the Peace River district." (Wickenden, 1945, p. 23).

Stelck in 1958 placed the Viking sandstone (=Pelican sandstone) in the lower part of the upper Albian and as much older than the Sikanni sandstone. He interprets the Viking and Joli Fou in the east as corresponding to a hiatus in the sequence in the Foothills Region to the west. Above both the Viking and the hiatus lie sequences that Stelck equates: Colorado, Labiche, Shaftesbury-Dunvegan, Hasler-Goodrich-Cruiser-Dunvegan, and Blackstone.

In the southern Plains of Alberta a fish-scale-bearing sandy unit about 700 feet above the base of the Colorado shale has been correlated with the Mowry shale of Montana (Spratt, 1931, p. 1172–1176).

HISTORY OF WORK ON THE PALEONTOLOGY OF THE FORMATIONS IN THE UNITED STATES

The earlier accounts of the Mowry and Aspen shales are primarily stratigraphic and deal only casually with paleontologic data. They usually cite the abundance of fish scales and bones and provide little record of the invertebrates. In fact, any comment about invertebrates is likely to be a remark on their scarcity. "*Inoceramus* sp." or "*Inoceramus labiatus*?" is the commonest form recorded, with a few citations of undetermined ammonites, "*Prionocyclus*? sp." "*Acanthoceras*? sp.," or "*Metoicoceras*? sp." "*Lingula* sp." is recorded at a few places.

Veatch (1907, p. 63) attributes to the base of the Bear River formation a collection of marine mollusks identified as *Cardium* sp., *Mactra* sp., *Corbula* aff. *C. pyriformis* Meek, *Liopistha* (*Psilomya*)? sp., and *Lunatia* sp. This collection was made east of the site of the former town of Cumberland, Wyoming (fig. 1, no. 110). Schultz (1914, p. 58) accepted Veatch's assignment. The present writers, however, place this collection in the lower part of the Aspen shale rather than the Bear River and have assembled a more varied fauna from the locality. Likewise, Veatch (1907, p. 62) and Schultz (1914, p. 58) attribute to the Bear River formation a horizon with marine pelecypods associated with a coal bed at Sage Junction, Wyoming (Stanton, 1892, p. 108) (fig. 1, no. 100). This locality was reported to yield "*Modiola multilinigera*, *Barbatia coalvillensis*, and a few other species." Later collections yield a more varied fauna. The present writers assign this lot to a horizon equivalent to part of the sequence of strata on Leeds Creek and consider it of Aspen age rather than of Bear River age. As only these two lots have been cited as evidence of the occurrence of marine beds in the Bear River formation, the writers know now of none such.

Cockerell (1919) named the following fish, represented chiefly by scales, from the Mowry and Aspen shales: *Holcolepis pulchellus*, *H. delicatus*, *H. transversus*, *H. obliquus*, *Hypsodon*? *granulosus*, *Leucicthyops vagans*, *Erythrinolepis mowriensis*, and *Halecodon denticulatus*. Most of the commoner scales can be assigned to these species.

Reeside and Weymouth (1931) reported from the Aspen shale of southwestern Wyoming (fig. 1, nos. 105 and 116) ammonites identified as *Kanabiceras wyomingense*, *Epengonoceras aspenanum*, *Metoico-*

ceras whitei, *M.* sp., and *Acompsoceras americanum*, and pelecypods identified as *Pteria* (*Oxytoma*) sp., *Ostrea* sp., *Anomia* sp., *Periplomya? aspenana*, *Thracia? wyomingensis*, *Tancredia? lincolniana*, *Aphrodina? aspenana*, *Linearia?* sp., *Tellina?* sp., *Mactra? incompta?*, and *Mactra? aspenana*. These species were assigned to an early Turonian age, though some disagreement was noted in the apparent significance of the species.

Brown (1933) reported from the Aspen shale of southwestern Wyoming the ferns *Anemia fremonti*, *Asplenium occidentale*, *Cladophlebis readi*, *Microtaenia paucifolia*, and the angiosperms *Sparganium aspensis*, *Populus? aspensis*, *Dryandroides lanceolata*, *Laurus aspensis*, *Sassafras bradleyi*, *Nelumbo weymouthi*, *Liquidambar fontanella*, *Prunus aspensis Staphylea? fremonti*, and *Sapindopsis schultzi*. This flora is in part identical with that found in a tuff bed in the lower part of the Frontier formation in the same region.

Read and Brown (1937, p. 112–119), following Seward (1924), reported the fern *Tempskya knowltoni* from the Colorado shale 500 feet above the base, southeast of Harlowton, Montana, which must be within the Mowry equivalent (fig. 1, nos. 24 to 37). Read and Brown also report *Tempskya grandis* and *T. minor* from localities in the Aspen shale of western Wyoming and the upper part of the Wayan formation of eastern Idaho.

Vokes (1941) described from the Mowry shale some fossil imprints of unknown origin. Later Brown and Vokes (1944) considered these imprints as possibly the work of some dibranchiate cephalopod. The imprints were assigned a new generic and specific name *Asterichnites octoradiatus*.

Brown (in Cobban, 1951, p. 2180) identified *Anemia fremonti*, *Nelumbites* sp., *Araucarioxylon* sp., *Tempskya knowltoni*, *Dryandroides?* sp., and *Pinus* sp. from the "Red Speck zone" below the middle of the Colorado shale of northwestern Montana. From sandy beds that are in part siliceous and overlie the "Red Speck zone" Cobban (1951, p. 2181) reported *Inoceramus nahwisi* vars. *goodrichensis* and *moberliensis*, *Neogastroplites* sp., and the fish scales *Osmeroides transversus*, *Leucichthyops vagans*, and *Erythrinolepsis mowriensis*.

Yen (1951) described from strata on Leeds Creek, southwestern Wyoming (fig. 1, nos. 93–98), a freshwater fauna that includes *Valvata praecursoris*, *Mesoneritina naticiformis*, *M. stantoni*, *Lioplacodes stachei*, *Parateinostoma altispirale*, *P. convexum*, *P. contractum*, *Parhydrobia cylindrica*, *Goniobasis leedsensis*, *Zaptychius haldemani*, *Rhytophorus* cf. *R. meeki*, *Melampoides clarki*, *Anisopsis minuta*, *Physa usitata*, and *Physa* sp. This fauna is considered younger than that of the Bear River formation, which would place it at a level equivalent to part of the Aspen shale.

Cobban and Reeside (1951) reported *Gastroplites americanus* from the Colorado shale of Montana, the Mowry shale of Wyoming and Colorado, and the Aspen shale of Wyoming, and *Neogastroplites wyomingensis* from the Colorado shale of Montana and the Mowry and Aspen shales of Wyoming. *Metengonoceras aspenanum* was reported in association with *Gastroplites*.

Cobban and Reeside (1952b, p. 1929) reported from the top of the Aspen shale near Cumberland Gap, 15 miles south of Kemmerer, Wyoming (fig. 1, no. 111), the following species: *Membranipora* sp., *Barbatia micronema*, *Ostrea* sp., *Anomia* cf. *A. subquadrata*, *Brachydontes* aff. *B. multilinigerus*, *Thracia?* cf. *T.? wyomingensis*, *Fulpia* ("*Cyrena*") *securis*, *Cuspidaria?* sp., *Cardium* (*Nemocardium?*) n. sp. aff. *C. kansasense*, *Aphrodina? aspenana*, *Tellina?* cf. *T. whitei*, *T.?* cf. *T. modesta*, *Protodonax* cf. *P. coalvillensis*, *P.* cf. *P. elongatus*, *Mactra? aspenana*, *Gyrodes depressa*, *Cerithium* sp., *Anchura* sp., *Neogastroplites* sp. This fauna was assigned to a late Early Cretaceous (late Albian) age.

La Rocque and Edwards (1954) described the section of Aspen shale on Willow Creek, Teton County, Wyoming, and recorded invertebrates at numerous levels. Most of them are referred to nonmarine genera known to persist over long periods and therefore of lesser significance. At two levels marine forms are noted, the higher level containing *Myalina?*, *Modiolus* sp., *Macoma?*, *Arca* sp., *Pecten?*, undetermined gastropod, and crustacean claw, and the lower, *Corbula* sp., *C.* cf. *C. engelmanni*, *Glycimeris?*, 3 undetermined pelecypods, *Modiolus* sp., *Pyrgulifera?*, *Cerithium?*, *Rhytophorus?*, *Bithynella?*, and an ostracode. Wanless and La Rocque (1955, p. 57–71) repeated in somewhat expanded form the same section and faunal lists.

Reeside and Cobban (1954) drew attention to the great number of ammonites found in single concretions at a few localities in the Mowry shale of Wyoming and the equivalent part of the Colorado shale of Montana. Hose (1955, p. 59, 102) recorded *Metengonoceras* sp. and *Neogastroplites wyomingensis* from the upper part of the Mowry shale near Buffalo, Wyoming, in siliceous shale associated with abundant fish scales. Richards (1957, p. 415) reported *Neogastroplites* sp. from siliceous concretions in the Colorado shale near Livingston, Montana.

Skolnick (1958a) reported on the Foraminifera of the Skull Creek shale, Newcastle sandstone, and the

lower part of the Mowry shale (Nefsy shale member of the Graneros shale of Collier) of the Black Hills, dealing with localities on the northern border in Wyoming and South Dakota. From the Skull Creek he described the following arenaceous forms: *Ammobaculites altilis*, *A. culmula*, *A. euides*, *A. imbricatus*, *A. impolitus*, *A. obliquus*, *A. subcretaceus*, *A. torosus*, *A. uniformis*, *Ammobaculoides minuens*, *A. whitneyi*, *Haplophragmoides paralius*, *H. regularis*, and *Trochammina phaseolus*; from the Newcastle *Ammobaculites impolitus* and *A. subcretaceus;* from the lower part of the Mowry *Ammobaculites subcretaceus* and *Trochammina depressa*. These were considered to represent one faunal unit from an environment like that of lagoonal areas along the present Gulf Coast of Mississippi and Alabama, and to be of early to middle Albian age.

HISTORY OF WORK ON THE PALEONTOLOGY OF THE CANADIAN FORMATIONS

MACROFOSSILS

The first paleontological publication on the *Gastroplites* and *Neogastroplites* faunas of Canada was by Whiteaves, who described ammonites collected by Selwyn, Dawson, and McConnell.

In 1885 Whiteaves described *Buchiceras? cornutum* from specimens collected by Selwyn from the upper part of the Fort St. John group along Peace River near Fort St. John. This species, later to become the genotype of *Neogastroplites*, was considered by Whiteaves in 1893 (p. 120) to be an *Acanthoceras*.

In 1889 Whiteaves described from the Liard River area of northeastern British Colombia an ammonite that he named *Placenticeras* (*perezianum*? var.) *liardense*. This species was later referred to *Gastroplites* (Stelck et al., 1956, p. 9, 10). Kindle (1944, p. 12) has noted the occurrence of Whiteaves' species only 100 feet above beds containing *Gastroplites* cf. *G. kingi*.

Whiteaves in 1893 described *Hoplites canadensis* from specimens collected by McConnell from the Peace River formation on Peace River below the mouth of Cadotte River. This species later became the genotype of *Gastroplites*.

McLearn in 1919 (p. 2C, 3C) assigned Whiteaves' *Buchiceras cornutum* to *Acanthoceras* and regarded it as a Late Cretaceous fossil. Whiteaves' *Hoplites canadensis* was considered of Early Cretaceous age. In 1930 (p. 6, 7) McLearn defined the new genus *Gastroplites*, with *Hoplites canadensis* as holotype. In 1931 he described the following new species of *Gastroplites: stantoni*, *allani*, *anguinus*, *spiekeri*, and *kingi*. He also described the new genus *Neogastroplites*, with Whiteaves' *Buchiceras? cornutum* as holotype. In addition he described several new species of pelecypods, including *Inoceramus cadottensis*, of probable *Gastroplites* age, and *Inoceramus nahwisi*, of *Neogastroplites* age. Both *Gastroplites* and *Neogastroplites* were considered of Albian age. In 1932 McLearn reviewed the Lower Cretaceous of the western interior of Canada and assigned *Gastroplites* to the early Albian and *Neogastroplites* to the late Albian. In the following year he presented better illustrations and more detailed descriptions of the species of *Gastroplites* and *Neogastroplites* and defined the new species *Neogastroplites selwyni*, from the upper part of the "Fort St. John shale" near Fort St. John.

Spath (1937) reported the discovery of *Gastroplites* in the English Gault and dated the genus as late middle Albian. He regarded *Neogastroplites* as late late Albian.

McLearn (1943) reviewed the sequence of *Inoceramus* in the Western Interior of Canada and added new forms from the Lower Cretaceous rocks. From the *Gastroplites* zone he described *Inoceramus cadottensis* var. *altifluminis* and from the *Neogastroplites* zone he described *Inoceramus nahwisi* vars. *goodrichensis* and *moberliensis*.

McLearn in 1944 and 1945 summarized the record of species from the *Gastroplites* and *Neogastroplites* zones of the Fort St. John group of Alberta and British Columbia. Aside from the species of *Gastroplites*, he noted that the most important fossil of that zone was *Inoceramus cadottensis*, which was known from the Cadotte member of the Peace River formation of the lower Peace River area, from the lower part of the Hasler formation of the upper Peace River area, from the upper part of the Commotion formation in the Pine River valley south of the upper Peace River, from the upper part of the Scatter formation and lower part of the Lepine formation on Liard River, and from unnamed beds [Sans Sault group]. McLearn records the *Neogastroplites* fauna from the Shaftesbury, Goodrich, and Sikanni formations, and from the Fort St. John group west of Fort Nelson. From the upper part of the Shaftesbury he cites *Neogastroplites cornutus*, *N. selwyni*, *Nucula dowlingi*, and *Posidonomya* [*Inoceramus*] *nahwisi*. From the Goodrich he lists *Oxytoma pinania*, *Posidonomya nahwisi* var. *goodrichensis*, *P. n.* var. *moberliensis*, *Entolium* sp., *Pleuromya wickendeni*, *P. kissoumi*, *Tancredia stelcki*, and *Lucina? goodrichensis*. From the four sandstone members of the Sikanni formation he cites: First sandstone, *Neogastroplites* cf. *N. cornutus*, *Oxytoma pinania*,

Posidonomya nahwisi var. *goodrichensis*, and *Solecurtus? (Azor?)* sp.; Second sandstone, *Neogastroplites cornutus*, *Pteria via-media*, *Posidonomya nahwisi* var. *goodrichensis*, *Pecten burlingi*, *Corbicula?* sp., and *Thracia stelcki;* Third sandstone, *Modiolus via-alaskanus*, *M. archisikanni*, *Pinna hagi*, *Posidonomya nahwisi* var. *goodrichensis*, *Pleuromya sikanni*, and *Thracia? yarwoodi*; Fourth sandstone, *Neogastroplites?* sp., *Oxytoma* sp., *Tancredia stelcki*, and *Pharus* sp. From the Fort St. John group west of Fort Nelson he cites *Posidonomya nahwisi* var. *goodrichensis*. McLearn continued to assign the *Neogastroplites* fauna to the Albian but pointed out that it might be of very early Late Cretaceous age.

McLearn and Henderson (1944, p. 3) record *Neogastroplites cornutus?* from a dark unnamed shale that forms the upper part of the Fort St. John group in the Lone Mountain area, about 100 miles south of Fort St. John.

Hage (1945, p. 20) lists *Neogastroplites cornutus?* and *Arctica?* sp. from the Fort St. John group near the junction of the Petitot and Liard Rivers at Fort Liard.

Warren in 1947 reviewed the Lower Cretaceous fossil record for the Mackenzie River Valley and figured some fragments attributed to *Gastroplites* from that area. These fragments, however, are provisionally placed by Casey (1954, p. 111) in *Subarctohoplites* and are associated with a fauna older than that of *Gastroplites*. Warren suggested erosion as the probable cause of the absence of the *Neogastroplites* fauna from the area.

McLearn and Kindle in 1950 summarized the fossil record from the *Gastroplites* and *Neogastroplites* zones in British Columbia. The species and localities cited are about the same as those given by McLearn in 1944 and 1945.

Stelck (1950, p. 14), in an unpublished work, recorded the ammonite *Pleurohoplites* from the top of the Goodrich formation on Pine River in British Columbia. He believed that the top of the Goodrich correlated with the highest of the sandstone members of the Sikanni formation and that *Pleurohoplites* marked the top of the *Neogastroplites* zone.

Thorsteinson (1952, p. 30) described a 500-foot unit of dark shale in the Grande Cache area of western Alberta as the "Fort St. John group." Near the middle he found fossils that were identified by J. A. Jeletzky as *Neogastroplites* ex gr. *cornutus*, *N.* ex aff. *cornutus*, *N.* sp. indet., *?Engonoceras* s. 1. sp. indet., cf. *Inoceramus* sp. indet., gastropod, barnacles, fish scales, and fossil wood.

Henderson (1954, p. 2282–2284) reported *Neogastroplites cornutus* from the sandy member of the Sikanni formation on the lower part of Sikanni River and *Inoceramus cadottensis* from the sandy member of the older Buckinghorse formation on Tetsa River.

Gleddie (1954, p. 489–494) divided the Shaftesbury formation of western Alberta into a "Lower Shaftesbury formation," containing at least three fish scale zones, and an "Upper Shaftesbury formation," with few fish scales. He noted *Neogastroplites* in one of the fish scale beds near Fort St. John.

Greiner (1955, p. 4) reported *Neogastroplites* ex gr. *cornutus* in the undivided "Fort St. John group" at the western edge of Alberta between the Lone Mountain and Grande Cache areas.

Stelck and others (1956, p. 9, 10) summarized the microfossil and megafossil zones of the Albian rocks of the Athabasca and Peace River areas of Canada. They proposed the following succession of megafossil zones for the *Gastroplites* and *Neogastroplites* zones:

Upper Albian:
- *Neogastroplites wyomingensis*
- *N. cornutus*
- *N. selwyni*
- *Posidonomya goodrichensis* [as *Posidonia*]
- *P. moberliensis* [as *Posidonia*]
- "*Ophiura*" sp.
- *Gastroplites* cf. *G. liardensis*

Middle Albian:
- *Inoceramus* cf. *I. comancheanus*
- *Gastroplites* cf. *G. cantianus*
- *G. canadensis*

Stelck (1958), in discussing the Viking "sand" of the Alberta Plains, records from the underlying Joli Fou formation *Inoceramus comancheanus* Cragin and *I. bellvuensis* Reeside. From the "*Miliammina manitobensis* zone," above the Viking formation, he records "*Placenticeras*" *liardense* Whiteaves and *Dipoloceras* cf. *D. fredericksburgense* Scott. He interprets the available microfaunal and macrofaunal data as placing the Viking in the basal part of the upper Albian. His correlation of the Viking with the components of the Fort St. John group of the Peace River region, on microfaunal and macrofaunal evidence, places the Viking as older than the Goodrich and Sikanni sandstones, and hence older than the *Neogastroplites* levels, and as younger than the Cadotte sandstone, with its *Gastroplites*.

MICROFOSSILS

Studies of the Foraminifera of the *Gastroplites* and *Neogastroplites* zones were begun in 1927 by Cushman, who described *Ammobaculites fragmentarius*,

Haplophragmoides gigas, and *Gaudryina canadensis* (as *Bigenerina angulata*) from beds now known to be equivalent to the Joli Fou formation. Wickenden (1932) studied the cuttings from wells scattered over much of southern Saskatchewan and noted that the *Haplophragmoides gigas* microfauna was widely distributed. He regarded this fauna as marking the top of the Lower Cretaceous rocks. Nauss in 1945 recorded Cushman's *Haplophragmoides gigas*, *Ammobaculites fragmentarius*, and *Gaudryina canadensis* from the basal part of the Lloydminster shale. In 1947 he figured from the basal Lloydminster the new species *Haplophragmoides linki*, *Ammobaculites humei*, *A. tyrrelli*, and *Gaudryina hectori*. Wickenden (1949, p. 16-21) named the Joli Fou formation and listed from its outcrop area along Athabasca River 12 genera of Foraminifera. Among the few species mentioned were *Haplophragmoides gigas* and *Gaudryina canadensis*.

Stelck (1950) studied the microfaunas of the *Gastroplites and Neogastroplites* zones. From the *Gastroplites* zone in the lower part of the "Upper St. John shales" on Peace River near Hudson Hope he noted the genera *Ammobaculites*, *Verneuilina*, *Proteonina*, *Trochammina*, and *Haplophragmoides*, but no species were named. The *Haplophragmoides* was said to show some affinity with *H. gigas*, but Stelck believed the Hudson Hope microfauna to be slightly older than that of *H. gigas*. A microfauna believed by Stelck to be younger than that of *H. gigas* but older than the *Neogastroplites* zone was collected from the upper part of the Buckinghorse formation on Sikanni Chief River. Stelck listed for this microfauna the genera *Ammobaculites*, *Haplophragmoides*, *Proteonina*, *Reophax*, *Trochammina*, *Ammobaculoides*, *Ventilabrella*, *Verneuilina*, *Bathysiphon*, *Glomospira*, and *Miliammina*. No species were named. From the shales between the First and Second and between the Second and Third sandstone members of the Sikanni formation on Sikanni Chief River Stelck recorded the genera *Proteonina*, *Thurammina*, *Reophax*, *Textularia?*, *Ammobaculites*, *Haplophragmoides*, *Bathysiphon*, *Miliammina*, and *Trochammina*. Again no species were named. This microfauna, of *Neogastroplites* age, was assigned a late Albian age by Stelck, who noted that it is "clearly younger than the *H. gigas* fauna."

Wickenden (1951) described and figured species of *Ammodiscus*, *Haplophragmoides*, and *Gaudryina* from the middle shale member (Harmon) of the Peace River formation on Peace River, and species of *Glomospira*, *Haplophragmoides*, *Ammobaculites*, *Eggerella?*, and *Miliammina* from the Cadotte member. Letters were used in place of formal species names.

Stelck and others (1956) have described the foraminiferal faunas of the *Gastroplites* zone and the overlying *Haplophragmoides gigas* zone in the Athabasca and Peace River areas. They recognized two microfaunas for beds of *Gastroplites* age, a lower *Haplophragmoides multiplum* zone, marking the level of the Harmon shale member of the Peace River formation, and an upper "Cadotte microfaunal zone." From the Harmon level they described the new species *Haplophragmoides multiplum*, *H. postis*, *H. spisum*, *Trochammina gatesensis*, and *Verneuilina porta*. In addition to Wickenden's lettered species from the Cadotte member, Stelck and others reported *Ammobaculites janus*, *Eggerella* sp., *Haplophragmoides linki*, and *Proteonina* sp. Above the "Cadotte microfaunal zone" Stelck and others recognized the *Haplophragmoides gigas* zone as coextensive with the Joli Fou formation. They listed its microfauna as: *Ammobaculites fragmentarius*, *A. f.* var., *A. tyrrelli*, *A. t.* var. *jolifouensis*, *Ammodiscus kiowensis*, *Gaudryina hectori*, *Haplophragmoides gigas*, *H. linki*, *H.* cf. *H. collyra*, *Hyperammina* sp., and *Miliammina sproulei*. They noted the possibility of connections with the Gulf of Mexico by the presence of *Ammodiscus kiowensis*, a species described from the Kiowa shale of Kansas.

Stelck (1958), in discussing the Viking "sand", concluded that it did not contain a microfauna significant for correlation, but considered the *Haplophragmoides gigas* fauna of the underlying Joli Fou formation and the "*Miliammina manitobensis* fauna" of the overlying beds, together with some macrofaunal evidence, sufficient to place the Viking in the basal part of the upper Albian.

PRESERVATION OF THE FOSSILS AND GENERAL COMPOSITION OF THE ASSEMBLAGES

The most widespread type of preservation of the marine fossils of the Mowry and contemporary formations is as somewhat flattened molds in porcelanite. Occasionally completely flattened shells are preserved in dark shale. Less frequent is the preservation with little distortion of all sorts of fossils in calcareous concretions. In the strata on Leeds Creek the nonmarine invertebrates occur mostly as silicified shells in limestone, the plants mostly as impressions in porcelanite, and the marine invertebrates mostly as molds in sandstone. Table 1 shows the kinds of fossils noted and the character of the matrix at all of the localities.

TABLE 1.—*Map and locality numbers, fossil assemblage, sorts of fossils, and character of the matrix noted in the collections examined*

[r, rare, 1 to 3 specimens; f, frequent, 4 to 10 specimens; c, common, 11 to 100 specimens; a, abundant, more than 100 specimens; X, unevaluated (plant remains and fish)]

Map No.	Locality No.	*Neogastroplites* assemblage	Plant remains	Radiolaria	*Lingula*	*Inoceramus*	Other pelecypods	*Neogastroplites*	Egonoceratids	*Asterichnites*	Fish remains	Reptiles	Lithologic character
	GSC												
2	17300	*N. maclearni*	X			r		a	r		X		Sandstone.
3	24693	*N. americanus*	X					f			X	X	Do.
	USGS												
4	23411	*N. cornutus*						r			X		Porcelanite.
5	26066							r			X		Sandstone.
6	26065							r			X		Porcelanite.
7	24705	*N. muelleri*						c	f		X		Calcareous concretion.
8	23410	*N. cornutus*						a			X		Do.
9	3954						r	r			X		Sandstone.
10	23412							r			X		Porcelanite.
11	24602					r					X		Sandstone.
12	24603	*N. cornutus*						c			X		Calcareous concretion.
13	24613							r			X		Siltstone.
14	24920							r			X		Porcelanite.
15	24918							r			X		Shale.
16	24917	*N. muelleri*						c			X		Calcareous concretion.
17	24601	*N. muelleri*						f	r		X		Do.
18	26224	*N. muelleri*	X	c		r		c	r		X		Do.
19	24600							r			X		Claystone.
20	24065	*N. muelleri*	X	c		r		a	a		X	f	Calcareous concretion.
21	24417	*N. muelleri*						r			X		Do.
22	24418	*N. muelleri*						f	f		X		Do.
23	24419	*N. muelleri*						r			X		Do.
24	24609	*N. maclearni*						c			X		Siltstone.
25	24610	*N. maclearni*						f			X		Porcelanite.
26	24611	*N. maclearni*					r	c	r		X		Calcareous concretion.
27	24612	*N. maclearni*						f	r		X		Do.
28	23042	*N. americanus*	X	c		f		a	a		X	r	Do.
29	23043	*N. americanus*						f			X		Porcelanite.
30	24608	*N. americanus*	X				r	a	c		X		Calcareous concretion.
31	24604						r	r			X		Sandstone.
32	24605	*N. muelleri*	X			f	r	c			X		Calcareous concretion.
33	24606							r			X		Sandstone.
34	24607							r			X		Do.
35	4612	*N. americanus*						r			X		Do.
36	4645	*N. americanus*						r			X		Siltstone.
37	4610	*N. americanus*						r			X		Sandstone.
38	23413						f				X		Do.
39	23498						f				X		Do.
40	23029						c				X		Do.
41	25716						r				X		Porcelanite.
42	25717						r				X		Do.
43	25718						r				X		Do.
44	23023					r		r			X		Do.
45	24566	*N. haasi*	X	r				a			X		Calcareous concretion.
46	24921	*N. cornutus*						r			X		Porcelanite.
47	9653	*N. cornutus*				r		f			X		Calcareous concretion.
48	24502	*N. americanus*						r			X		Do.
49	10443	*N. americanus*						r			X		Do.
50	20932	*N. cornutus*						f			X		Porcelanite.
51	20933							r			X		Do.
52	23245							r			X		Ferruginous concretion.
53	17934, 24555	*N. americanus*				c		a	c		X		Calcareous concretion.
54	20370	*N. americanus*					f	r			X		Ferruginous concretion.
55	26413	*N. haasi*						f			X		Manganiferous concretion.
56	26414	*N. haasi*						f			X		Do.
57	10415	*N. americanus*				f		r	r		X		Porcelanite.
58	23465	*N. americanus*				r		c	c		X		Shale.
59	12739					r					X		Porcelanite.
60	24565	*N. americanus*	X			f	r	c	c		X		Calcareous concretion.
61	24554	*N. americanus*				c		c	c	f	X	r	Do.
62	24569	*N. cornutus*				r		c			X		Do.
63	24567	*N. americanus*				c		c	c	r	X	r	Do.
64	24568	*N. americanus*				f		a	c		X	r	Do.
65	23021	*N. cornutus*	X			c		a	r		X		Do.
66	23020									f	X		Porcelanite.
67	24560						r				X		Do.
68	24561	*N. americanus*				f		a	r		X		Calareous concretion.
69	24562						r				X		Porcelanite.
70	24563						r				X		Do.

TABLE 1.—*Map and locality numbers, fossil assemblage, sorts of fossils, and character of the matrix noted in the collections examined* —Continued.

[r, rare, 1 to 3 specimens; f, frequent, 4 to 10 specimens; c, common, 11 to 100 specimens; a, abundant, more than 100 specimens; X, unevaluated (plant remains and fish) —Continued.

Map No.	Locality No.	*Neogastroplites assemblage*	Plant remains	Radiolaria	*Lingula*	*Inoceramus*	Other pelecypods	*Neogastroplites*	Egonoceratids	*Asterichnites*	Fish remains	Reptiles	Lithologic character
71	24564	*N. americanus*				c		a	f		X		Calcareous concretion.
72	17173, 18137, 24558	*N. cornutus*		r		r	r	c			X		Do.
73	24559					r					X		Do.
74	25360	*N. cornutus*						r			X		Porcelanite.
75	6713					r		r			X		Do.
76	4941							r			X		Do.
77	23581	*N. cornutus*						r	r		X		Do.
78	8535	*N. americanus*						r	r		X		Do.
79	6680	*N. cornutus*						c			X		Do.
80	23427				c		r				X		Do.
81	6735	*N. americanus*				r		r	r		X		Do.
82	6764					r					X		Do.
83	6762					r					X		Do.
84	20670	*N. cornutus*				f		r			X		Do.
85	9006					r					X		Do.
86	8979					r		r			X		Do.
87	23217	*N. cornutus*				f	r	f			X		Do.
88	24500	*N. cornutus*						r			X		Do.
89	24570	*N. cornutus*				c		c			X		Do.
90	17874						c				X		Sandstone.
91	3847, 16056, 17304						c		f		X		Do.
92	21699					f							Do.
93	20779, 21678, 22044						c				X		Do.
94	21679						r				X		Do.
95	21680					f	f				X		Do.
96	21702						c				X		Do.
97	21703						c				X		Do.
98	21704						c				X		Do.
99	22047						f				X		Do.
100	21714, 22048						c				X		Do.
101	21715, 22028						f				X		Do.
102	21717, 22049						f				X		Do.
103	22942								f				Do.
104	26609					r							Siltstone.
105	14718, 22989, 24539	*N. americanus*					c	c	c		X		Porcelanite.
106	24540						r				X		Do.
107	24542				c						X		Do.
108	24543						r				X		Do.
109	24552						f				X		Do.
110	3386, 21727						a				X		Do.
111	22980, 24545	*N. americanus*					c	f			X		Do.
112	24544						r				X		Do.
113	24547				c		r				X		Sandstone.
114	24548				c		r				X		Porcelanite.
115	24549						f				X		Do.
116	14719, 24550	*N. cornutus*				r		c			X		Do.
117	793	*N. cornutus*						r			X		Siltstone.
118	17834	*N. cornutus*						r			X		Porcelanite.
119	26342	*N. cornutus*						f			X		Sandstone.
120	988	*N. cornutus*						r			X		Siltstone.
121	25586	*N. americanus*		r		r		r			X		Limestone.
122	26223	*N. cornutus*				r		r			X		Porcelanite.
123	11665	*N. americanus*				r		r			X		Do.
124	7100							r			X		Do.
125	24717					f					X		Do.

PORCELANITE

In the porcelanites (see footnote, p. 00) the preservation is generally as more or less flattened molds, though a few natural casts are available. Isolated specimens of gastroplitine and engonoceratid ammonites and of *Inoceramus* have been found widely on the surfaces of the flat "chips" into which the porcelanites commonly weather. At a few places, notably in southwestern Wyoming and in the Bighorn Basin of north-central Wyoming, a relative abundance of pelecypods and gastropods, together with a few bryozoans and lingulas, has been noted. Some of the frequently reported fish scales and bones preserve the phosphatic original material of the fossils, but more often these remnants are also represented only by molds. Such fossil material, is concentrated by weathering away of the softer layers, on the surface in the resistant "chips" of porcelanite and, though actually the invertebrates are not common, is likely to be found by the somewhat casual collector. Nearly half of the collections available to the writers, about 50 in number, are of this sort.

This type of preservation is shown by specimens illustrated as plate 16, figure 1; plate 21, figures 1-4; plate 26, figures 1, 4; plate 45, figures 10-12; and plate 46, figures 13, 14.

SHALES

Preservation in dark, little silicified shales usually results in the retention of much of the material of the shells, but they are completely flattened. Generally only ammonites and *Inoceramus* have been collected, though disarticulated fish remains are also present. It is more difficult to find material of this sort, for it is readily destroyed by weathering, and only half a dozen collections are available to the writers.

This type of preservation is represented by specimens illustrated as plate 46, figures 29, 30.

CONCRETIONS

The least frequent type of preservation, but the most important to the paleontologist, is that in calcareous concretions. At places the material contains enough iron to make it brown in weathering and at a few places enough manganese to make it black. Because their content of less distorted specimens is of greater value for study, these fossiliferous concretions have been sought diligently, and in spite of their scarcity over 30 of the collections available to the writers are of this type. They have been found chiefly in the western part of the Bighorn Basin in Wyoming, in southern Montana, and in central Montana—near Cody, Wyo., and near Limestone, Teigen, Winnecook, and Belt, Mont. In size the concretions range from 5 inches (80 mm) to 6 feet (2 m) in diameter, and single concretions have yielded large amounts of fossil material.

This type of material is represented by most of the unflattened specimens illustrated in the plates accompanying this paper.

The fossiliferous concretions have certain features in common. They are usually in a stratum with many other similar-appearing concretions that are barren of invertebrates, as are also the enclosing beds. They contain abundant disarticulated fish remains in at least parts of the concretions, so abundant as to form the matrix of the invertebrates—this matrix must once have been a sludge of scales and bones of fishes (see pl. 4, figs. 1, 2, 4). Some of the concretions contain scattered bones of reptiles, and marine, flying, and even terrestrial reptiles are represented. They contain abundant pieces of carbonized wood, some as much as several feet in length, and other resistant parts of plants.

The invertebrates of the concretions are dominantly gastroplitine ammonites, with a very much smaller number of individuals of the pelecypod *Inoceramus*. In the concretions at higher levels a small proportion of engonoceratid ammonites is included and in a few a tiny sprinkling of pelecypods other than *Inoceramus*.

The ammonites are unsorted and unoriented. Costate, nodose and spinose variants are mingled together indiscriminately. Tiny immature forms 10 mm or less in diameter are associated with others up to 50 mm in diameter and usually there are a few broken shells or fragments that may represent forms up to 300 mm or more in diameter. In most specimens the living chamber, which housed the soft parts of the animal, is missing or crushed, and in many the septate part has been damaged.

A phenomenal number of ammonites is present in some of the concretions. One found near Winnecook, Montana, yielded nearly 1,300 gastroplitine ammonites, the largest 270 mm in diameter, and 230 engonoceratid ammonites. A second found near Teigen, Montana, yielded about 3,800 gastroplitine ammonites, the largest 400 mm in diameter, and 400 engonoceratid ammonites. A third found near Cody, Wyoming, yielded 2,400 gastroplitine ammonites, the largest 400 mm in diameter, but only two specimens of an engonoceratid ammonite. For none of these concretions, each about 6 feet (2 m) in diameter, was the collection probably as much as half the original content of the concretion. Some of the smaller concretions are proportionately nearly as fossiliferous.

1

2

3

4

REPRESENTATIVE MATRICES OF FISH SCALES AND BONES ENCLOSING SPECIES OF *NEOGASTROPLITES*

One yielded 600 specimens, others 330, 200, 150, and 120 specimens, respectively, of ammonites.

STRATA ON LEEDS CREEK, WYOMING

Because of the complex composition of the sequence on Leeds Creek, it contains a variety of types of preservation of its fossils. Much of the sequence appears to be of nonmarine origin. The nonmarine invertebrates (Yen, 1951) are found scattered through limestones, with the shells at many places silicified. A number of massive porcelanites are present, and some of them contain fossil plants, mostly ferns, as impressions scattered through the matrix. Little of the vegetable material is left and the fossils run very irregularly through the matrix. Coal is found in the sequence, mostly associated with massive sandstones that have yielded molds of the interior and exterior of marine pelecypods.

ACCUMULATION OF THE FOSSILS

The writers (1954) have discussed briefly the problem of the accumulation of the fossils of the Mowry and contemporaneous formations, particularly those of the especially productive concretions.

The occurrences in the porcelanites, the dark shales, and in the various rock types of the strata on Leeds Creek differ little from many other occurrences of fossils in other formations and at other places. They can be interpreted as readily as most of the others. For the most part the finds of invertebrates seem to be accumulations of dead shells distributed by currents or other agencies of transportation. None seems to represent a biocoenosis, an accumulation at the site of living. The ubiquitous and highly characteristic bones and scales of fishes scattered over the surfaces of the rock layers certainly imply an effective means of distribution of the hard parts of the organisms after death. Whether such explanations are always correct might well be doubted, but at least they are orthodox and seem satisfactory.

The occurrences in the very fossiliferous concretions, however, seem to call for some unusual interpretation. Fossils other than the disarticulated fish remains are normally rare in the Mowry and Aspen formations. Extensive search usually produces only a specimen or two of invertebrates from even the best exposures, and the concretions are usually barren. Yet some set of conditions has produced at a few places single accumulations of hundreds of ammonites of various sizes and differing morphological characters, associated with an abundance of disarticulated fish remains, scattered reptile bones, and carbonized wood, but few other invertebrates. Few of the ammonite shells preserve the living chamber intact; usually it is broken off or squashed and the septate part shows some damage. In the matrix surrounding the masses and in other concretions at the same level are found no trace of fossils except the scattered fish scales and bones. What mechanism would produce such a condition?

The persistent presence of fossil wood and other resistant vegetable debris suggests currents that would sweep the shells together, but there has been little sorting, such as currents might be expected to produce, and it is difficult to see why only one such mass in a considerable area would result, why other concretions would be barren, and why the matrix would be unfossiliferous. Little is known about the habits of ammonites. If they lived in swarms, the mass killing of a swarm by some catastrophe, such as a sudden fouling of the water by volcanic detritus or the abrupt expansion in numbers of some microorganism that was lethal to the ammonites might conceivably result in the preservation in one spot of a large number of individuals. It is difficult to understand why, in such an event, there would be no stragglers somewhere in the vicinity, whose remains would be preserved outside the concretion or in other concretions.

The speculation that has appealed most to the writers is that these concentrations are accumulations of the fecal matter of some large carnivore—reptile, fish, or cephalopod. This thesis would offer some explanation for the damage to the shells, particularly that to the living chamber with its original content of the soft parts of the ammonite, the lack of complete individuals, the lack of sorting, and the disarticulated, sludge-like condition of the fish remains. The diet of the carnivore would have had to be almost

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EXPLANATION OF PLATE 4

FIGURES 1–4. Fish scales and bones constituting the matrix of ammonites at four localities and horizons (× 1) (p. 33). 1. Large concretion just below middle of Mowry shale at USGS loc. 24065, Petroleum County, Mont. Horizon of *Neogastroplites muelleri*. Material very largely vertebrae and other bones. USNM 129638. 2. Concretion in Colorado shale at base of 40-foot fish-scale shale overlying 33-foot porcelanite (Arrow Creek member) at USGS loc. 23410, Cascade County, Mont. Horizon of *Neogastroplites cornutus*. Material chiefly scales. USNM 129637. 3. Bed in Fort St. John group at GSC loc. 17300, Grande Cache map area, Alberta. Horizon of *Neogastroplites maclearni*. Material chiefly scales. GSC 13672. 4. Concretion in Colorado shale 115 feet below Big Elk sandstone member at USGS loc. 23042, Wheatland County, Mont. Horizon of *Neogastroplites americanus*. Material chiefly scales. USNM 129636.

entirely ammonites and fish, and the carnivore would perhaps, like the living octopus, have had to frequent a sort of lair, to which it repaired and in which the mucous-bound fecal matter could accumulate. The presence of small logs and other fragments of vegetable debris seems discordant with such a speculation, but to the writers the thesis explains more details than any other.

THE FOSSIL ASSEMBLAGES

The collections from the United States and Canada available to the writers (as of June 6, 1957) represent 125 localities. Some of these include only pelecypods and gastropods that seem not to be closely restricted stratigraphically, and some include only ammonites that are difficult to identify. About half of the localities, however, yield species of *Neogastroplites* that may be taken as characteristic of specific assemblages, and assignment of these lots is shown in table 1.

Five assemblages may be recognized by the species of ammonites contained in them. To these the writers have for convenience assigned names, in order from latest at the top to earliest at the bottom, as follows:

5. *Maclearni* assemblage, typified by the faunule (GSC 17300) at map locality 2 (fig. 7). This contains the typical form *Neogastroplites maclearni* and its variants, a few specimens of *Metengonoceras* B?, rare specimens of *Inoceramus anglicus* Woods, a barnacle, abundant fish scales, fossil wood and other vegetable debris. Five localities.

4. *Americanus* assemblage, typified by the faunule in a single concretion (USGS 23042) at map locality 28 (fig. 1). This contains the typical form *Neogastroplites americanus* and its variants, *Metengonoceras* A and its variants, fairly abundant *Inoceramus anglicus* Woods, abundant fish remains, radiolarians, *Cycadeoidea* sp., fossil wood and other vegetable debris. At places a varied pelecypod-gastropod fauna is present at this level, and the imprints called *Asterichnites octoradiatus*. Twenty-five localities.

3. *Muelleri* assemblage, typified by the faunule in a single concretion (USGS 24065) at map locality 20 (fig. 1). This contains the typical form *Neogastroplites muelleri* and its variants, *Metengonoceras* B and its variants, rare *Inoceramus* sp., abundant fish remains, bones of pterosaurs, plesiosaurs, and ichthyosaurs, radiolarians, and fossil wood and other vegetable debris. Nine localities.

2. *Cornutus* assemblage, typified by the faunule in a single concretion (USGS 23021) at map locality 65 (fig. 1). This contains the typical form *Neogastroplites cornutus* and its variants, two specimens of *Metengonoceras*, fairly abundant *Inoceramus anglicus*, a few other pelecypods, and fossil wood. It is notable that there are known only two specimens of *Metengonoceras*. Twenty three localities.

1. *Haasi* assemblage, typified by the faunule in a single concretion (USGS 24566) at map locality 45 (fig. 1). This contains the typical form *Neogastroplites haasi* and its variants, and fossil wood. No other fossils were noted. Three localities.

In the earlier stages of the study reported in this paper, the sequence in time of the assemblages was not known, and the writers supposed that the *americanus* assemblage contained the genus *Gastroplites* and that it was the oldest (Cobban and Reeside, 1951, 1952a). Subsequent field and office work has shown that this supposition is false (Imlay and Reeside, 1954, p. 225) and that the order given above is more nearly correct. Suggestions as to the relative order of the fossils are given by certain physical criteria, such as relation of faunal levels to persistent bentonite beds or other traceable beds or position in the sequence of porcelanitic strata, but the writers believe the true relations of the *cornutus*, *muelleri*, *americanus*, and *maclearni* assemblages have been definitely established by the recognition of two or more of them in single stratigraphic sequences. The *haasi* assemblage is assigned, however, largely by its stratigraphic position, though the writers have considerable confidence in this. A summary of the relationships shown by five local sequences is given in the following diagram, table 2:

TABLE 2.—*Stratigraphic distribution of* Neogastroplites *assemblages*

Belt Butte, Montana		Winnecook Ranch, Montana		Limestone, Montana		Cody, Wyoming		Kemmerer, Wyoming	
		Colorado shale (part)	>100 feet			Frontier formation (part)	>150 feet	Frontier formation (part)	>600 feet
			N. maclearni assemblage	Mowry shale (part)	>175 feet	Mowry shale	200 feet		
			50 feet						
			N. americanus assemblage				*N. americanus* assemblage	Aspen shale	*N. americanus* assemblage
	>50 feet		120 feet				160 feet		400 feet
	N. muelleri assemblage		*N. muelleri* assemblage						
	40 feet		>75 feet						
	N. cornutus assemblage				*N. cornutus?* assemblage		*N. cornutus* assemblage		*N. cornutus* assemblage
Colorado shale (part)	>400 feet			Thermopolis shale (part)	31 feet	Thermopolis shale (part)	>600 feet		375 feet
					N. haasi assemblage				
					>125 feet			Bear River formation (part)	>100 feet

AGE OF THE FORMATIONS

The placement of the *Neogastroplites* assemblages in the lithologic sequences of the western interior of both Canada and the United States seems established beyond doubt. The determination of the levels where they fit into the standard succession of stages, established in western Europe and applied with varying degree of assurance over the rest of the world, is not, however, equally certain. Any assignment to a standard stage has to be made by somewhat indirect methods, for the genus *Neogastroplites* has not, to the writers' knowledge, been found outside of its area in western Canada and the United States, and the associated genera and species are for the greater part not sufficiently restricted in range or of sufficiently wide distribution to be closely diagnostic.

McLearn (1945) summarized the problems of correlation of the Lower Cretaceous formations of Canada with the standard stages, and McLearn and Kindle (1950, p. 73–76) reviewed the subject in connection with a general discussion of the geology of northeastern British Columbia.

In the lower part of the Fort St. John group (Moosebar, Gates, Buckinghorse, Loon River, and Clearwater formations, and lower sandstone of the Peace River formation of McLearn) and in the equivalent beds of the Mackenzie River valley and Great Bear Lake are found ammonites that have been long referred to the genera *Lemuroceras* and *Beudanticeras* and considered early Albian and basal middle Albian. Casey (1954, p. 111) has placed in *Subarcthoplites* McLearn's *Lemuroceras belli* and questioned the validity of assigning some other Canadian species to *Lemuroceras*, but he has continued to assign these faunas to the early Albian and basal middle Albian.

In the middle of the Fort St. John group (Scatter, Lepine, Hasler, and Commotion formations and Cadotte member of the Peace River formation) is found the genus *Gastroplites*, represented by an array of species and considered middle Albian. A single specimen of *Gastroplites* has been found in England at the top of the middle Albian (Spath, 1937), and many specimens, assignable to several species, have been found in Alaska (Imlay and Reeside, 1954, p. 237, 242), associated with middle Albian or older species. There seems little doubt that *Gastroplites* is to be placed no higher than the top of the middle Albian.

McLearn and Kindle (1950, p. 93) have drawn attention to the possibility that Whiteaves' *Placenticeras liardense* may represent a younger zone than that of *Gastroplites*, inasmuch as Kindle (1944, p. 12) found Whiteaves' species about 100 feet higher than beds containing *Gastroplites* cf. *G. kingi* in the Lépine formation. Later writers (Stelck and others, 1956; Stelck, 1958) assign *liardense* to such a zone.

In the upper part of the Fort St. John group, but well below the top, are found two species of the genus *Neogastroplites*, assigned tentatively to the late Albian, with the reservation that it may possibly belong to the very early Cenomanian. Henderson (1954, p. 2282) recorded *Acanthoceras*, a Cenomanian ammonite genus, from the upper or shale member of the Sikanni formation. He recorded *Neogastroplites cornutus* from the lower or sandy member. If the identification of *Acanthoceras* is correct, the boundary between the Lower and Upper Cretaceous falls within the Fort St. John group.

Henderson (1954, p. 2282) mentioned a "Fish scale zone" above the *Neogastroplites cornutus* beds and in part overlapping his "*Acanthoceras* zone." Other authors have recorded such horizons, and it is apparent that fish scales are abundant and widely distributed in the Western Interior of Canada near the *Neogastroplites* levels. Fish-scale beds have been noted in the Colorado or Alberta shale in the subsurface of southern Alberta (Spratt, 1931, p. 1172–1176), in the basal part of the "Barren zone" of the Blackstone formation of the southern Foothills of Alberta (Webb and Hertlein, 1934, p. 1392, 1393), in the Shaftesbury formation of the Peace River Valley (Gleddie, 1954, p. 489–493), and as far north as the Mackenzie valley (Stewart, 1945, p. 7). In the Foothills area west of Calgary the lower part of the Blackstone formation contains a basal "Grit bed" with fish scales and bones and, about 100 feet higher, a fish-scale-bearing bed of thin-bedded to massive sandstone (Webb and Hertlein, 1934, p. 1392, 1393). In the Foothills belt southwest of Calgary, Hume (1930, p. 8B) noted that the "Grit zone" was highly siliceous and as much as 40 feet thick. Scruggs (1956, p. 24, 27) has suggested that the "Grit bed," by eastward thickening, becomes part of the Bow Island sandstones of southern Alberta or the Viking sandstones of central Alberta. It would seem that the higher "Fish Scale sand" of the Foothills belt is the equivalent of the fish-scale beds of Gleddie (1954), Badgley (1952), Stelck and others (1956), and other writers. Gleddie noted that as many as three fish-scale-bearing zones were present in his "Lower Shaftesbury formation" on Peace River and that *Neogastroplites* occurred in one of them. He placed the boundary between the Lower and Upper Cretaceous at the top of the "Fish remains zone." Badgley (1952) and Stelck and others (1956) placed the boundary within the "Fish-scale zone," whereas some other authors (for example, Thompson and Ax-

ford, 1953) drew the boundary at the base of the "Fishscale sand." The fish-scale beds naturally suggest a northward continuation of the fish-scale beds of the Mowry shale and a restricted time interval, but it seems not to have been shown that they are all of one age and that they are a completely reliable guide. Jeletzky (personal communication), for example, does not think any part of the Blackstone formation is as old as the horizons with *Neogastroplites* and of Early Cretaceous age.

As a somewhat dubious interval lies between the zone of *Neogastroplites* and the top of the Fort St. John group, and as the lower part of the overlying Dunvegan formation is also of somewhat dubious age, it becomes a matter of personal judgment whether the zone of *Neogastroplites* is to be assigned to the highest Albian or lowest Cenomanian.

In the United States a similar situation exists. Over much of the area of the Mowry and Aspen shales they are the first marine Cretaceous deposits. In the Black Hills, however, the Mowry rests on the thin Newcastle sandstone, and it in turn on the Skull Creek shale. The Skull Creek contains a small marine macrofauna correlated with the much larger fauna of the Kiowa shale of Kansas, which is generally assigned to the upper middle Albian, and an arenaceous foraminiferal fauna (Skolnick, 1958). Crowley (1951) assigned the Newcastle to the Lower Cretaceous and associated it with the Skull Creek, and Skolnick (1958a, b) includes the Skull Creek, Newcastle, and the lower part of the Mowry (Nefsy of Collier) in the lower and middle Albian. Upon the Mowry lies the Belle Fourche shale, the lower part of which is essentially barren and the upper part of which contains two zones of acanthoceratid ammonites of Cenomanian age. The next higher unit is the Greenhorn limestone, which contains in the lower part two zones with species of the upper Cenomanian ammonite *Dunveganoceras*. Thus it becomes again a matter of personal judgment whether the Mowry with its *Neogastroplites* is to be assigned to the highest Albian or lowest Cenomanian.

Yen (1952, 1954) presented the thesis that the nonmarine Bear River formation of western Wyoming, which underlies the marine Aspen shale and the strata on Leeds Creek, should be assigned to the Cenomanian stage. If adopted, this thesis would automatically place the Aspen, and even more surely the Mowry, fairly high in the Cenomanian, for the Bear River is about 1500 feet thick, of fairly fine grain, and must represent considerable time. Yen's reasons, as given in his first paper (1952, p. 757), for favoring a Cenomanian age for the Bear River are:

> (1) Species of *Pyrgulifera*, a characteristic genus of the Bear River, have been recorded abundantly in * * * Europe, and their known range is Upper Cretaceous (Cenomanian to Danian); (2) species of *Pyrgulifera* and at least 10 congeneric and closely similar species of the Bear River formation were found in the Gardonian formation in southern France * * * a standard representative of Upper Cenomanian; (3) The *Pyrgulifera*-bearing beds exposed elsewhere in Europe, which are considered to be younger than Cenomanian, did not yield species closely similar and congeneric * * *; (4) species of *Pyrgulifera* in North America have been found * * * above the Bear River, but not below it.

He added in his second paper (1954, p. 2413) a brief evaluation of *Gastroplites* and its bearing on correlation. The conclusion reached was that the single known specimen of *Gastroplites cantianus* Spath (1937), from the lower Gault (bed VIII) of Folkestone, England, and the specimens from Greenland recorded by Spath (1946, p. 8) as "*Gastroplites* sp. nov.?" are not adequate basis for assigning the Mowry shale (and hence the underlying Bear River) to the Lower Cretaceous.

To the writers the thesis that very similar or even identical faunal facies in Europe and America must be interpreted as meaning identical age is not necessarily true; further, that the genus *Pyrgulifera*, which is recorded as having a range from upper Cenomanian to Danian in Europe, could not have appeared there or in America in the only moderately earlier upper Albian seems an unwarranted conclusion; and finally, the occurrences of *Gastroplites* have, in the present state of knowledge, only indirect bearing on the ages of formations that contain *Neogastroplites* (the writers on another page have acknowledged their former identification of *Gastroplites* in the Mowry shale as an error).

A few additional items need to be considered. *Neogastroplites* is closely related to the earlier *Gastroplites*, some forms being very readily confusable, and it is difficult to accept the thesis of a long interval between the appearances of the two genera, which is demanded, if the Bear River is accepted as Cenomanian. In both the Mowry and Aspen shales the most common pelecypod, known at some 40 localities (including 30 that have also *Neogastroplites*), is a species of *Inoceramus* that the writers cannot distinguish from the form commonly called *I. anglicus* Woods, a widespread Albian species close to, as suggested by Donovan (1954, p. 23), if not identical with, *I. comancheanus Cragin*, a Lower Cretaceous form. At several localities occurs *Cardium kansasense* Meek, which was described from the Kiowa shale, a middle Albian formation, and has not been reported previously in later beds. The arenaceous Foraminifera

reported by Skolnick (1958a) from the Skull Creek, Newcastle, and the lower part of the Mowry of the Black Hills include six species previously known from the Lower Cretaceous rocks of the Gulf region. *Tempskya minor* Read and Brown (1937, p. 117), a species of fern common in the Aspen formation of Wyoming, has been reported by Zeller and Read (1956) in a chiefly marine upper Albian formation in southern New Mexico. Gleddie (1954, p. 492) cites Stelck as identifying the ammonite *Pleurohoplites*, a latest Albian form, in the uppermost part of the *Neogastroplites* zone in the Pine River area of British Columbia. Further, the development of indubitable Cenomanian deposits, such as those of the Black Hills with *Acanthoceras? amphibolum*, *Acanthoceras? wyomingense* and *Dunveganoceras*, must have occupied a considerable part of Cenomanian time; and the still older post-Mowry interval represented by the barren lower part of the Belle Fourche shale must also be fairly long. There would not appear to be much time left in the early Cenomanian to accommodate the interval of the Mowry shale nor of the Aspen shale, not to mention that of the Bear River formation.

Though the writers feel that the likelihood is high that the horizons with *Neogastroplites* will eventually prove to be of late Albian age, it is not possible now to make any such unreserved assertion. The conclusion that seems most justified is still that expressed by McLearn and Kindle (1950, p. 96) that *Neogastroplites* and its associates are to be "dated late Albian * * *, but the possibility of an early Cenomanian (early Upper Cretaceous) date cannot be entirely eliminated."

A summary of the relationships as interpreted by the writers is given in the following diagram, table 3.

TABLE 3.—*Relations of faunal zones of several areas*

Europe	Northeastern British Columbia		Black Hills, Wyoming and South Dakota		Southwestern Wyoming	
Lower Turonian	Smoky River group (part)	*Inoceramus labiatus*	Greenhorn limestone	*Inoceramus labiatus*	Frontier formation (part)	*Inoceramus labiatus*
				Metoicoceras		Nonmarine beds
Cenomanian		*Dunveganoceras*		*Dunveganoceras*		
	Dunvegan formation	*Acanthoceras?*	Belle Fourche shale	*Acanthoceras?*		
	Ft. St. John group					
Upper Albian		*Neogastroplites*	Mowry shale	*Neogastroplites*	Aspen shale	*Neogastroplites*
			Newcastle and Skull Creek formations			
Middle and lower Albian		*Gastroplites*		*Inoceramus comancheanus*	Bear River formation	Nonmarine beds
			Fall River sandstone	Nonmarine beds		
		Cleoniceras, Lemuroceras and *Beudanticeras*				

STRATIGRAPHIC SECTIONS

1. Section near Casper-Alcova highway about 10 miles southwest of downtown Casper, on side road to Mohawk Ranch, in NW¼ sec. 6, T. 32 N., R. 80 W., Natrona County, Wyo.

[Measured by John B. Reeside, Jr.]

	Feet
Frontier formation (part): Slope and valley with few exposures, assumed to be underlain by soft rocks of lower part of Frontier formation. Not measured.	
Mowry shale:	
Sandstone, black, dense, hard, calcareous	1
Shale, bluish-white, hard	57
Porcelanite, grayish-white; weathers platy	3
Shale, bluish-white, hard; concretion near base	41
Porcelanite; weathers white; blocky	3
Shale, bluish-white, hard	25
Porcelanite; weathers white; platy	1
Shale, bluish-white, hard; near middle contains a zone of coffee-brown concretions as much as 6 ft in diameter that have much cone-in-cone structure. Fish scales only fossils noted	23
Porcelanite; weathers white; blocky	5
Shale, bluish-white, hard; upper part bentonitic	8
Porcelanite; weathers bluish gray	1
Dip slope and valley with few exposures, but probably all hard bluish-gray shale	6
Porcelanite, grayish-white, hard, blocky, ridge-forming; makes conspicuous lines on ground. USGS Mesozoic loc. 24570	4
Interval poorly exposed, but shows some bluish-gray hard shale and some black softer shale	41
Porcelanite; weathers grayish white; platy	1
Bentonite, yellow, nearly pure	3
Porcelanite; weathers grayish white; platy	1
Total Mowry shale	224
Thermopolis shale (part):	
Shale, dark	4
Zone of large coffee-brown concretions, as much as 10 ft in diameter, with much cone-in-cone structure on a large scale; matrix black shale. No fossils seen	10
Dip slope and valley with black shale and thin dark sandstone not measured.	

2. Section near secondary road, about 6 miles southwest of Cody in SE¼ sec. 13, T. 52 N., R. 103 W., and SW¼ sec. 18, T. 52 N., R. 103 W., Park County, Wyo.

[Measured by John B. Reeside, Jr.]

Frontier formation (part):	Feet
Sandstone, gray to tan, fine-grained (part), massive	30
Concealed	10
Sandstone, gray to tan, fine-grained, platy to thick-bedded	15
Concealed	20
Sandstone, gray to tan, fine-grained, platy to thick-bedded	10
Concealed	15
Sandstone, gray to tan, fine-grained, platy to thick-bedded	15
Concealed	20
Sandstone, gray to tan, fine-grained, platy to thick-bedded; at base contains black chert pebbles as much as 1 in. in diameter	8
Total Frontier formation measured	143

2. Section near secondary road—Continued

Mowry shale:	Feet
Interval poorly exposed, but apparently all light-gray hard porcelanitic shale	54
Sandstone, gray to tan, fine-grained, platy to thick-bedded; makes crest of ridge, but not especially hard. At base USGS Mesozoic loc. 24560	30
Shale, blue-gray, hard porcelanitic. 15 ft below top USGS Mesozoic locs. 24562 and 24563	80
Porcelanite; weathers grayish white; breaks into flat chips; 2-ft bentonite bed near middle	27
Shale, gray to tan, sandy, hard, porcelanitic, with several resistant zones. In scattered concretions 10 ft above base USGS Mesozoic loc. 24561; in concretions 30 ft above base USGS Mesozoic loc. 24564	60
Porcelanite, gray, massive	1
Shale, gray to tan, sandy, hard, porcelanitic; contains a few scattered 6-ft concretions 20 ft above base	66
Porcelanite; weathers yellow; massive	6
Interval poorly exposed, but apparently soft shale beds containing a few harder layers	24
Porcelanite, gray; weathers yellow; sandy	4
Bentonite, gray	6
Shale, dull- to yellowish-gray, sandy, porcelanitic, laminated; some layers harder than others	8
Bentonite, yellow	2
Shale, dull- to yellowish-gray, sandy, procelanitic, laminated	24
Bentonite, locally yellow and fairly pure	4
Sandstone, dull yellowish-gray, muddy; weathers platy; contains widely scattered 6-ft concretions, some with fossils; USGS Mesozoic loc. 23021	5
Shale, yellowish-gray, sandy, and soft silty sandstone	25
Total Mowry shale	426
Thermopolis shale:	
Upper shale member:	
Talus at foot of Mowry ridge; scattered exposures are all of black shale member	110
Valley containing road; exposures poor, but all of black shale	210
Total upper shale member	320
Muddy sandstone member; Sandstone, light-gray to yellow, fine-grained, rather massive, cross-laminated; contains much plant debris and numerous clay pellets	25
Lower shale member:	
Shale, black; contains bentonite beds and a few irregular beds of sandstone; upper part not well-exposed	235
Sandstone, coffee-brown to black, medium-grained, irregularly bedded; contains worm? trails	1
Shale, black, flaky, with some yellow bentonitic bands	28
Talus, apparently on black shale	17
Total lower shale member	281
Total Thermopolis shale	626
Cloverly formation.	

3. Section along main irrigation canal and Trail Creek road 2 miles northwest of Cody in NE¼ sec. 26, T. 53 N., R. 102 W., Park County, Wyo.

[Measured by John B. Reeside, Jr.]

	Feet
Frontier formation (part):	
Shale and sandstone, not well exposed	15
Sandstone, ridge-forming, massive	6
Concealed in slope	20
Sandstone, yellow to gray; weathers nearly black; very dense, fine-grained; in thin beds; makes ridge and dip slope	20
Interval with black shale in upper part; lower part concealed in valley	72
Interval poorly exposed, but probably shale; could equally well be called Mowry	20
Total Frontier formation measured	153
Mowry shale:	
Sandstone, gray, dense; black on surface	1
Shale, bluish-gray, porcelanitic, hard	30
Bentonite; mined in past years by trenching	10
Porcelanite; weathers into grayish-white platy chips; forms persistent ridge	40
Bentonite	6
Sandstone, gray, porcelanitic, very hard	6
Concealed	60
Shale, blue-gray, porcelanitic, hard, with thin porcelanite layers that weather light gray	30
Shale, yellowish-gray, with some porcelanitic layers; poorly exposed	55
Porcelanite; weathers grayish white; contains brown calcareous concretions. USGS Mesozoic loc. 24554	3
Bentonite, yellow	3
Porcelanite; weathers grayish white to tan; massive; contains *Asterichnites octoradiatus* Brown and Vokes on upper surface	3
Bentonite, yellow	2
Shale, yellow-gray; includes three 1-ft layers of bentonite	10
Porcelanite; weathers gray white; massive	3
Shale, yellow-gray, bentonitic	17
Porcelanite; four 1-ft beds separated by 2-ft beds of yellow shale	10
Bentonite, yellow	5
Shale, gray, porcelanitic	3
Porcelanite; weathers grayish white; massive	3
Shale, dove-gray, porcelanitic, with thin zones of bentonite and platy porcelanite; three 2-ft layers of bentonite in upper part	48
Bentonite	4
Porcelanite; weathers grayish white; massive	10
Bentonite and bentonitic shale	8
Porcelanite; weathers grayish white; massive	5
Shale, yellow, bentonitic	20
Bentonite, gray	3
Shale, yellow, with hard platy porcelanitic layers	4
Bentonite and bentonitic shale	12
Total Mowry shale	414
Thermopolis shale (part):	
Sandstone, yellowish-gray, platy, in shale; could as well be called Mowry	30

3. Section along main irrigation canal—Continued

	Feet
Thermopolis shale (part)—Continued	
Bentonite and dark bentonitic shale	12
Sandstone, brown, platy, in dark shale	12
Shale, yellowish	8
Bentonite	2
Sandstone, brown, platy, in dark shale	6
Shale, black	15
Bentonite	1
Shale, black	30
Sandstone, brown, ferruginous, hard, platy	5
Shale, yellow to brown	12
Shale, black	60
Concealed interval, not measured	----
Total Thermopolis shale measured	193

4. Section 6.7 miles by Clarks Fork road north of the Shoshone River at Cody and about three-fourths of a mile east of road in NE¼ sec. 3, T. 53 N., R. 102 W., Park County, Wyo.

[Measured by Alejandro Calderón Garcia]

	Feet
Frontier formation (part):	
Sandstone, gray, fine-grained, massive	53
Mowry shale:	
Interval concealed in valley; creek bed at 133 ft above base	204
Porcelanite, silvery-gray, splintery; with concretions 40 ft above base. In concretions USGS Mesozoic loc. 24565	72
Sandstone, light-gray, fine-grained	1
Porcelanite, silvery-gray, splintery	41
Porcelanite, gray; makes small ridge; not splintery	6
Interval concealed	26
Sandstone, light-gray, fine-grained, well-bedded	6
Interval concealed	66
Interval concealed; soil color indicates Mowry	8
Total Mowry shale	430
Thermopolis shale (part):	
Interval concealed; dark soil color indicates Thermopolis	28
Shale, black	91
Total Thermopolis shale measured	119

5. Partial section of Mowry shale on divide between Line and Bennett Creeks in NE¼SE¼ sec. 34, T. 58 N., R. 103 W., Park County, Wyo.

[Measured by John B. Reeside, Jr.]

	Feet
Talus and terrace materials; bedrock concealed.	
Sandstone, brown, hard, probably porcelanitic	10
Concealed by talus and wash	30
Sandstone, brown, hard	12
Interval partly concealed, but with exposures that suggest that it is all hard porcelanitic shale	90
Sandstone, grayish-white, hard, probably porcelanitic	6
Concealed by talus and wash	10
Sandstone, gray-white, porcelanitic; contains scattered dark-brown calcareous concretions. USGS Mesozoic locs. 17934 and 24555	3
Concealed by talus and wash	21
Sandstone, grayish-white, hard, porcelanitic	2
Concealed by talus and wash	66
Sandstone, grayish-white, hard, porcelanitic	3

5. Partial section of Mowry shale—Continued

	Feet
Concealed by talus and wash	18
Sandstone, grayish-white, hard, porcelanitic	3
Concealed by talus and wash	27
Porcelanite, gray to brown	12
Concealed by talus and wash	15
Sandstone, grayish-white, hard, porcelanitic	4
Talus and wash; bedrock not exposed	
Total Mowry shale measured	332

6. Mowry shale and Newcastle sandstone on northeast side of Thornton dome in sec. 8, T. 48 N., R. 65 W., Weston County, Wyo.

[Measured by C. S. Robinson and others]

	Feet
Belle Fourche shale (part): Shale, grayish-black, soft; contains several beds of dark purplish-black siderite concretions that weather grayish red to dark reddish brown; bed of light-gray bentonite about 1 ft thick 5 ft above the base	25+
Mowry shale:	
Bentonite, light-gray (Clay Spur bed)	3
Shale, dark-gray; weathers light gray; brittle; contains a dark-gray limestone concretion 20 ft long and 1.5 ft thick about 6 ft above base; abundant fish scales in lower part; upper part not continuously exposed	55
Bentonite, gray	.7
Shale; weathers light gray; contains fish scales	14
Shale; weathers light gray; several 1- to 3-in. thick beds of gray bentonite in upper part	60
Bentonite, pale yellowish-gray	.5
Shale; weathers light gray	5
Bentonite, light-gray	1.5
Shale; weathers light gray; two 1-in. thick beds of gray bentonite in upper part	25
Bentonite, light-gray	2
Shale; weathers light gray	3
Bentonite, pale yellowish-gray	.7
Shale, dark-gray, soft; near top bed of calcareous siltstone concretions that weather brown and have cone-in-cone structure	13
Total Mowry shale	183.4
Newcastle sandstone:	
Sandstone and interlaminated shale; sandstone light gray and fine grained; shale medium gray, silicified, and very hard; unit forms inconspicuous ledge	.5
Shale, dark-brown, carbonaceous; contains a few stringers of yellowish-gray bentonite	2
Shale, gray, bentonitic; locally contains partings of light-gray slightly carbonaceous sandy shale	3
Shale, dark-brown to black, carbonaceous	1.5
Poorly exposed; mostly medium-gray bentonitic shale	4
Sandstone, very light gray, fine-grained, well-sorted, thin-bedded, slightly carbonaceous, lenticular; forms hard blocky ledge	1
Sandstone and sandy claystone; light- to dark-gray, bentonitic; upper 0.5 ft grayish black and very carbonaceous	2
Bentonite and bentonitic shale; olive-gray, mottled red locally	2
Total Newcastle sandstone	16

6. Mowry shale and Newcastle sandstone—Continued

	Feet
Skull Creek shale (part): Shale, grayish-black, soft, fissile, noncalcareous; about 12 ft below top a bed of black silty limestone concretions that weather brownish red; in the lower part several beds of siderite concretions that weather purplish red	35+

7. Mowry shale on cutbank of Belle Fourche River near center of sec. 20, T. 57 N., R. 62 W., Crook County, Wyo.

[Modified from S. H. Patterson, written communication, 1954]

	Feet
Belle Fourche shale (part):	
Shale, gray; weathers light gray; siliceous; interlaminated with gray bentonitic shale	0.9
Mowry shale:	
Bentonite, light yellowish-green, waxy (Clay Spur bed)	2
Shale, dark brownish-gray; weathers light silvery gray; siliceous; limonitic stain along joints; contains fish remains in lower part; somewhat less resistant than lower siliceous strata	31
Bentonite, light-gray, waxy, limonite-stained (bed B)	.9
Shale, gray to brownish-gray, siliceous; limonitic stain along joints; upper 2 in. very hard	13
Bentonite, light-gray, waxy	.9
Shale, brownish-gray, siliceous; limonitic stain along joints; abundant fish remains	11
Bentonite, light-gray, waxy	.9
Shale, brownish-gray, siliceous, hard; contains calcareous lenses as much as 4 in. thick and 3.5 ft long that have poorly developed cone-in-cone structure; some lenses overlain by thin seams of fibrous gypsum	3.1
Bentonite, light-gray, waxy	.3
Shale, dark brownish-gray, siliceous, hard; contains abundant fish remains	3.2
Bentonite, light brownish-gray; dark-gray laminae in upper part; waxy	.1
Shale, dark brownish-gray, siliceous, hard; limonitic stains along joints	.4
Bentonite, light yellowish-gray, waxy	.1
Shale, dark brownish-gray, siliceous, hard	.7
Bentonite, light yellowish-gray, waxy	.6
Shale, brownish-gray, siliceous, hard; yellow stains along joints	9
Shale, dark-gray, somewhat siliceous; much softer than adjacent strata	1.2
Shale, brownish-gray, siliceous, hard; yellow stains and tiny gypsum crystals along joints; contains abundant fish remains	25
Shale, dark-gray, siliceous; several laminae of bentonite	.9
Shale, dark brownish-gray, siliceous; limonitic stain along joints; contains fish remains	2.2
Shale, dark-gray, siliceous; contains many thin laminae of bentonite	4.5
Shale, dark brownish-gray, siliceous, hard; many vertical joints, most of which are coated by yellow powdery residue and stain	10
Shale, dark-gray, somewhat siliceous, much softer than enclosing beds; bentonitic near base	1.1
Bentonite, brownish-gray, waxy, limonite-stained	.2
Shale, dark brownish-gray, siliceous, hard; yellow powdery residue along joints; contains abundant fish remains	2.5

12. Section on south side of Belt Butte—Continued

Colorado shale (part)—Continued	Feet
Upper unnamed shale member—Continued	
Sandstone, light medium olive-gray, very fine grained, very thin bedded and flaggy; consists of ripple-marked lenses and layers ⅛ to 5 in. thick separated by black shale films and thin layers. Worm trails and burrows abundant on surfaces	10
Concealed	7. 5
Total upper unnamed shale member	240. 7
Bentonitic member (red speck zone):	
Claystone, olive-gray, olive, and light- to dark-gray; bentonitic; rather soft but with locally harder parts containing pebbles of green clay; occasional carbonaceous flakes and pieces of fossil wood as much as 3 in. in diameter; poorly exposed; and forms slope covered by debris from overlying sandstone	18
Sandstone, light to very light gray, fine to very fine grained; mostly thick bedded and massive; contains gray shale pebbles. Middle part concealed; lower and upper parts form conspicuous ledges	7. 7
Concealed	10. 5
Sandstone, light-gray; weathers tan; very fine grained, hard, thick bedded; forms small ledge	4
Total bentonitic member	40. 2
Lower unnamed shale member (part):	
Shale, dark-gray, largely concealed	26. 5
Sandstone, siltstone, and shale; alternate units of hard ledge-forming thick-bedded very fine grained medium-gray sandstone, beds as much as 1 ft thick of siltstone that weather olive gray, and darker hard silty chunky shale. Occasional fish scales	12
Shale, dark-to dark medium-gray, hard, chunky; contains a few layers of bentonite; largely concealed. Thickness measured	45
Total lower unnamed shale member measured	83. 5
Thickness of Colorado shale measured	475. 9

13. Section 2 miles north of Geyser, less than one-fourth mile west of county road, starting from head of small reservoir close to east line of SE¼ sec. 30 and traversing NNE to top of bench in NW¼NW¼ sec. 29, T. 18 N., R. 10 E., Judith Basin County, Mont.

[Measured by W. A. Cobban]

Colorado shale (part):	Feet
Arrow Creek member (part): Bentonite and porcelanite, yellowish-cream and light-gray; unit weathers white and caps bench. Part measured	31
Unnamed shale member (part):	
Claystone, very light gray; weathers medium gray; silty, very shaly, hard, platy, ledge-forming; contains occasional lenses of more massive claystone with fossils. USGS Mesozoic loc. 24603	1
Shale, dark-gray, fissile, rather firm; 1- to 2-in. layer of conglomerate with chert pebbles as much as ¼ in. in diameter near top	13

13. Section 2 miles north of Geyser—Continued

Colorado shale (part)—Continued	Feet
Unnamed shale member (part)—Continued	
Sandstone, brown, fine-grained, massive, firm; top surface cross-ripple marked. Contains a few large *Inoceramus* and lenses of fish bones, teeth, and scales. USGS Mesozoic loc. 24602	. 5
Shale, largely concealed; exposures show dark-gray fissile to dark medium-gray or brownish-gray silty shale with numerous thin layers of bentonite	46. 5
Shale, dark bluish-gray, fissile, soft; contains an occasional thin gray lens of silt or very fine grained sandstone or a slabby ferruginous silty concretion that weathers dark purplish brown	23
Bentonite, medium-gray; weathers to light-gray gumbo bare of vegetation	17
Claystone concretions, light medium-gray coated with black manganese oxides; conchoidal fracture	. 2
Shale, dark medium-gray, silty to very fine sandy; contains numerous fine to very fine grained hard gray sandstone lenses that weather olive gray to medium gray, are as much as 2 in. thick, and increase in abundance toward top	23
Bentonite, medium-gray; becomes impure upward	3
Claystone concretions, light medium-gray coated with black manganese oxide	. 2
Shale, very dark gray, fissile, soft	11. 5
Shale, dark-gray and fissile to dark medium-gray, silty and more massive; contains numerous lenses of medium-gray to medium olive-gray fine to very fine grained hard ripple-marked sandstone as much as 2 in. thick that weather gray, tan, or grayish-red and commonly show worm? burrows and trails; also contains scattered ferruginous concretionary lenses that weather dark brown to dark purplish brown. 93 ft above base USGS Mesozoic loc. 24613	153
Sandstone, medium olive-gray, fine-grained, moderately thick bedded, glauconitic, fairly porous but firm, ledge-forming; top coarse and sprinkled with black chert pebbles as much as ½ in. in diameter. Part measured	3
Total unnamed shale member measured	294. 9
Total Colorado shale measured	325. 9

14. Section on north side of Arrow Creek 4.5 miles northeast of Geyser in NW¼ sec. 23, T. 18 N., R. 10 E., Judith Basin County, Mont.

[Measured by W. A. Cobban]

Colorado shale (part):	Feet
Equivalent of Blue Hill shale member of Carlile shale (part): Shale, dark bluish-gray, fissile; largely concealed. Not measured.	
Equivalent of Fairport chalky shale member of Carlile shale: Shale, gray; weathers tannish orange; soft, slope-forming; contains several beds of creamy-gray bentonite and some thin shaly tannish-orange limestone beds with a simple oyster; rarely a limestone concretion that weathers bright tan	14. 5

14. Section on north side of Arrow Creek—Continued

	Feet
Colorado shale (part)—Continued	
Equivalent of Greenhorn limestone:	
Shale, gray; weathers tannish orange; limy; contains lentils of gray limestone; forms prominent cliff	10
Shale, dark-gray, calcareous	17
Shale, dark-gray; weathers gray; calcareous; grades upward into bluish-black less calcareous papery shale	25.5
Bentonite, light-olive to medium-gray, inconspicuous	3.5
Shale, dark-gray; weathers light medium gray; calcareous	13.5
Concretions, medium-gray; weather lighter gray; limy, closely spaced; highly septarian, with thick brown and pale-yellow calcite veins	1.2
Total Greenhorn equivalent	70.7
Equivalent of Belle Fourche shale:	
Shale, dark bluish-gray, fissile; grades upward into more sandy beds of massive mudstone and dark shale with lenticular beds and lenses as much as 3 in. thick of very fine- to fine-grained hard sandstone that weathers tan. *Metoicoceras* present but rare	30
Mudstone; weathers light blue; arenaceous to sandy; and dark sandy shale. Firm; cut by thin sandstone dikes	26
Bentonite, cream-colored, pure	1
Shale, dark bluish-gray, fissile, firm; basal 2 ft sandy and in part mudstone; top 3 ft hard, sandy	8.7
Bentonite, cream-colored; base micaceous	.5
Sandstone and shale interbedded, gray, soft	6.5
Bentonite, yellow to cream	1
Sandstone and shale, interbedded; hard, very fine grained; unit weathers blue, forms ledge, and contains some carbonaceous flakes	3
Shale, dark-gray; weathers blue; hard, finely arenaceous, interlaminated with lenses of very fine grained hard sandstone that weathers blue; contains some carbonaceous flakes	12.7
Bentonite, cream-colored	.5
Shale and sandstone, gray, very fine grained, interlaminated	7.7
Shale, brown, bentonitic	1
Total Belle Fourche shale equivalent	98.6
Mowry shale member:	
Upper shale unit:	
Shale, dark-gray; weathers light bluish gray; hard, finely arenaceous	.5
Bentonite, creamy-gray, pure	2.7
Shale, dark-gray, hard, finely arenaceous	.7
Bentonite, cream-colored	.5
Sandstone, gray; weathers to prominent brown ledge; very fine grained, hard shaly, ripple-marked; contains abundant fish bones	1.5
Shale, dark medium-gray; weathers light gray, hard, finely arenaceous; contains some fish scales; several thin bentonite layers	10.5

14. Section on north side of Arrow Creek—Continued

	Feet
Colorado shale (part)—Continued	
Mowry shale member—Continued	
Upper shale unit—Continued	
Sandstone, salt and pepper, massive, hard; contains abundant fish bones	.2
Bentonite, creamy-gray	1
Sandy unit:	
Sandstone, gray; weathers to a brownish ledge; fine-grained to very fine grained; thin-bedded; in layers as much as 6 in. thick separated by ripple-marked dark shale films and thin layers that weather blue	2.5
Sandstone, gray, fine-grained to very fine grained, soft; in thin ripple-marked layers separated by shale films and sandy shale layers	6
Bentonite, creamy-gray	1
Sandstone, gray, fine-to very fine grained, soft; in thin ripple-marked layers separated by shale partings	18
Shale, dark-gray to brownish-gray, soft, arenaceous, interbedded with very fine grained soft ripple-marked gray sandstone; contains minute carbonaceous flakes and one thin bed of bentonite	27
Bentonite, cream-colored	.2
Shale, brown, soft, arenaceous; interbedded with thin layers of soft very fine grained gray sandstone; a few fish scales; two very thin layers of bentonite	16.2
Lower shale unit:	
Shale, dark-gray; weathers light gray; hard, finely arenaceous; contains a few fish scales	2.7
Shale, dark-gray, firm, finely arenaceous	2.5
Total Mowry shale member	93.7
Arrow Creek member:	
Bentonite, creamy- to light medium-gray	6.2
Bentonite, tuff, and porcelanite; massive; form prominent barren white outcrop; contain rare fish scales	25
Bentonite, olive; grades upward into yellow, cream, and pale yellow	9
Total Arrow Creek member	40.2
Unnamed shale member (part):	
Shale, dark bluish-gray, hard, silty, with interbedded lenses of hard very fine grained sandstone as much as 1 in. thick	11
Sandstone, gray to brown, fine to gritty, very porous, pebbly; in crossbedded lenses as much as 1.5 ft thick separated by dark-gray shale; contains minute fragments of carbonized wood and pebbles of black chert as much as ¾ in. in diameter	2.7
Shale, dark bluish-gray, hard, silty, with interbedded lenses of hard very fine grained sandstone	12.5
Sandstone, gray; weathers brown; fine-grained with very fine grained to coarse streaks; thin-bedded, ripple-marked, crossbedded, hard, ledge-forming; contains fish bones	1.2

14. Section on north side of Arrow Creek—Continued

	Feet
Colorado shale (part)—Continued	
Unamed shale member (part)—Continued	
Shale, dark bluish-gray, hard; silty, with interbedded lenses of hard very fine grained sandstone. Part measured	5
Total unnamed shale member measured	32. 4
Total Colorado shale measured	350. 1

15. Section on hogback about 2 miles north-northeast of Spring Creek Colony in S½NW¼ sec. 5, T. 16 N., R. 17 E., Fergus County, Mont.

[Measured by W. A. Cobban]

	Feet
Colorado shale (part):	
Equivalent of Greenhorn limestone: Shale, gray, weathers light gray; calcareous, poorly exposed. Not measured.	
Equivalent of Belle Fourche shale: Shale, bluish-gray, soft; contains silty partings. Poorly exposed	75
Mowry shale member:	
Upper shale unit:	
Bentonite, cream-colored, poorly exposed	2. 5
Shale; mostly concealed, but small exposures show hard silty shale that weathers pale bluish gray	70
Shale, medium-gray; weathers pale blue to bluish white; hard; in part a silty claystone; forms inconspicuous ridge but is poorly exposed	4
Shale, medium-gray; weathers pale brown to bluish white; largely concealed	22. 5
Bentonite, cream-colored	1. 5
Sandy unit:	
Sandstone, buff-gray; weathers tannish buff; very fine grained to silty, thin-bedded, ripple-marked, firm; forms hogback	3. 5
Siltstone and shale interbedded, light to medium brownish-gray, soft; contains minute carbonaceous specks and some shaly very fine grained sandstone	49. 5
Bentonite, creamy-gray, olive, and orange	1
Siltstone and shale interbedded; siltstone is very thin bedded to shaly; unit rests sharply on underlying shale	20
Lower shale unit:	
Shale, medium-gray; weathers light gray; hard to firm; contains some fish scales	5. 5
Bentonite, cream-colored	. 5
Shale, medium-gray; weathers light gray	2
Bentonite, cream-colored	1. 5
Shale, medium-gray; weathers light gray	9
Shale, medium-gray to brown, silty	4
Total Mowry shale member	197
Unnamed shale member:	
Shale, dark bluish-gray; weathers medium bluish gray; firm	4. 5
Porcelanite, light-gray; weathers white; massive; thickness variable. USGS Mesozoic loc. 24920	. 7
Bentonite, yellow	1
Shale, dark bluish-gray; rather firm, with an occasional harder shale parting	14. 5
Total unnamed shale member	20. 7

15. Section on hogback—Continued

	Feet
Colorado shale (part)—Continued	
Arrow Creek member:	
Shale, very light gray, firm, somewhat platy; lower part rather soft and interbedded with bentonite layers; upper part contains hard silty claystone layers and lenses. Weathers to ledges	8
Bentonite and bentonitic shale; gray bentonite below, grades upward into silty bentonite interbedded with silty and bentonitic shale, with occasional hard thin shale partings that weather light gray. Unit weathers to light-gray bare gumbo	11. 5
Bentonite, yellow, high-swelling; weathers to bare pale gumbo	4
Total Arrow Creek member	23. 5
Unnamed shale member (part):	
Shale, dark-gray, interbedded with medium-gray shaly ripple-marked crossbedded siltstone; beds as much as 2 ft thick	8
Bentonite, cream-colored	. 2
Shale, dark bluish-gray, fissile, with an occasional thin siltstone layer	6
Shale and siltstone, dark to medium-gray, interbedded	10
Shale, dark bluish-gray, fissile, with a few thin hard layers and lenses of gray siltstone and some ferruginous concentrations. Not measured.	
Total unnamed shale member measured	24. 2
Total Colorado shale measured	340. 4

16. Section on west face of hogback 2 miles southwest of Brooks in center of SE¼ sec. 32, T. 17 N., R. 18 E., Fergus County, Mont.

[Measured by W. A. Cobban]

	Feet
Colorado shale (part):	
Mowry shale member (part):	
Upper shale unit (part):	
Porcelanite, medium-gray; weathers white; massive	0. 2
Bentonite, creamy-gray, poorly exposed	5
Sandy unit:	
Siltstone, very light gray to pale-tan, very hard, very shaly and platy; weathers light gray; contains some fish scales; forms prominent ledge	2
Interval mostly concealed; contains thick layer of bentonite at base	12. 5
Sandstone, light medium-gray; weathers tan; very fine grained, thin-bedded to shaly, ripple-marked, firm; forms conspicuous lichen-covered ledge	4. 5
Shale, siltstone, and sandstone, very fine grained, interbedded and interlaminated; soft; unit readily breaks down into light buff-gray soil; largely concealed	16. 5
Siltstone and sandstone, medium-gray; weathers gray to dark brown, very fine grained, shaly, ripple-marked; firm; unit tends to be concretionary; contains fish scales	1. 5

16. Section on west face of hogback—Continued

	Feet
Colorado shale (part)—Continued	
Mowry shale member (part)—Continued	
Sandy unit—Continued	
Shale, siltstone, and sandstone, interbedded and interlaminated	19. 5
Siltstone and sandstone, light medium-gray; weathers medium gray to dark brown; very fine grained, very shaly; in layers less than 1 in. thick; hard; unit forms inconspicuous ledge; fish scales locally abundant	1. 2
Shale, siltstone, and sandstone, interbedded and interlaminated	22. 5
Bentonite, creamy-gray	. 5
Lower shale unit:	
Shale, dark medium-gray; weathers medium bluish gray; firm	6. 5
Bentonite, cream-colored	1
Shale; weathers medium bluish gray; top 2.5 ft slightly harder	8
Bentonite, cream-colored	. 2
Shale; weathers medium bluish gray	2
Claystone and shale, medium-gray; weathers pale bluish gray; hard; joints coated with yellow powder; unit forms conspicuous ledge. USGS Mesozoic loc. 24918	3
Total Mowry shale member measured	106. 6
Unnamed shale member: Shale, covered below. Upper part silty, firm, medium gray; weathers light gray and alternates with harder shale that weathers light bluish gray. Contains fish scales and has a few thin bentonite layers in upper part	23
Arrow Creek member: Bentonite, gray, high-swelling; grades upward into silty bentonite alternating with thin gray silty bentonitic shale; weathers to very light gray gumbo and gives rise to seeps	18
Unnamed shale member (part): Siltstone, light-gray, ripple-marked, in thin lenses as much as 3 ft thick separated by dark-gray shale and some lenses of very fine grained sandstone	5
Total Colorado shale measured	152. 6

17. Section 1.5 miles south of the Fort Maginnis school, starting with the lowest good exposures of Colorado shale in SW¼SW¼ sec. 7, T. 16 N., R. 21 E., and traversing southeastward to county road in center N½NW¼ sec. 18, T 16 S., R. 21 E., Fergus County, Mont.

[Measured by W. A. Cobban]

	Feet
Colorado shale (part):	
Equivalent of Belle Fourche shale (part):	
Sandstone, gray; weathers brown; fine- to coarse-grained, mostly thick-bedded, and cross-bedded, ridge-forming	3
Shale, dark bluish-gray, soft, fissile	7
Sandstone, medium-gray, fine- to coarse-grained, thin- to thick-bedded; some parts with black chert granules and pebbles as much as ¼ in. in diameter; forms gray ledge	1. 7
Shale, dark bluish-gray, soft, fissile	10
Bentonite, cream-colored	1
Interval concealed	75
Total Belle Fourche equivalent measured	97. 7

17. Section 1.5 miles south of the Fort Maginnis school—Con.

	Feet
Colorado shale (part)—Continued	
Mowry shale member:	
Upper shale unit:	
Claystone and shale; weathers tan to whitish gray; silty, hard; an occasional silty calcareous concretion that weathers brown; interval partly concealed	30
Bentonite, creamy-yellow	. 5
Interval largely concealed, but probably claystone and shale; a few concretions that weather brown and have cone-in-cone structure	11. 5
Claystone and shale; weathers tan to whitish gray; hard, silty	13
Bentonite, creamy-yellow	. 5
Shale, weathers tan to bluish gray; hard, silty	7. 5
Interval concealed	8
Claystone and shale; weather tan to whitish gray	8
Sandy unit:	
Siltstone; weathers tan; hard, ripple-marked, shaly; capped by a 1-ft bed of massive coarse-grained sandstone with abundant comminuted fish bones and occasional black chert granules; forms hogback	10
Bentonite, creamy-gray	1
Shale and shaly siltstone; weathers light bluish gray; firm, ripple-marked	1. 5
Bentonite, creamy-gray	1. 5
Shale and shaly siltstone; weathers light bluish gray	1. 5
Bentonite, cream-colored	4
Sandstone, light-gray, very fine grained, in layers and ripple-marked lenses ⅛ to 2 in. thick; thicker lenses gently cross-bedded; firm; forms hogback	3
Interval largely concealed; buff sandy soil; bentonite layer at base	35
Sandstone, light-gray, very fine grained, in thin layers and ripple-marked lenses ⅛ to 3 in. thick, contains fish scales and bones; firm; forms conspicuous buff ledge	2. 5
Interval concealed; buff sandy soil	13. 5
Concretions; weather dark brown; calcareous, silty; show thin rippled-marked bedding planes and gentle crossbedding. USGS Mesozoic loc. 24917	1
Interval mostly concealed; buff gray silty soil; apparently a shaly siltstone and silty shale unit	28
Lower shale unit:	
Shale, dark medium-gray; weathers medium bluish gray with some harder and lighter layers; firm; tends to form outcrops bare of vegetation; some fish scales	8
Bentonite, cream-colored	1. 5
Claystone and shale, dark medium-gray; weather light bluish gray; hard, somewhat platy; unit contains fish scales and forms low ledge	4
Shale, dark medium-gray; weathers bluish gray	15
Claystone and shale; unit weathers light bluish gray	1. 5
Total Mowry shale member	211. 5

17. Section 1.5 miles south of the Fort Maginnis school—Con.

Colorado shale (part)—Continued	Feet
Unnamed shale member: Shale, dark-gray; weathers medium bluish gray; fissile, firm; tends to crop out as poorly vegetated surface. Contains a few hard shaly siltstone lenses that weather light bluish gray or buff	19
Arrow Creek member:	
Shale, brown; weathers light buff gray; bentonitic, soft	18
Bentonite, cream-colored, high-swelling; usually concealed	4
Siltstone; weathers gray; shaly, hard, iron-stained, ripple-marked, interbedded with dark-gray shale	3
Total Arrow Creek member	25
Unnamed shale member (part):	
Shale, dark-gray, soft, fissile; contains lenses and partings of hard ripple-marked very fine grained sandstone that weathers gray, olive, or tan, and occasional silty ferruginous concretions that weather dark brown or purplish black	105
Bentonite, cream-colored; grades upward into gray; high-swelling	2.5
Shale, dark-gray; weathers medium gray; fissile, soft; contains scattered concretionary lenses of ferruginous siltstone that weathers dark brown or purplish black and scattered lenses or partings of hard ripple-marked siltstone that weathers gray or tan; claystone concretions at top. Interval largely concealed	67
Shale, dark-gray, with hard lenses as much as 2 ft thick of light medium-gray siltstone that is irregularly bedded, has poorly developed ripple-marks and weathers buff; unit makes low buff ridge that bears growth of pines	15
Shale, dark-gray; weathers medium gray; soft, fissile, poorly exposed	55
Sandstone, buff, very fine grained, gently cross-bedded, ripple-marked; tends to be concretionary and weather dark brown; forms prominent hogback	3
Shale, dark-gray; weathers medium gray; fissile, soft; contains a few ferruginous concretions that weather dark brown to purplish black; poorly exposed	77
Sandstone, light-gray; weathers pale tan; very fine grained, argillaceous, poorly bedded; contains dark shale films and pebbles; forms ledge and supports pine trees	7
Total unnamed shale member measured	331.5
Total Colorado shale measured	684.7

18. Section on north side of Alkali Creek valley about 2 miles northwest of Ayers Colony and 8 miles west-northwest of Grassrange in NE¼ sec. 17, T. 15 N., R. 22 E., Fergus County, Mont.

[Measured by W. A. Cobban]

Colorado shale (part):	Feet
Mowry shale member (part):	
Sandy unit:	
Sandstone, light-gray, fine to very fine grained; thin-bedded in layers as much as 1.5 in. thick; hard; forms dip slope	1.2

18. Section on north side of Alkali Creek valley—Continued

Colorado shale (part)—Continued	Feet
Mowry shale member—Continued	
Sandy unit—Continued	
Sandstone, siltstone, and shale, interbedded; medium-gray to brown, soft, very fine grained; contain fish scales; occur as thin ripple-marked lenses as much as 1 in. thick; bentonite bed at base. Partly exposed in cut in county road ½ mile northwest of section	32
Interval largely concealed; top 1 ft is hard buff thin-bedded siltstone that weathers gray, contains fish scales, and forms dip slope	3
Bentonite, cream-colored	.7
Sandstone and siltstone, poorly exposed. USGS Mesozoic loc. 24601	7
Sandstone and siltstone; unit tends to be concretionary and to weather dark brown	1.2
Sandstone and siltstone, medium-gray to brown, interbedded	9.2
Concretionary bed, medium-gray; weathers dark brown; silty to very fine sandy; shows thin bedding and poorly developed ripple marks; some crossbedding in thicker layers	3.5
Sandstone and siltstone, poorly exposed	9
Bentonite, creamy-orange	.7
Sandstone, siltstone, and shale, interbedded; in lower part several thin beds of bentonite; unit rests with sharp boundary on underlying unit	12.5
Shale unit:	
Shale, dark medium-gray; weathers light bluish gray; hard but not quite a claystone; forms steep bare slopes	13.7
Bentonite, cream-colored	.2
Shale; weathers light bluish gray	7.5
Bentonite, cream-colored, grades upward into creamy gray	1.5
Claystone and shale, dark medium-gray; weathers light bluish gray; hard, platy; form prominent ledge; unit contains a few fish scales. USGS Mesozoic loc. 24600	3
Shale and shaly siltstone, dark medium-gray; weathers brown; unit contains abundant fish scales and several layers of impure bentonite	3.5
Bentonite, cream-colored	.2
Shale and shaly siltstone	1.5
Total Mowry shale member measured	111.1
Unnamed shale member:	
Shale, dark-gray; weathers medium bluish gray; fissile; lower part soft, upper part harder; contains a few hard gray siltstone lenses and layers that weather bluish gray and tan	28.5
Arrow Creek member:	
Shale, brown to gray; weathers light brown; bentonitic, silty, soft	7
Bentonite, creamy-gray to brown, low-swelling, impure, soft	3

18. Section on north side of Alkali Creek valley—Continued

	Feet
Colorado shale (part)—Continued	
Arrow Creek member—Continued	
Bentonite, cream-colored, high-swelling; weathers to bare gray gumbo locally, but is usually grassed over and concealed; slumped locally	5
Siltstone, medium-gray, hard, shaly; contains fish scales	.5
Total Arrow Creek member	15.5
Unnamed member (part):	
Shale, dark-gray; weathers medium bluish gray, soft, fissile. Part measured	15
Total Colorado shale measured	170.1

19. Section about 1.5 miles south of Teigen, starting in stream bottom near center of N½S½ sec. 31 and extending northeast across NW¼SE¼ and across country road to top of hill in SW¼NE¼ sec. 31, T. 15 N., R. 25 E., Petroleum County, Mont.

[Measured by W. A. Cobban]

	Feet
Colorado shale (part):	
Equivalent of Belle Fourche shale (part):	
Shale, dark bluish-gray, soft, fissile, with a few thin rusty ferruginous layers. Top of hill. Part measured	15
Shale, dark-gray, soft, fissile, bentonitic; forms dark gumbo soil; in lower part contains some bentonitic layers, scattered ferruginous concretions that weather dark brownish purple, and clayey concretions that weather brown	29
Total Belle Fourche equivalent measured	44
Mowry shale member:	
Upper shale unit:	
Bentonite, cream-colored	1.2
Shale, dark-gray, with medium-gray siltstone partings; softer and darker than underlying unit; breaks down to soil	8.5
Shale, dark-gray, with medium-gray siltstone partings; softer and more silty than beds below; weathers light bluish gray and light tan	22
Interval concealed; contains thin layers of bentonite	2.5
Claystone and shale, dark-gray; weather light bluish-gray to white; hard, platy: unit contains a few fish scales and forms steep slopes barren of vegetation except pines	23
Bentonite, cream-colored	.7
Claystone and shale; weather light bluish gray to white	17.7
Siltstone; weathers buff gray; shaly; contains fish scales. Poorly exposed	10
Bentonite, cream-colored and orange	.2
Interval largely concealed, but apparently a series of alternating beds of silty shale that weathers buff and light bluish-gray claystone; some beds of bentonite present	26
Claystone and shale; weather to light bluish gray barren outcrops; some fish scales	7

19. Section about 1.5 miles south of Teigen—Continued

	Feet
Colorado shale (part)—Continued	
Mowry shale member—Continued	
Upper shale unit—Continued	
Siltstone and shale; weather buff; largely concealed	6.5
Bentonite, cream-colored	2
Sandy unit:	
Siltstone and very fine grained sandstone, thin-bedded, hard; weather to a conspicuous pale-tan ledge; contain fish scales	2
Siltstone and very fine grained sandstone; weather buff; soft, shaly; contain fish scales. Poorly exposed	1
Sandstone, dark-gray; weathers rusty; fine-grained, pyritic, hard, massive; contains pebbles of gray chert as much as ½ in. in diameter, dark-brown phosphatic pebbles, fish teeth and fragments of larger bones; apparently marks a disconformity	.2
Siltstone and sandstone	1
Bentonite, cream-colored	1
Siltstone and sandstone	2.5
Siltstone and very fine grained sandstone, thin-bedded to shaly; tend to be concretionary and to weather dark brown; unit contains silty and sandy concretions as much as 6 ft in diameter that show thin bedding, ripple-marks, and fine cross-bedding	2
Siltstone and sandstone; weather buff	10
Bentonite, creamy-gray	.5
Sandstone, medium-gray, very fine grained, shaly; contains dark shale laminae and abundant fish scales	1
Lower shale unit:	
Shale, dark medium-gray; weathers light bluish gray; in part a claystone; tends to form light outcrops barren of vegetation	15
Bentonite, cream-colored and orange	.5
Shale; weathers light bluish gray	16
Bentonite, creamy-gray	2.5
Claystone and shale, dark medium-gray; weather light bluish gray; hard, platy; form conspicuous ledge	3.7
Siltstone, medium-gray; weathers brown; shaly; contains fish scales	6.5
Bentonite, cream-colored	2
Sandstone and siltstone, medium-gray, very fine grained, shaly	.1
Total Mowry shale member	194.8
Unnamed shale member:	
Shale, dark-gray; weathers medium bluish gray, fissile	9
Bentonite, cream-colored	.2
Shale, dark-gray; weathers medium bluish gray; soft, fissile; with an occasional thin shaly siltstone parting; middle part concealed	40
Arrow Creek member:	
Bentonite, creamy-gray	2.5

19. Section about 1.5 miles south of Teigen—Continued

	Feet
Colorado shale (part)—Continued	
Unnamed shale member (part):	
Shale, dark-gray; weathers medium bluish gray; soft, fissile; contains scattered clay-ironstone concretions that weather dark brown to dark maroon brown. Part measured	19
Total Colorado shale measured	309. 5

20. Section 3 miles southeast of Teigen, on north side of Elk Creek valley, approximately in center sec. 4, T. 14 N., R. 25 E., Petroleum County, Mont.

[Measured by W. A. Cobban]

	Feet
Colorado shale (part):	
Mowry shale member (part):	
Shale unit (part):	
Shale, medium-gray; weathers tan; silty to very fine sandy, interbedded with thin hard lenses of siltstone and very fine grained sandstone. Part measured	7
Claystone and shale, dark medium-gray; weather pale bluish gray to white; form bare outcrops and support poison ivy	7. 5
Siltstone, in hard ripple-marked lenses as much as 1 in. thick that weather pale tan, separated by dark-gray shale partings as much as ½ in. thick; abundant fish scales; forms ledge	2. 5
Siltstone, medium-gray, shaly, interbedded with dark-gray silty shale. Interval largely concealed	3
Bentonite, cream-colored, soft, inconspicuous	2. 5
Sandy unit:	
Siltstone and very fine grained sandstone, medium-gray, with lighter and darker laminae; weather pale tan; in part slightly calcareous; thin-bedded, slightly ripple-marked; thicker sandstone commonly shows fine crossbedding; fish scales common; unit forms conspicuous and persistent ledge	2
Siltstone; weathers buff; cone-in-cone structure; developed along a thin layer of bentonite	. 5
Siltstone and very fine grained sandstone, thin-bedded: at or near top of unit one or two 1- to 3-in. layers of dark-brown fine-grained sandstone composed largely of comminuted fish bones and small teeth and some coarse grains of black chert; scattered large concretions. One concretion with fossils (USGS Mesozoic loc. 24605) shows medium-gray siltstone with some thin bedding, some fine crossbedding and some poor ripple marks. The piece still in place measures 3.5 ft in diameter and through a thickness of 1.5 ft contains fossils, mostly ammonites, crowded together in a mass of fish scales and bones, the ammonites being in all positions from horizontal to vertical; fossil wood is common in fragments as much as 15 in. long and several inches in diameter. The fossil mass grades into a more shaly outer part of the concretion where the fossils are crushed and arranged parallel to the bedding. The central part of the concretion contains thick veins of very coarsely crystalline pale-yellow to white calcite, smaller crystals of dark-brown siderite(?), and rarely coarsely crystalline pale-blue barite	2
Siltstone and very fine grained sandstone; medium-gray; weathers buff; mostly shaly; contains some darker shale partings; rather soft; fish scales abundant; unit supports growth of bushes	2
Siltstone and sandstone; tend to be concretionary, with calcareous concretions 2 ft thick and 6 to 7 ft in diameter that weather dark brown and retain bedding and shaly partings; unit contains fish scales	2
Siltstone and sandstone, shaly	8. 5
Bentonite, mottled cream-colored and pink	. 5
Siltstone, light medium-gray, with dark shale partings; abundant fish scales	1
Shale unit:	
Shale, dark medium-gray; weathers light bluish gray, hard; in part a claystone; tends to form barren outcrops; occasional fish scales	18
Bentonite, cream-colored and orange	. 5
Shale; weathers light bluish gray; hard; in part a claystone	17. 5
Bentonite, creamy-gray, soft, shaly, inconspicuous	2. 2
Claystone and shale, dark medium-gray; weathers light bluish gray; hard, platy; unit contains a few fish scales and forms conspicuous ledge	2. 2
Siltstone, grayish-brown, soft, shaly; contains fish scales	5. 7
Bentonite, creamy-gray	1. 2
Siltstone, medium-gray, shaly, with fish scales	. 2
Total Mowry shale member measured	88. 5
Unnamed member (part):	
Shale, dark bluish-gray; weathers medium bluish gray; rather soft and fissile; thin sandy parting near base contains abundant fish scales	9. 5
Bentonite, cream-colored	1
Total Colorado shale measured	99

21. Section of "Fort St. John" group on the Sulphur River, 1¾ miles east of junction with the Smoky River, Grande Cache map area, Alberta, Canada.

[Adapted from R. Thorsteinson, 1952, Geol. Survey Canada Paper 52-26, p. 29]

"Fort St. John" group:	Feet
Shale, dark-gray; weathers buff to gray; argillaceous, fissile; grades imperceptably upward into siltstone	36
Shale, yellow-stained, dark-gray, friable	100
Shale, dark-gray; weathers rusty; argillaceous, hard, fissile; 12 ironstone concretionary bands or ellipsoidal layers occur in lower 120 ft. Fossils at 215 ft above base of unit. GSC loc. 17300	243. 5
Conglomerate and shale; weather dark gray; chert and quartzite pebbles in a fine-grained quartzite groundmass, 1 ft thick, overlying a bed of dark-gray fissile shale 0.5 ft thick	1. 5
Total "Fort St. John" group	381

COLLECTING LOCALITIES

The fossils that are discussed in this paper were found at localities shown on the maps, figure 7 for Canada and figure 1 for the United States. Two localities in Canada are recorded, in addition to the original localities of *Neogastroplites* and its associates (McLearn, 1933, p. 21-23) in the general vicinity of Fort St. John, B.C. The collections from the United States total 138 and represent 122 localities. A list of the locality numbers used on maps in this paper, arranged primarily from west to east and secondarily from north to south, relates the map numbers to the catalog numbers of the Geological Survey of Canada and the U.S. Geological Survey's Mesozoic locality numbers. The detailed descriptions of the localities then follow in numerical order.

Localities in order of numbers on figures 1 and 7

[Localities 2 and 3 have catalog numbers of Geological Survey of Canada; localities 4–125 have USGS Mesozoic locality numbers]

1	Near Fort St. John, B. C.	42	25717	84	20670
2	17300	43	25718	85	9006
3	24693	44	23023	86	8979
4	23411	45	24566	87	23217
5	26066	46	24921	88	24500
6	26065	47	9653	89	24570
7	24705	48	24502	90	17874
8	23410	49	10443	91	3847, 16056, 17304
9	3954	50	20932	92	21699
10	23412	51	20933	93	20779, 21678, 22044
11	24602	52	23245	94	21679
12	24603	53	17934, 24555	95	21680
13	24613	54	20370	96	21702
14	24920	55	26413	97	21703
15	24918	56	26414	98	21704
16	24917	57	10415	99	22047
17	24601	58	23465	100	21714, 22048
18	26224	59	12739	101	21715, 22028
19	24600	60	24565	102	21717, 22049
20	24065	61	24554	103	22042
21	24417	62	24569	104	26609
22	24418	63	24567	105	14718, 22989, 24539
23	24419	64	24568	106	24540
24	24609	65	23021	107	24542
25	24610	66	23020	108	24543
26	24611	67	24560	109	24552
27	24612	68	24561	110	3386, 21727
28	23042	69	24562	111	22980, 24545
29	23043	70	24563	112	24544
30	24608	71	24564	113	24547
31	24604	72	17173, 18137, 24558	114	24548
32	24605	73	24559	115	24549
33	24606	74	25360	116	14719, 24550
34	24607	75	6713	117	793
35	4612	76	4941	118	17834
36	4645	77	23581	119	26342
37	4610	78	8535	120	988
38	23413	79	6680	121	25586
39	23498	80	23427	122	26223
40	23029	81	6735	123	11665
41	25716	82	6764	124	7100
		83	6762	125	24717

Localities at which fossils were collected

Locality: Map localities 2 and 3 have catalog numbers of Geological Survey of Canada; map localities 4–125 have U.S. Geological Survey Mesozoic locality numbers.
Description: Data in quotation marks from collector shown in preceding column. Locality numbers are U.S. Geological Survey Mesozoic locality numbers listed in column 2.

No. on figures 1 and 7	Locality	Collector, date	Description
1	-------	F. M McLearn, 1933	Upper part of Fort St. John shale on north side of Peace River between mouth of Cache Creek and a little below Fort St. John, British Columbia.
2	17300	R. Thorsteinson, 1949.	Pearl Creek, about 1,900 ft from its junction with Sulphur River; about 217 ft above the base of the formation, Grande Cache map area, Alberta. Fort St. John group.
3	24693	E. J. H. Irish, 1954	Ridge between heads of Ziggy Creek and of Muskeg River, west half of Adams Lookout map area, Alberta. Fort St. John shale.
4	23411	W. A. Cobban, 1936	Muddy Creek, 3 miles south of Power, NW¼ sec. 13, T. 22 N., R. 1 W., Teton County, Mont. Horizon in sandy beds containing fish-scale beds above 3-ft bed of bentonite and less than 60 ft below top of Blackleaf sandy member of Colorado shale.
5	26066	W. A. Cobban, 1955	Beside county road 15½ miles west of Great Falls, NW¼NE¼ sec. 18, T. 20 N., R. 1 E., Cascade County, Mont. Siliceous member of Colorado shale equivalent to Mowry shale.
6	26065	R. W. Lemke, 1955	Five and a half miles north of Great Falls, SE¼ sec. 3, T. 21 N., R. 3 E., Cascade County, Mont. Bentonite bed 30 ft below top of Mowry equivalent in Colorado shale.
7	24705	W. A. Cobban, 1953	South side of Belt Butte, 1½ miles east of Belt, NW¼SE¼ sec. 30, T. 19 N., R. 7 E., Cascade County, Mont. Shaly sandstone bed 39 ft above top of Arrow Creek member of Colorado shale.
8	23410	W. A. Cobban, 1936	Belt Butte, 2 miles east of Belt, SE¼ sec. 30, T. 19 N., R. 7 E., Cascade County, Mont. Horizon at base of 40-ft sandy fish-scale shale overlying 33-ft porcelanite bed (Arrow Creek member) in Colorado shale.
9	3954	C. A. Fisher, 1906	Near high butte along county road 2¼ miles northwest of Geyser, Judith Basin County, Mont. "Colorado shale, 50 to 100 ft below volcanic ash bed [Arrow Creek member]."
10	23412	W. A. Cobban, 1948	Arrow Creek, 6 miles northeast of Geyser, Judith Basin County, Mont. Sandy lenses 25 ft below conspicuous white ash bed (Arrow Creek member) of Colorado shale.
11	24602	W. A. Cobban, 1953	Two miles north of Geyser, NW¼NW¼ sec. 29, T. 18 N., R. 10 E., Judith Basin County, Mont. Colorado shale, 6-in. bed of sandstone 14 ft below 30-ft bed of bentonite and porcelanite (Arrow Creek member) below Mowry shale member of Colorado shale.
12	24603	-----do----------	Same locality as 24602. Horizon in 1-ft silt-claystone ledge immediately beneath 30-ft bed of bentonite and porcelanite (Arrow Creek member) below Mowry shale member of Colorado shale.
13	24613	-----do----------	Two miles north of Geyser, NW¼NW¼ sec. 29, T. 18 N., R. 10 E., Judith Basin County, Mont. Sandy shale possibly 100 ft below base of 30-ft bed of bentonite and porcelanite (Arrow Creek member) in Colorado shale.
14	24920	O. O. Mueller, 1953	Two miles north-northeast of Spring Creek Colony, S½NW¼ sec. 5, T. 16 N., R. 17 E., Fergus County, Mont. Float specimen, probably from 9-in. porcelanite bed 15 ft above 23-ft bentonite unit (Arrow Creek member) in Colorado shale; about 200 ft below top of Mowry shale member.
15	24918	W. A. Cobban, 1953	West face of hogback 2 miles southwest of Brooks, center SE¼ sec. 32, T. 17 N., R. 18 E., Fergus County, Mont. Three-foot claystone ledge at base of Mowry shale member of Colorado shale.
16	24917	W. A. Cobban, 1953	One and a half miles south of Fort Maginnis school, SW¼SW¼ sec. 7, T. 16 N., R. 21 E., Fergus County, Mont. Silty calcareous concretions that weather brown 58 ft above base of Mowry shale member of Colorado shale.
17	24601	-----do----------	Same locality as 24600. Horizon in hard siltstone 75 ft above base of Mowry shale member of Colorado shale.
18	26224	O. O. Mueller, 1956	Due north of Ayers Colony, sec. 15 or 16, T. 15 N., R. 22 E., Fergus County, Mont. Colorado shale, 75 ft above base of Mowry shale member.
19	24600	W. A. Cobban, 1953	North side of Alkali Creek valley, 8 miles west-northwest of Grassrange, NE¼ sec. 17, T. 15 N., R. 22 E., Fergus County, Mont. Horizon in 3-ft hard claystone ledge 5 ft above base of Mowry shale member of Colorado shale.
20	24065	O. O. Mueller, 1952	About 2½ miles southeast of Teigen, center sec. 4, T. 14 N., R. 25 E., Petroleum County, Mont. Large concretion just below middle of Mowry shale member of Colorado shale.
21	24417	-----do----------	Between ½ and ¾ mile east of loc. 24065, in W½ sec. 3, T. 14 N., R. 25 E., Petroleum County, Mont. Concretion just below middle of Mowry shale member of Colorado shale.
22	24418	-----do----------	About 250 yards east of loc. 24417, near center sec. 3, T. 14 N., R. 25 E., Petroleum County, Mont. Concretion just below middle of Mowry shale member of Colorado shale.
23	24419	-----do----------	About 200 yards east of loc. 24418, near center sec. 3, T. 14 N., R. 25 E., Petroleum County, Mont. Concretion just below middle of Mowry shale member of Colorado shale.
24	24609	W. A. Cobban, 1953	Timber Coulee, 2 miles southwest of Winnecook Ranch, NW¼SE¼ sec. 14, T. 7 N., R. 16 E., Wheatland County, Mont. Horizon in hard 2-ft sandstone 207 ft above 30-ft glauconitic sandstone bed in Colorado shale and 60 ft beneath Big Elk sandstone member of Colorado shale.
25	24610	-----do----------	Same locality as 24609. Horizon in 2-in. siltstone layer 8 ft above conspicuous sandstone rimrock; 217 ft above 30-ft glauconitic sandstone bed and 50 ft beneath Big Elk sandstone member of Colorado shale.
26	24611	-----do----------	Timber Coulee, NE¼SE¼NW¼ sec. 14, T. 7 N., R. 16 E., Wheatland County, Mont. Concretionary bed 19 ft above conspicuous sandstone rimrock; 227 ft above 30-ft glauconitic sandstone bed and 40 ft below Big Elk sandstone member of Colorado shale.
27	24612	-----do----------	Same locality as 24611. Horizon in sandstone 227 to 237 ft above 30-ft glauconitic sandstone bed and 40 to 30 ft beneath Big Elk sandstone member of Colorado shale.

Localities at which fossils were collected—Continued

No. on figures 1 and 7	Locality	Collector, date	Description
28	23042	W. A. Cobban and others, 1950.	East side Timber Coulee on Winnecook Ranch, 8½ miles southeast of Harlowton; on north flank of middle dome of Shawmut anticline; center SW¼ sec. 14, T. 7 N., R. 16 E., Wheatland County, Mont. Horizon 115 ft below base of Big Elk sandstone member of Colorado shale and 150 ft above top of 30-ft glauconitic sandstone in lower part of Colorado shale.
29	23043	-----do----------	About center S½ sec. 14, T. 7 N., R. 16 E., Wheatland County, Mont. Horizon same as loc. 23042.
30	24608	O. O. Mueller, 1953--	Near head of east tributary to Timber Coulee, 2.5 miles southwest of Winnecook Ranch, center N½NE¼ sec. 23, T. 7 N., R. 16 E., Wheatland County, Mont. Concretion 153 ft above 30-ft bed of glauconitic sandstone in Colorado shale; same level as that of loc. 23042.
31	24604	W. A. Cobban, 1953-	Timber Coulee on Winnecook Ranch, 8½ miles southeast of Harlowton, on north flank of middle dome of Shawmut anticline, SE¼SW¼ sec. 14, T. 7 N., R. 16 E., Wheatland County, Mont. Horizon at top of 30-ft bed of glauconitic sandstone and 270 ft below base of Big Elk sandstone member of Colorado shale.
32	24605	-----do----------	Same locality as 24604. Horizon in hard siltstone layers in 21-ft bed of shale that overlies 30-ft bed of glauconitic sandstone.
33	24606	W. A. Cobban, 1953-	Timber Coulee, near loc. 24604, NE¼SW¼SW¼ sec. 14, T. 7 N., R. 16 E. Horizon in hard 6-in. siltstone layer that underlies 8-ft bentonitic bed and is 21.5 ft above 30-ft bed of glauconitic sandstone.
34	24607	-----do----------	Same locality as 24606. Horizon in 1 in. pebbly bed that overlies 8-ft bentonitic bed and is 29.5 ft above 30-ft glauconitic sandstone bed.
35	4612	M. I. Goldman, 1907-	SE¼ sec. 13, T. 7 N., R. 16 E., Wheatland County, Mont. "Dakota(?) sandstone."
36	4645	R. W. Stone, 1907---	NE¼ sec. 1, T. 6 N., R. 16 E., Wheatland County, Mont. "About 200 ft below base of Colorado shale, at base of Dakota sandstone."
37	4610	M. I. Goldman, 1907-	SE¼ sec. 34, T. 7 N., R. 17 E., Wheatland County, Mont. "Dakota(?) sandstone."
38	23413	M. R. Klepper, 1949-	Indian Creek road, 1½ miles east of Hassel, sec. 5, T. 6 N., R. 1 E., Broadwater County, Mont. Tuffaceous greenish-gray sandstone interbedded in black shale in lower part of Colorado shale.
39	23498	M. R. Klepper, 1951-	North of Indian Creek road, sec. 6, T. 6 N., R. 1 E., Broadwater County, Mont. Basal sandstone of Mowry(?) shale.
40	23029	M. R. Klepper and others, 1950.	About 5 miles southwest of Radersburg, on south line of sec. 4, T. 4 N., R. 1 W., Broadwater County, Mont. In sandy beds of Colorado shale, about 420 ft above base.
41	25716	R. W. Swanson, 1955-	Madison Range area, NE¼SE¼ sec. 2, T. 7 S., R. 3 E., Gallatin County, Mont. One-foot sandstone bed in Mowry shale.
42	25717	-----do----------	Madison Range area, SE¼NE¼ sec. 32, T. 6 S., R. 3 E., Madison County, Mont. Upper part of Mowry shale.
43	25718	-----do----------	Madison Range area, NE¼NE¼ sec. 9, T. 7 S., R. 4 E., Gallatin County, Mont. Middle of Mowry shale.
44	23023	W. A. Cobban and others, 1950.	One mile west of West Boulder ranger station, NE¼ sec. 26, T. 3 S., R. 11 E., Park County, Mont. Horizon in sandy shale forming lower part of unit of Mowry age in Colorado shale.
45	24566	W. A. Cobban and others, 1953.	Castle Creek, 0.6 mile above mouth and 40 ft above creek; 0.7 mile south of Limestone schoolhouse; near Clay Donohoe Ranch, N½SW¼NW¼ sec. 29, T. 4 S., R. 15 E., Stillwater County, Mont. Concretion in dark shales just beneath Mowry shale. Lot by Cobban and others is a secondary collection. First collection from this locality was made available by Otto H. Haas, Am. Mus. Nat. History, and Keith Young, Texas Univ.
46	24921	W. A. Cobban, 1953-	Castle Creek, near Limestone schoolhouse; near loc. 24566, but about 35 ft higher in the section.
47	9653	C. J. Hares, 1916----	Southeast of Bridger, T. 7 S., R. 24 E., Carbon County, Mont. Mowry shale, near middle.
48	24502	Collector unknown; received from J. P. Conlin, 1953.	Ten miles northeast of Fromberg, Carbon County, Mont. Mowry shale.
49	10443	Collector unknown, received through F. H. Moffit, 1920.	"Locality 15 miles southwest of Billings, just beneath Eagle [Frontier] sandstone," probably in T. 2 S., R. 25 E., Yellowstone County, Mont. Mowry shale.
50	20932	W. A. Cobban, 1947-	Soap Creek dome, NW¼NW¼ sec. 35, T. 6 S., R. 32 E., Big Horn County, Mont. Ferruginous concretions 29 to 32 ft below top of Thermopolis shale.
51	20933	-----do----------	Soap Creek dome, NW¼NW¼ sec. 35, T. 6 S., R. 32 E., Big Horn County, Mont. Lower part of bentonite bed 142 ft below top of Mowry shale.
52	23245	-----do----------	Soap Creek dome, NW¼NW¼ sec. 35, T. 6 S., R. 32 E., Big Horn County, Mont. Ferruginous concretions in upper 16 ft of Thermopolis shale.
53	17934	R. P. Bryson, 1938--	Divide between Line and Bennett Creeks, about 2 miles north of Tolman Ranch, 6 miles airline northwest of Clark post office, NE¼SE¼ sec. 34, T. 58 N., R. 103 W., Park County, Wyo. Mowry shale. See also loc. 24555.
53	24555	J. B. Reeside, Jr., and others, 1953.	See loc. 17934.
54	20370	R. W. Brown, 1936---	Near Lovell, Big Horn County, Wyo. Mowry shale.
55	26413	D. L. Eicher and K. M. Waagé, 1956.	Near Cloverly, about sec. 13, T. 54 N., R. 92 W., Big Horn County, Wyo. Upper part of Thermopolis shale. Original material in Peabody Mus. (YPM 6552–1). Plaster replicas in U.S. Natl. Mus.
56	26414	-----do----------	Near Greybull, Big Horn County, Wyo. Upper part of Thermopolis shale. Original material in Peabody Mus. (YPM 6552–2). Plaster replicas in U.S. Natl. Mus.

Localities at which fossils were collected—Continued

No. on figures 1 and 7	Locality	Collector, date	Description
57	10415	A. J. Collier, 1920	Railroad cut, sec. 3, T. 48 N., R. 66 W., Crook County, Wyo. Mowry shale.
58	23465	W. A. Cobban, 1951	Bank of Belle Fourche River about 12 miles southeast of Alzada, Mont., NE¼ sec. 28, T 57 N., R. 62 W., Crook County, Wyo. Mowry shale, about 60 ft below top.
59	12739	W. W. Rubey, 1924	Head of Poison Creek, NW part T. 54 N., R. 66 W., Crook County, Wyo. Mowry shale.
60	24565	A. Calderón García and D. W. Taylor, 1953.	Three-fourths mile east of Clarks Fork road near State Fish Hatchery, 6.7 miles by road north of Cody, NE¼ sec. 3, T. 53 N., R. 102 W., Park County, Wyo. Horizon 236 ft below top, 194 ft above base of Mowry shale.
61	24554	J. B. Reeside, Jr., and others, 1953.	Near main irrigation canal, 2 miles northwest of Cody, NE¼ sec. 26, T. 53 N., R. 102 W., Park County, Wyo. Horizon 203 ft above base of Mowry shale.
62	24569	D. W. Taylor, 1953	Same general locality as 24567, but on west limb of minor anticline. Horizon at base of Mowry shale.
63	24567	J. B. Reeside, Jr., and others, 1953.	East limb of minor anticline on east flank of Horse Creek-Cedar Mountain anticline, near Wyoming State Route 120, 2 miles south of Cody airport, SW¼ sec. 17, T. 52 N., R. 101 W., Park County, Wyo. Horizon 235 ft beneath top of Mowry shale.
64	24568	D. W. Taylor, 1953	Horizon and general locality same as 24567, but on west limb of minor anticline.
65	23021	W. A. Cobban and others, 1950.	Hillside 50 ft south of side road along southwest flank of Rattlesnake-Cedar Mountain anticline, 6 miles west-southwest of Cody, SE¼ sec. 13, T. 52 N., R. 103, W., Park County, Wyo. Concretions in basal part of Mowry shale.
66	23020	do	Shore of Buffalo Bill (Shoshone) Reservoir, 6 miles airline west-southwest of Cody, at end of side road along southwest flank of Rattlesnake-Cedar Mountain anticline, NE¼SW¼ sec. 13, T. 52 N., R. 103 W., Park County Wyo. About middle of Mowry shale.
67	24560	A. Calderón García, 1953.	Same locality as 23021. Horizon in sandy porcelanite 348 ft above base of Mowry shale.
68	24561	J. B. Reeside, Jr., and others, 1953.	One-fourth mile southeast of loc. 23021, SW¼ sec. 18, T. 52 N., R. 102 W., Park County, Wyo. Horizon 185 ft above base of Mowry shale.
69	24562	A. Calderon García, 1953.	Same locality as 23021. Horizon 329 ft above base of Mowry shale.
70	24563	do	Three-fourths mile southeast of loc. 23021, NE¼ sec. 19, T. 52 N., R. 102 W., Park County, Wyo. Horizon 329 ft above base of Mowry shale.
71	24564	J. B. Reeside, Jr., and others, 1953.	Same locality as 24563. Horizon 205 ft above base of Mowry shale.
72	17173	D. A. Andrews, 1935	Between Marquette and Carter Creeks, about 13 miles airline southwest of Cody, SE¼ sec. 22, T. 51 N., R. 103 W., Park County, Wyo. Thermopolis shale. See also locs. 18137 and 24558.
72	18137	D. A. Andrews, 1939	See loc. 17173.
72	24558	A. Calderón García, 1953.	Same locality and probably same horizon as 17173.
73	24559	J. B. Reeside, Jr., 1953.	Same locality as 17173. Horizon in Thermopolis shale 75 ft below top.
74	25360	A. B. Shaw, 1954	Core 3 (3893–3906 feet) from Richfield No. 1 State, Dry Creek, SW¼SW¼ sec. 16, T. 50 N., R. 100 W., Park County, Wyo. Mowry shale, 413 ft below top, 108 ft above base. Plaster cast.
75	6713	O. B. Hopkins, 1910	Camp at Chimney Sisters Hill, about sec. 11, T. 49 N., R. 83 W., Johnson County, Wyo. Mowry shale.
76	4941	T. E. Williard, 1907	About 2¾ miles west of Klondike, about sec. 23, T. 49 N., R. 83 W., Johnson County, Wyo. Mowry shale.
77	23581	R. K. Hose, 1951	Bull Creek area, south of Buffalo, in SW¼ sec. 25, T. 46 N., R. 83 W., Johnson County, Wyo. Mowry shale, about 60 ft below top.
78	8535	D. F. Hewett, 1913	Hamilton dome, NE¼SW¼NE¼ sec. 14, T. 44 N., R. 98 W., Hot Springs County, Wyo. Mowry shale, near middle.
79	6680	Eliot Blackwelder, 1910.	Slope just north of Gros Ventre River, east of mouth of Slate Creek, about sec. 15, T. 42 N., R. 113 W., Teton County, Wyo. "Lowest part of Colorado group."
80	23427	W. A. Cobban, 1951	Horse Creek, near Dubois, about sec. 7, T. 41 N., R. 106 W., Fremont County, Wyo. Mowry shale.
81	6735	William Mulholland, 1910.	Near flowing well in south prong of Salt Canyon, SE¼NW¼ sec. 5, T. 40 N., R. 81 W., Natrona County, Wyo. "Middle portion of Mowry shale member of Benton shale."
82	6764	O. B. Hopkins, 1910	Mowry ridge south of Salt Canyon, about sec. 5, T. 40 N., R. 81 W., Natrona County, Wyo. Near middle of Mowry shale.
83	6762	C. J. Hares, 1910	South branch of Salt Canyon, SE¼ sec. 32, T. 41 N., R. 81 W., Natrona County, Wyo. Middle part of Mowry shale.
84	20670	G. M. Richmond, 1944.	North fork of Gypsum Creek, about 1 mile southeast of Little Sheep Mountain, Green River Lakes area, Sublette County, Wyo. Mowry shale.
85	9006	C. J. Hares, 1914	Beaver Hill, sec. 4, T. 30 N., R. 96 W., Fremont County, Wyo. Mowry shale.
86	8979	K. C. Heald, 1914	Thirty miles east of Lander, about sec. 33, T. 33 N., R. 94 W., Fremont County, Wyo. Mowry shale.
87	23217	J. D. Love, 1950	Two miles east of Ervay, SE¼ sec. 33, T. 34 N., R. 88 W., Natrona County, Wyo. Concretion in Mowry shale 225 ft above Muddy sandstone member of Thermopolis shale.
88	24500	Raymond Sidwell, 1930.	Bessemer Bend of North Platte River, about 14 miles southwest of Casper, Natrona County, Wyo. Mowry shale. Plaster casts.
89	24570	J. B. Reeside, Jr., and others, 1953.	Side road to Mohawk Ranch from Wyoming State Route 220, about 10 miles southwest of Casper, NW¼ sec. 6, T. 32 N., R. 80 W., Natrona County, Wyo. Horizon 46 ft above base of Mowry shale.

Localities at which fossils were collected—Continued

No. on figures 1 and 7	Locality	Collector, date	Description
90	17874	W. W. Rubey, 1938	Poison Meadows, Greys River, 1 mile below bench mark 8465 in Afton topographic quadrangle, about sec. 32, T. 30 N., R. 116 W. (unsurveyed), Lincoln County, Wyo. Calcareous sandstone in lower part of Aspen shale.
91	3847	A. R. Schultz, 1906	Trail up south fork of Middle Piney Creek, NW¼SW¼SW¼ sec. 11, T. 30 N., R. 115 W., Lincoln County, Wyo. Transition beds between Aspen and Frontier formations. See also locs. 16056 and 17304.
91	16056	W. W. Rubey, 1931	See loc. 3847.
91	17304	W. W. Rubey, 1936	See loc. 3847.
92	21699	W. W. Rubey, 1949	Beside road near head of Greys River, NW¼SW¼ sec. 29, T. 30 N., R. 116 W., Lincoln County, Wyo. Sandstone in Aspen shale 500 to 550 ft above base.
93	20779	W. W. Rubey, 1945	Antelope Creek coal prospect (abandoned), west-center SW¼ sec. 4, T. 22 N., R. 119 W., Lincoln County, Wyo. Middle of strata equivalent to those on Leeds Creek. See also locs. 21678 and 22044.
93	21678	W. W. Rubey, 1949	See loc. 20779.
93	22044	W. W. Rubey, 1947	See loc. 20779.
94	21679	W. W. Rubey, 1949	Near Antelope Creek coal prospect (abandoned), west-center SW¼ sec. 4, T. 22 N., R. 119 W., Lincoln County, Wyo. Loose on surface just below porcelanite above coal bed of the strata equivalent to those on Leeds Creek.
95	21680	W. W. Rubey, 1949	Near Antelope Creek coal prospect (abandoned), SW¼ sec. 4, T. 22 N., R. 119 W., Lincoln County, Wyo. *Inoceramus* bed 35 ft below Antelope Creek coal bed of the strata equivalent to those on Leeds Creek.
96	21702	do	Spillway of reservoir on Y creek, 1¾ miles north of Leeds Creek, SE¼ sec. 21, T. 23 N., R. 119 W., Lincoln County, Wyo. Three feet stratigraphically above 2½-ft coal bed of the strata equivalent to those on Leeds Creek.
97	21703	do	Loose on surface. Same locality as 21702; presumably from same horizon.
98	21704	do	Same locality as 21702. Horizon between 2½-ft coal bed and 5-ft coal bed of the strata equivalent to those on Leeds Creek.
99	22047	W. W. Rubey, 1947	Same locality as 21714. Horizon at top of tan sandstone 300 ft east of Sage coal mine.
100	21714	W. W. Rubey, 1949	Powder house at Sage coal mine (abandoned), Sage Junction, center E½ sec. 7, T. 21 N., R. 119 W., Lincoln County, Wyo. Sandstone about 45 ft below main coal of the strata equivalent to those on Leeds Creek. See also loc. 22048.
100	22048	W. W. Rubey, 1947	See loc. 21714.
101	21715	W. W. Rubey, 1949	Same locality as 21714. Horizon 15 ft west of easternmost coal and 138 ft stratigraphically below main coal of the strata equivalent to those on Leeds Creek. See also loc. 22028.
101	22028	W. W. Rubey, 1947	See loc. 21715.
102	21717	W. W. Rubey, 1949	Same locality as 21714. Horizon 5 ft above easternmost coal. See also loc. 22049.
102	22049	W. W. Rubey, 1947	See loc. 21717.
103	22942	J. B. Reeside, Jr., 1950.	Bell Springs, 12 miles north of Rawlins, NE¼SW¼ sec. 3, T. 23 N., R. 88 W., Carbon County, Wyo. Thermopolis shale, just below base of Muddy sandstone member.
104	26609	J. B. Marcou, 1885	Union Pacific RR., 6 miles east of Como station, Carbon County, Wyo. Mowry shale.
105	14718	A. A. Weymouth, 1929.	Three miles southeast of Kemmerer on U. S. Highway 30N, NW¼NW¼ sec. 32, T. 21 N., R. 115 W., Lincoln County, Wyo. Aspen shale, 70 to 100 ft beneath top. See also locs. 22989 and 24539.
105	22989	W. W. Rubey, 1950	See loc. 14718.
105	24539	J. B. Reeside, Jr., and others, 1953.	See loc. 14718.
106	24540	do	Same locality as 14718. Horizon 330 ft beneath top of Aspen shale.
107	24542	do	Same locality as 14718. Horizon 540 ft beneath top of Aspen shale.
108	24543	do	Same locality as 14718. Horizon 630 ft beneath top of Aspen shale.
109	24552	J. B. Reeside, Jr., 1953.	Just south of Hams Fork, 4 miles south-southeast of Kemmerer, N½ sec. 10, T. 20 N., R. 116 W., Lincoln County, Wyo. Horizon at very top of Aspen shale.
110	3386	A. C. Veatch, 1905	East flank of anticline on Little Muddy Creek, 3 miles southeast of Cumberland (abandoned), E¼ sec. 4, T. 18 N., R. 116 W., Uinta County, Wyo. "Base of Bear River formation." (Actually near base of Aspen shale). See also loc. 21727.
110	21727	W. W. Rubey, 1949	See loc. 3386.
111	22980	H. R. Christner, 1950.	Just east of Cumberland Gap and 15 miles south of Kemmerer, NE¼ sec. 32, T. 19 N., R. 116 W., Lincoln County, Wyo. Horizon 40 ft below top of Aspen shale as defined by Veatch. See also loc. 24545.
111	24545	J. B. Reeside, Jr., and others, 1953.	See loc. 22980.
112	24544	A. Calderón García, 1953.	Same locality as 22980. Horizon at top of Aspen shale.
113	24547	J. B. Reeside, Jr., 1953.	Same locality as 22980. Horizon at base of Aspen shale.
114	24548	do	Same locality as 22980. Horizon 200 ft below top of Aspen shale.
115	24549	J. B. Reeside, Jr., and others, 1953.	South of Little Muddy Creek on Carter road, east of Cumberland Gap and 15 miles south of Kemmerer, center sec. 8, T. 18 N., R. 116 W., Uinta County, Wyo. Horizon near top of Aspen shale.
116	14719	A. A. Weymouth, 1929.	About 30 miles southwest of Kemmerer, on side road from U. S. Highway 189 through Spring Gap to Bridger Station on Union Pacific RR., NW¼ sec. 17, T. 16 N., R. 117 W., Uinta County, Wyo. Aspen shale, 500 ft below top.
116	24550	Eduardo Rodríguez Santana, 1953.	See loc. 14719.

Localities at which fossils were collected—Continued

No. on figures 1 and 7	Locality	Collector, date	Description
117	793	T. W. Stanton, 1891	West side of Bear River, 2 miles above mouth of Sulphur Creek, Uinta County, Wyo. "Beds overlying Bear River Laramie."
118	17834	J. B. Reeside, Jr., 1938.	Old Aspen Station on abandoned right-of-way of Union Pacific RR., sec. 30, T. 14 N., R. 118 W., Uinta County, Wyo. Type locality of Aspen shale.
119	26342	N. P. Cuppels, 1955	Two miles north-northwest of Hermosa, S½NE¼NW¼ sec. 19, T. 2 S., R. 8 E., Pennington County, S. Dak. Lower part of Mowry shale.
120	988	T. W. Stanton, 1892	Between Peoa and Rockport, Summit County, Utah. "Soft, drab beds with indurated bands that contain fish scales and a fragment of an ammonite, much like those above the Bear River formation at Bear River City."
121	25586	Mrs. B. R. Untermann, 1949.	Steinaker Draw, 6 miles north of Vernal, Uintah County, Utah. Mowry shale, 18-in. limestone, middle of formation.
122	26223	W. R. Hansen, 1956	About 15 miles east of Manila, center SW¼ sec. 29, T. 3 N., R. 22 E., Daggett County, Utah. Mowry shale, 3 to 9 ft above base where shale is about 190 ft thick.
123	11665	J. D. Sears, 1923	Vermilion Creek, SW¼SE¼ sec. 11, T. 10 N., R. 101 W., Moffat County, Colo. Mowry shale, 75 ft above base.
124	7100	A. L. Beekly, 1911	Northeast of Hill Ranch, NW¼SE¼ sec. 8, T. 11 N., R. 81 W., Jackson County, Colo. "Mowry shale member of Benton shale."
125	24717	Robert Osborne, 1950.	North of Walden, T. 10 N., R. 79 W., North Park, Jackson County, Colo. Near contact of upper part of Dakota sandstone and Mowry shale. Plaster cast.

PROBLEMS OF CLASSIFICATION OF THE GASTROPLITINE AMMONITES

As noted on previous pages, the most conspicuous part of the fauna discussed in this paper is that composed of the gastroplitine ammonites. They are represented at 82 of the 125 localities recorded as of June 1957. At 17 of these the available material lends itself only to generic determination, but at 65 others the forms present may be more definitely named. Some of the localities have yielded only one to several specimens, but others have yielded tens, hundreds, or even thousands (see the tables of distribution on following pages). The total number of specimens examined approaches ten thousand.

As also noted on a previous page, these gastroplitine ammonites may be placed in five species, each of which appears to represent a brief time interval. Where two or more of these species have been observed in a continuous sequence of rocks, the intervals between them have yielded no fossils. Whether some of the lots that have been found isolated would actually fall into the intervals that are barren in these occurrences of multiple horizons cannot now be determined, but it has seemed simpler to consider the isolated lots as belonging to the particular taxonomic groups and stratigraphic horizons with which their morphologic characters associate them.

For each of the species there is available at least one large lot that came out of a single concretion or out of a single bed and constitutes presumably a natural association. It is as near as it is possible to get to such a thing, and each such lot is taken by the writers as a representative sample. Special consideration is given in later pages to each of these lots, though data are provided for all of the collections assigned to each species.

The range of form, relative composition, and other features presented by each of these species raise questions that will be discussed in the following section.

Each of the five species of gastroplitine ammonites noted above includes a range of morphologic types from compressed costate forms through stout nodose forms to subglobose spinose forms. It is possible to select a series of individuals that suggests complete gradation from the compressed costate shells to the subglobose spinose shells and three such series are shown in plates 5 to 7.

Though each of the several species contains the stated range of morphologic features, they differ in the proportions of the constituents present. Taking the three named morphologic varieties as a convenient classification, in the oldest level the subglobose spinose portion is the greatest; in the next to the oldest level the stout nodose portion is predominant; in the third and fourth levels the compressed costate portion is predominant; and in the fifth or top level the compressed costate portion is somewhat reduced and constitutes about half the specimens in the total sample examined, whereas the subglobose spinose portion again is prominent.

Taking all the collections available, the quantities involved are shown in table 4.

TABLE 4.—*Number and percentage of variants of species of* Neogastroplites *in total collections*

Form	Number of specimens and percentages of groups from number of localities shown.									
	haasi (3)		*cornutus* (23)		*muelleri* (9)		*americanus* (25)		*maclearni* (5)	
	Specimens	Percentage	Specimens	Percentage	Specimens	Percentage	Specimens	Percentage	Specimens	Percentage
Compressed costate	108	30	1,017	35.4	2,855	75	2,294	84	107	49
Stout nodose	88	26	1,845	64.3	346	9	280	10	26	12
Subglobose spinose	148	44	8	0.3	617	16	159	6	85	39
Totals	344	100	2,870	100	3,818	100	2,730	100	218	100

The compressed costate shells in these five species resemble very much some of the species of the older genus *Gastroplites*, whereas the stout nodose shells resemble those of the younger genus *Neogastroplites*. Neither the compressed costate shells nor the subglobose-spinose shells have been previously recognized or recorded adequately, so far as the writers know. Reeside and Weymouth (1931), working with flattened molds, had costate and nodose forms from the Aspen shale, but failed to recognize them and assigned them in error to other genera.

When the present writers began the study of these fossils, they did not know the time relations of the species. The abundance of the costate shells at the *americanus* localities and the abundance of the nodose shells at the *cornutus* localities led to the supposition that the *americanus* localities contained *Gastroplites* and were the older and the *cornutus* localities contained *Neogastroplites* and were the younger (Cobban and Reeside, 1951, 1952a). The presence at the *americanus* localities of a relatively small proportion of nodose and spinose shells recalling *Neogastroplites* was puzzling and led to the further supposition that the *americanus* localities were probably somewhat younger than the Canadian horizons with *Gastroplites* and had perhaps the initial forms of *Neogastroplites*, but were not as young as the Canadian horizons with *Neogastroplites* alone. Further field work, however, eventually established the order of the groups and showed that the *americanus* localities are younger than the *cornutus* localities.

Undoubtedly the writers, influenced by the more or less traditional interpretation of systematic relations among the ammonites, would at one time have put the specimens with the seemingly large range of morphologic character shown in each of the assemblages into several genera, and would have proposed numerous species in each, in spite of the seemingly obvious continuity of variation in each group. However, the stout nodose shells in all five of the groups recognized seem to the writers to fit adequately the genus *Neogastroplites* as originally defined (McLearn, 1931, p. 7; 1933, p. 21). Some of the specimens are, in fact, indistinguishable from the genotype, *N. cornutus* (Whiteaves). The compressed costate shells and the subglobose spinose shells were not actually included in the original generic concept, and it is necessary to provide for them. The facts that in each group both of these sorts are directly associated with the stout nodose form in single concretions and are connected by nearly complete gradation with it seem to the writers to preclude the drawing of any satisfactory taxonomic boundaries and to compel the inclusion of all of them in *Neogastroplites* and they are so treated in this paper. The necessary restatement of the generic concept is attempted on a later page.

A second problem concerns the taxonomic grade to be assigned to the five groups. Because of the similarities between some of the median forms in each group, it would be possible to make a case for viewing all of these *Neogastroplites* as constituting a single species made up of five variable chronologic subspecies. Yet, because it is not possible to demonstrate that the groups are actually connected in time by intermediate forms and because there are consistent minor differences of various sorts between them, it seems to the writers more practical to consider each group a species and to designate it by a distinctive name. Five such names have been referred to on earlier pages and will be formally defined on later pages: *haasi*, *cornutus*, *muelleri*, *americanus*, and *maclearni*.

A third problem relates to the taxonomic grade to be assigned to subordinate units within the groups. Theoretically, if the groups are viewed as species, subordinate units could be viewed as subspecies. Examination for each group of the series of forms associated in a single concretion, presumably a natural association, shows, however, that all of the variants known for each group occur together. As the material in each comes from one point, it is difficult to see how it could contain either geographic subspecies, ecologic subspecies, or chronologic subspecies. The variants are therefore viewed in this paper as infrasubspecific units of a polytypic species.

It could be argued that the material of each lot is an assemblage of dead shells brought together by natural means from differing geographic or ecologic niches and that the differing morphologic varieties are therefore of higher rank than infrasubspecific. The type of preservation within each lot is, however, identical and this similarity is against a purely mechanical association of the shells. To this may be added the

lack of sorting by size, shape, and ornamentation that transportation might be expected to bring about and the lack of wear.

The presence of small inflated individuals and large compressed individuals at one locality or in one level might suggest a sex differentiation. No sharp division into two sorts, however, exists in the collections; on the contrary, there is complete gradation in form from the compressed to the subglobose forms. Such a lack of segregation would seem to the writers to rule out the possibility of a sex differentiation recognizable by form alone.

That the range of variation in these Cretaceous ammonites is not a wholly unusual problem can be noted in many articles in the literature on ammonites, though it is not always as clean-cut as in the present case. A relatively recent article is that by Silberling (1956), who states that the Upper Triassic *Protrachyceras shastense* Smith, 1904, includes "an intergrading morphologic series from compressed forms with delicate strigate ornament to relatively robust forms with coarse ornamentation on the mature shells." The series contains forms previously assigned to *Trachyceras* (*Protrachyceras*) *lecontei* Hyatt and Smith, *T.* (*P.*) *shastense* Smith, *T.* (*P.*) *madisonense* Smith, *T.* (*P.*) *lindgreni* Smith, *T.* (*P.*) *beckeri* Smith, and *T.* (*P.*) *californicum* Smith.

Each series of forms, ranging from compressed costate to subglobose spinose, though it constitutes, for all practical purposes, a continuous sequence, nevertheless does not show an even distribution quantitatively throughout the sequence. It is a matter of personal judgment, of course, how the morphological variants in a series are to be grouped, and it is likely that no two persons would arrive at exactly the same apportionment of the material from a single lot or even that the same individual would at different times agree exactly with himself as to such an opportionment. Nevertheless, the writers believe that the differences would be minor and that it is useful to make and record such judgments as an indication of the general composition of the individual lots. In describing these subordinate units on later pages, for convenience the term variety (var.) is used, with letters to designate the portions segregated. An association from a single concretion for each of four groups, as classified by the writers, is given in table 5, together with the association from a single locality in Alberta, which is said to have come from a single bed.

TABLE 5.—*Variants in a single lot of each of the several species of* Neogastroplites

	Compressed costate			Stout nodose		Subglobose spinose			
N. maclearni									
(GSC locality 17300. 177 specimens)									
Variant	A		B	C		D		E	
Number of specimens, variant group	49		24	21		61		22	
Total, character group	73			21		83			
Percent, total character group per species total	41			12		47			
N. americanus									
(USGS Mes. locality 23042. 1,286 specimens)									
Variant	A	A–B	B	B–C	C	C–D	D	D–E	E
Number of specimens, variant group	930	6	189	13	59	7	41	7	34
Total, character group	1,125			72		89			
Percent, total character group per species total	87			6		7			
N. muelleri									
(USGS Mes. locality 24065. 3,708 specimens)									
Variant	A	A–B	B	B–C	C	C–D	D	D–E	E	E–F	F	F–G	G
Number of specimens, variant group	176	20	1,894	43	676	19	153	16	111	13	264	84	239
Total, character group	2,809					299				600			
Percent, total character group per species total	76					8				16			

TABLE 5.—*Variants in a single lot of each of the several species of* Neogastroplites—Continued

	Compressed costate				Stout nodose						Subglobose spinose
N. cornutus **(USGS Mes. locality 23021. 2,471 specimens)**											
Variant	A	B	B–C	C	C–D	D	D–E	E	E–F	F	G
Number of specimens, variant group	47	277	51	532	89	712	100	486	107	65	5
Total, character group	907				1,559						5
Percent, total character group per species total	36.7				63						0.3
N. haasi **(USGS Mes. locality 24566. 333 specimens)**											
Variant	A		B		B–C		C		C–D	D	D–E	E	F
Number of specimens, variant group	21		80		7		78		20	56	4	51	16
Total, character group	101				85				147				
Percent, total character group per species total	30				26				44				

The similarities of the compressed costate shells in all of the lots to several species of the earlier genus *Gastroplites* certainly bear out McLearn's inference (1933, p. 22) that *Neogastroplites* was derived from it by acquiring nodes. It is interesting to note that, if either the classification given for all of the specimens (table 4), shown on an earlier page, or the more detailed classification of single lots (table 5) is considered, it appears that by the time of the *haasi* assemblage a considerable element of subglobose spinose forms had appeared. This was followed by the *cornutus* assemblage, in which these forms seem so greatly reduced as to be nearly missing, but in which the stout nodose variants were more prominent. Then came the *muelleri* and *americanus* assemblages, in which the compressed costate, *Gastroplites*-like variants were overwhelmingly predominant. It is essentially a reversion from the nodose toward the older costate type. The subglobose spinose variants were present, however, and again appear strongly in the highest group studied, the *maclearni* assemblage. It is notable that *Gastroplites* had no true nodes and that *Neogastroplites haasi*, deemed the oldest of the five groups, had lateral and ventrolateral nodes but no median ventral nodes (cf. the Canadian *N. selwyni* McLearn, 1933, p. 24, pl. 2, fig. 3; pl. 3, fig. 1). The other four groups all have median ventral nodes on the stout and subglobose forms, though in *N. muelleri* and *N. americanus* this portion of the groups is minor. The stout nodose portion of the *cornutus* group, particularly the variety E, appears to the writers indistinguishable from the Canadian *N. cornutus* (Whiteaves). Figure 9 shows in graphic form the percentage composition of five lots representing single concretions or beds.

SYSTEMATIC DESCRIPTIONS

Family Hoplitidae Douvillé, 1890

Subfamily GASTROPLITINAE Wright, 1952

The writers have followed Wright (1952, 1955, 1957) and Casey (1954) in assigning to the subfamily Gastroplitinae the genera *Gastroplites* McLearn and *Neogastroplites* McLearn. Casey added also the genera *Arcthoplites* Spath and *Subarcthoplites* Casey, and Wright added *Cymahoplites* Spath and *Lemuroceras* Spath. The subfamily is characterized by Casey (1954, p. 111) as diverging

> from the normal evolutionary path of the Hoplitidae by strengthening rather than weakening the ornament along the siphonal line, and by acquiring tubercles only at a late phylogenetic stage.

As *Arcthoplites*, *Subarcthoplites*, *Cymahoplites*, and *Lemuroceras* do not enter into consideration here, they will not be discussed. The genera *Gastroplites* and *Neogastroplites*, however, are of direct interest, though *Gastroplites* has not been recognized south of northern Alberta and British Columbia.

Genus GASTROPLITES McLearn, 1930

Plate 8, figures 1–21; plate 9, figures 1, 2

1930. *Gastroplites* McLearn, Royal Soc. Canada Trans. ser. 3, v. 24, sec. 4, p. 7.

1933. *Gastroplites* McLearn. McLearn, idem, v. 27, sec. 4, p. 14.

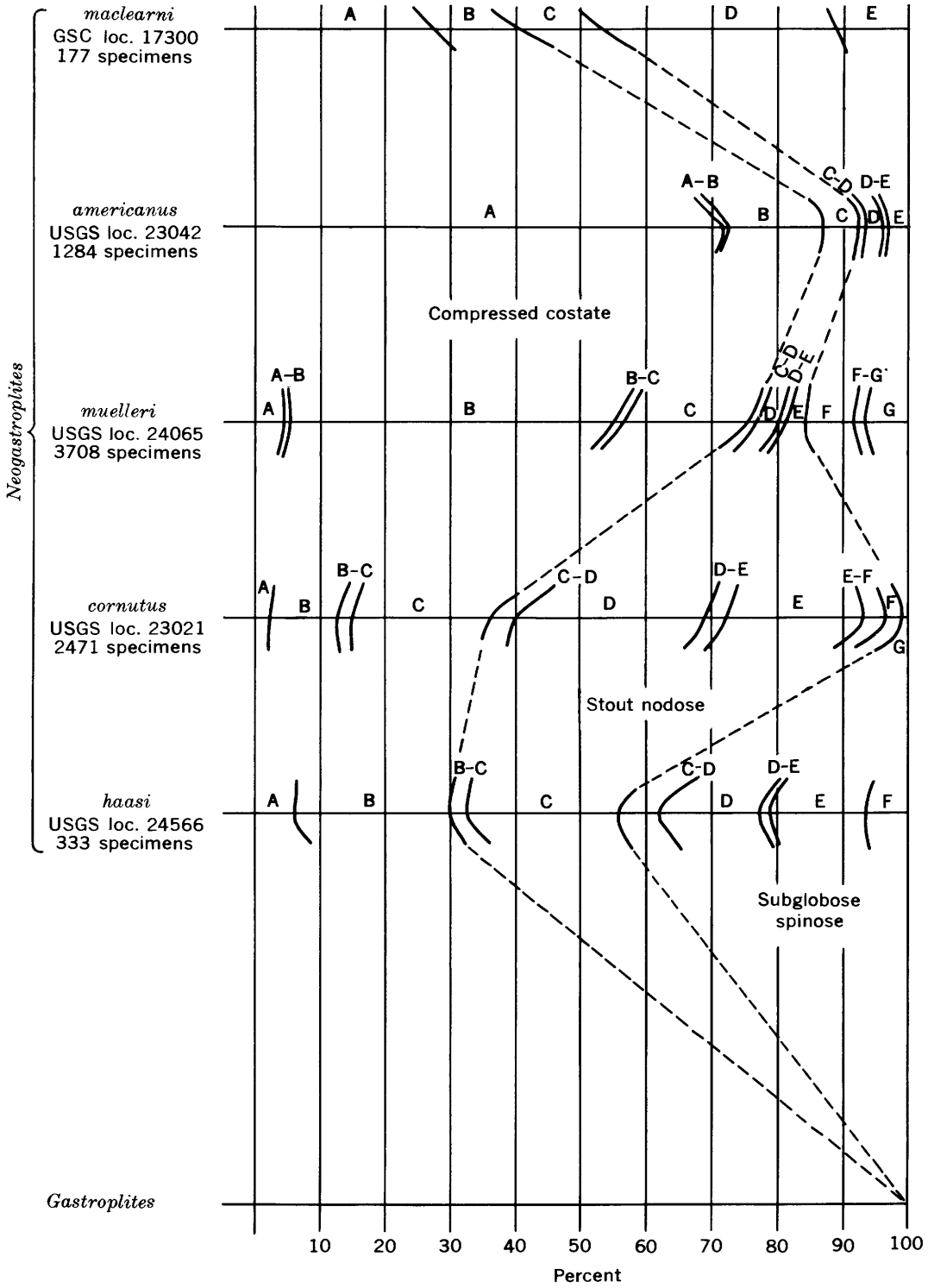

FIGURE 9.—Percentages of variants of species of *Neogastroplites* at five levels, as shown by single lots.

1937. *Gastroplites* McLearn. Spath, Annals Mag. Nat Hist., ser. 10, v. 19, p. 257–260.
1947. *Gastroplites* McLearn. Warren, Jour. Paleontology, v. 21, p. 120.
1954. *Gastroplites* McLearn. Casey, Washington [D.C.] Acad. Sci. Jour., v. 44, p. 111 (in discussion of *Tetrahoplitoides* Casey).
1957. *Gastroplites* McLearn. Wright, *in* Arkell and others, Treatise on invertebrate paleontology, pt. L, Mollusca 4, Cephalopoda, Ammonoidea, p. L400.

McLearn in 1930 defined *Gastroplites* as follows:

Gastroplites n. gen. The genotype is *Hoplites canadensis* Whiteaves, Trans. Roy Soc. Can., Sec. IV, 1892 [1893], p. 118, Pl. 11, figs. 3, 3a. Compressed shells with flattened venters and ribs extending across the venter. Suture line reduced. One species has slightly angulate venter and almost pseudoceratitic suture line.

In 1933 McLearn expanded the generic definition to state:

"This genus includes, typically, moderately involute, compressed, oligogyral shells, with flattened sides, well defined ventral shoulders and tabulate or only slightly arched venters. The slightly flexuous and angular ribs mostly unite in pairs on the inner part of the lateral area to form a short primary which soon dies out on the inner margin. They are thickened or elevated a little where joined, but no actual bulla is formed. The ribs are curved a little on the sides, are thickened and prorsiradiate just on the ventral shoulder and cross the venter, where they are bent forward a little and broadened.

"The suture line is reduced and rather simple. L1 is broad-stemmed, is longer than EL and is asymmetric, having a small saddle projecting into it on the outer side. L2 is small. ES is broad and S1 is not so broad as ES. There are two or three auxiliary lobes and saddles.

"The genotype is *Hoplites canadensis* Whiteaves."

Besides the type species, *Gastroplites canadensis* (Whiteaves) (1892, p. 118, pl. 11, figs. 3-5; McLearn, 1933, p. 15, pl. 1, figs. 4, 5), McLearn included *G. canadensis* var. (1933, p. 16, pl. 1, figs. 1-3), *G. stantoni* McLearn (1931, p. 5; 1933, p. 17, pl. 1, figs. 9, 10), *G. allani* McLearn (1931, p. 5; 1933, p. 18, pl. 1, figs. 6-8), *G. kingi* McLearn (1931, p. 5; 1933, p. 19, pl. 3, figs. 4, 5), *G. anguinus* McLearn (1931, p. 5; 1933, p. 20, pl. 2, figs. 1, 2), and *G. spiekeri* McLearn (1931, p. 5; 1933, p. 21, pl. 3, figs. 2, 3), and Spath added *G. cantianus* Spath (1937, p. 257; 1937-1942, p. 703, pl. 57, fig. 37). To facilitate comparisons these species are illustrated from casts of the types in plates 8 and 9 of this paper, together with several other Canadian specimens.

In general terms the most typical forms are moderately involute, have the flanks flattened, the venter flattened, the lateral ribs slightly sinuate and mostly forked near the umbilical shoulder, the ventral ribs nearly straight or only gently convex forward; and no nodes at any stage. The species originally included in the genus do, however, diverge somewhat from such a characterization. Included are forms with a flat, sharply truncated venter and others with a gently arched venter, forms with strong distinct ribs crossing the venter and others with the ventral ribs faint or nearly absent on the middle of the venter, and forms with small umbilicus and others with relatively wide umbilicus. Some species have the ribs bent sharply forward at the ventrolateral margin and the ribs arch forward on the venter, whereas others seem to lack the bend and have ribs passing nearly straight across the venter.

The Canadian species are cited mostly from the Cadotte member of the Peace River sandstone, but the genus *Gastroplites* has been found at various places in other units near the middle of the Fort St. John group. The recognition of *Gastroplites* at the top of the middle Albian in England (Spath, 1937) and its occurrences in Greenland and Alaska (Imlay and Reeside, 1954, p. 237, 242) would place it as no younger than middle Albian. There is no question that *Gastroplites* is considerably older than *Neogastroplites*.

Type specimen.—Hoplites canadensis Whiteaves, GSC 7430. Peace River, 20 miles below Cadotte River, Alberta. (This paper, pl. 8, figs. 1, 2.)

Genus NEOGASTROPLITES McLearn, 1931

Plate 9, figures 3–8; plate 10, figures 1–4; plate 11, figures 16, 20; text figure 10

1931. *Neogastroplites* McLearn, Royal Soc. Canada Trans., 3d ser., v. 25, p. 7.
1931. *Kanabiceras* Reeside and Weymouth (part), U. S. Nat. Mus. Proc., v. 78, art. 17, p. 11.
1931. *Acompsoceras* Hyatt (part). Reeside and Weymouth, idem, p. 17.
1931. *Metoicoceras* Hyatt (part). Reeside and Weymouth, idem, p. 19.
1933. *Neogastroplites* McLearn. McLearn, Royal Soc. Canada Trans., 3d ser., v. 27, sec. 4, p. 21–22.
1951. *Gastroplites* McLearn (part). Cobban and Reeside, Am. Assoc. Petroleum Geologists Bull., v. 35, p. 1892–1893.
1951. *Neogastroplites* McLearn. Cobban and Reeside, idem.
1957. *Neogastroplites* McLearn. Wright, in Arkell and others, Treatise on invertebrate paleontology, pt. L, Mollusca 4, Cephalopoda, Ammonoidea, p. L400.

In proposing the genus in 1931 McLearn defined it as follows:

"*Neogastroplites* n. gen. This is similar in form and ornament to *Gastroplites* but differs in the pres-

ence of tubercles and in some species, a median thickening of the ribs on the venter. It appears to represent a later Albian development of *Gastroplites*. The genotype is *Buchiceras? cornutum* Whiteaves (Trans. Roy. Soc. Can., vol. 2, sec. 4, pp. 239-240, 1885). The type of the genotype is in National Museum of Canada; type cat. no. 5039."

In 1933 McLearn expanded this definition to state:

> *Neogastroplites* includes fairly involute platycones with flattened sides, tabulate to slightly convex venter, distinct ventral shoulders and rostrate aperture. The lateral ribs are either angular or of low relief and unite in pairs just outside the umbilical margin or are single. The ribs are bent forward at the ventral shoulder and continuous and arcuate across the venter where they are much thickened or even considerably elevated into a node-like form. There is an inner row of bullate tubercles at the union of the ribs on the sides and an outer row of clavellate tubercles on the ventral shoulder. The suture line is reduced and L1 asymmetric. The genotype is *Buchiceras? cornutum* Whiteaves.
>
> *Neogastroplites* is at a higher horizon than *Gastroplites* and appears to have been derived from it by the taking on of the two rows of tubercles and the greater thickening and elevation of the ribbing on the venter until it almost resembles a ventral row of tubercles. The tuberculate appearance of the ventral ribbing, however, may be accentuated by the crushing that most of the specimens have undergone. The L1 is not so asymmetric as in *Gastroplites*. The size is larger than that of *Gastroplites*.

McLearn has figured several specimens of *Neogastroplites* that were in Whiteaves' hands and casts of these, together with specimens from the same region, are illustrated in plates 9 to 11.

The definition given above specifies an ammonite with compressed form, flat sides, two rows of tubercles on the flanks, and node-like thickening of the ribs at the middle of the venter. It does not include the *Gastroplites*-like compressed costate forms without nodes or thickening of the ventral ribs, nor does it include the subglobose spinose forms at the other end of the series of variants, both of which should be included. It is necessary, therefore, to amplify the generic concept.

Neogastroplites is redefined as follows:

Shell moderately involute, ranging in form from compressed through stout to subglobose. Flanks in compressed forms flattened, in stout forms arched, in subglobose forms subangulate. Venter well defined, tabulate to slightly convex, in some of the subglobose forms merging with the outer part of the flank to form a broadened ventral zone. Umbilical shoulders distinct. Aperture rostrate. Aptychus a striaptychus in Trauth's classification (1927, p. 229; 1928, p. 134), usually preserved as a brown carbonaceous material, perhaps originally chitinous.

Sculpture of smaller stages of low to angular primary ribs that incline gently forward from the umbilical shoulder to a point near the middle of the flank. There the primary ribs commonly divide into two secondary ribs, the rear branch running nearly radially and the forward branch inclining foward to the margin of the venter; some secondary ribs arise independently on the flank. The ribs on the flanks appear to have a shallowly sigmoid course. At the margin of the venter the ribs bend sharply forward and are convex forward and continuous across the venter. In the nodose and spinose variants the point of division of the primary ribs becomes a node or spine elongated radially (bulla) and the forward-bending part on the margin of the venter commonly becomes a transverse node (clavus); the ribs on the venter commonly show a thickening or even a distinct rounded or elongated node on the midline, but in some forms are uniform across the venter.

The number of ribs per whorl shows some range of variation. In general the number of primary ribs per whorl is greatest in the compressed variants and least in the stout variants. The secondary ribs show the same tendency, but it is less marked. Figure 10 shows these features graphically.

With increase in size the compressed forms lose their ornament and become smooth or nearly smooth discoid shells; maximum size as much as 600 mm in diameter. The stout nodose forms tend to retain or somewhat accentuate their ornament and become thick discoid shells; maximum size as much as 175 mm in diameter. The subglobose spinose forms accentuate the ornament, but attain only a relatively small size; maximum as much as 90 mm in diameter. There appears to be an inverse relation between maximum size on the one hand and degree of stoutness and strength of ornamentation on the other.

The suture line is relatively simple, with the first lateral lobe a little larger than the ventral lobe and asymmetrical and four to six much smaller and rather narrow additional lobes between it and the line of involution. The dorsal suture contains four slender lobes on each side of the dorsal lobe.

The most distinctive characters are the nodose or spinose ornament, particularly on the midline of the venter, and the forward arching of the ribs on the venter.

In this paper five species of *Neogastroplites* are recognized, each containing infrasubspecific variants: *haasi* Reeside and Cobban, with six described variants; *cornutus* (Whiteaves), with seven described variants; *muelleri* Reeside and Cobban, with seven described variants; *americanus* (Reeside and Weymouth), with

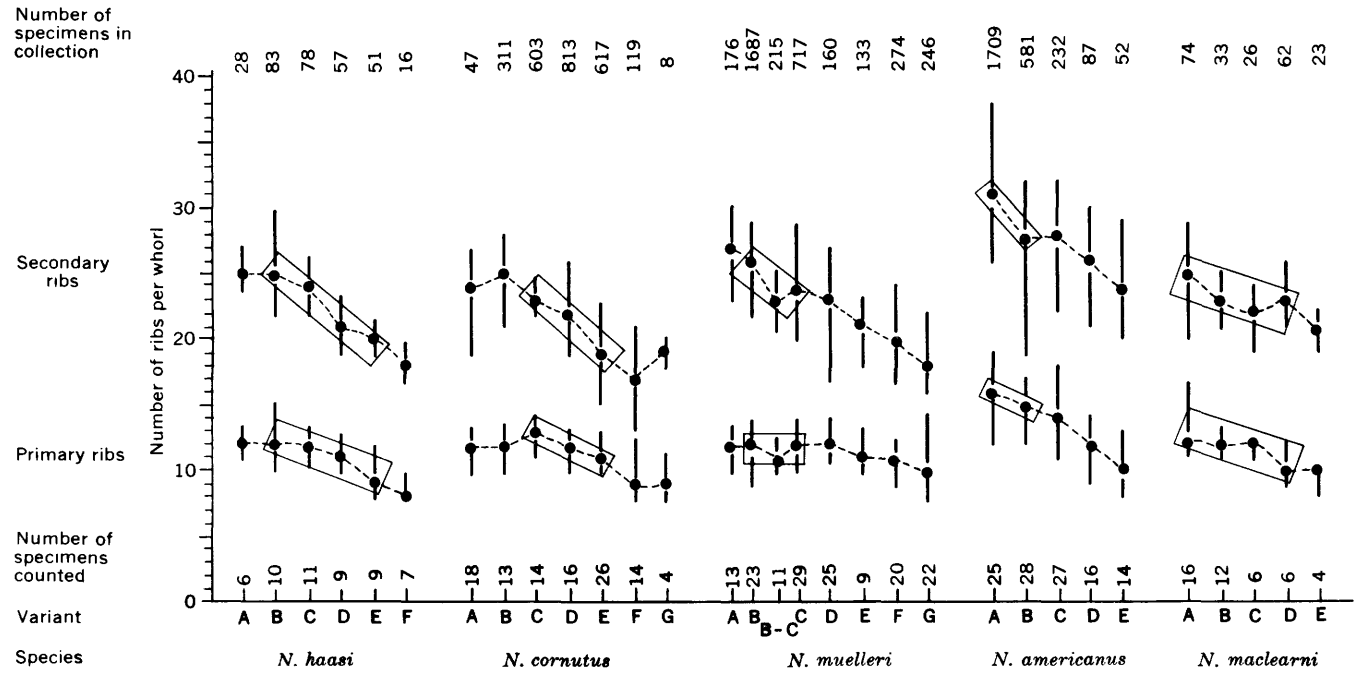

FIGURE 10.—Average number of ribs per whorl of species and variants of *Neogastroplites* (dot) and extreme range of rib counts (solid line). Rectangles enclose the most abundant variants.

five described variants; and *maclearni* Reeside and Cobban, with five described variants. The species *N. selwyni* McLearn (1933, p. 24) may be identical with *N. haasi*, but the writers feel it better to leave the question open at this time.

Type specimens.—Buchiceras? cornutum Whiteaves, several specimens. Peace River near Fort St. John, British Columbia. McLearn (1933, p. 22, pl. 2, fig. 4) has selected a lectotype, GSC 5039. (See pl. 9, fig. 6, and pl. 10, fig. 4.)

Neogastroplites haasi Reeside and Cobban, n. sp.

Plate 13, figures 19–21; text figures 11–13

As in the other species of *Neogastroplites* here considered, the range in *N. haasi* of form and ornamentation precludes any simple statement of characters. It is distinguished by relatively coarse strong sculpture, very gently convex venter (not actually tabulate), distinct ventral ribs; in all but the most compressed variants the early appearance and distinctness of lateral and ventrolateral nodes and in even the most globose variants the persistent position of the lateral nodes near the umbilical shoulder and the sharp distinction between flank and venter; and lack of nodes on the venter at any stage.

Neogastroplites haasi differs from *N. cornutus* (Whiteaves) and *N. muelleri* Reeside and Cobban in its stronger sculpture, its lack of median ventral nodes at any stage, in the early appearance and persistence of lateral and ventrolateral nodes, and in stout forms in the position of the lateral nodes near the umbilicus. It differs from *N. americanus* (Reeside and Weymouth) and *N. maclearni* Reeside and Cobban in its less numerous ribs, its lack of median ventral nodes, its arched, nontabulate venter, in the position of the lateral nodes near the umbilicus, and in the subglobose forms in the distinctness of the flank and venter.

Neogastroplites selwyni McLearn (1933, p. 24, pl. 2, fig. 3; pl. 3, fig.1. This paper, pl. 11, figs. 16, 20) is like *N. haasi* in general form and ornamentation, particularly in the nonnodose ventral ribs. It is difficult, however to compare the two species because most of the available specimens of *N. haasi* are small and the one figured specimen of *N. selwyni* is relatively large. However, several fragments from the eastern Bighorn Basin assigned to *haasi* (pl. 12, figs. 11, 12; pl. 14, figs. 18, 19), though somewhat crushed and distorted, do permit some comparisons. The Canadian specimen appears to have nearly twice as many ribs per whorl as the Wyoming specimens and the ribs are more distinct on the flanks. They may be variants of one species, but until more material is available for comparison, it seems best to consider them separate entities. It is to be noted that Stelck, Wall, Bahan, and Martin (1956, p. 9) place *N. selwyni* as older than *N. cornutus*, which would be the relationship between *N. haasi* and *N. cornutus*.

The writers have found it convenient to recognize six variants, to which the letters A to F are applied. It is notable that the proportions of the three general groups of variants of *N. haasi* are quite different from those of species of the earlier genus *Gastroplites*, in which no nodose or spinose forms have been recorded. In *N. haasi* the *Gastroplites*-like compressed costate group comprises 30 percent of the assemblage, the stout nodose group 26 percent, and the subglobose spinose group 44 percent. Table 6 shows the distribution of the variants.

The suture line of the species is that of the genus. External sutures of all of the variants are shown in figure 11.

TABLE 6.—*Distribution of specimens of* Neogastroplites haasi *by locality, variant, and size*

USGS Mesozoic locality No.	Map No.	Diameter of shell (mm)	Number of specimens for indicated character group and variant									Total
			Compressed costate		Stout nodose		Subglobose spinose					
			A	B	B-C	C	C-D	D	D-E	E	F	
Montana												
24566	45	<25	13	23	3	40	5	23	2	25	6	140
		25–50	8	56	4	34	13	30	2	25	8	180
		>50	0	1	0	4	2	3	0	1	2	13
Total, Montana			21	80	7	78	20	56	4	51	16	333
Wyoming												
26413	55	<25	0	0								0
		25–50	4	0								4
		>50	1	1								2
Total			5	1								6
26414	56	<25	0	0				0				0
		25–50	1	1				0				2
		>50	1	1				1				3
Total			2	2				1				5
Total, Wyoming			7	3				1				11
Grand total			28	83	7	78	20	57	4	51	16	344

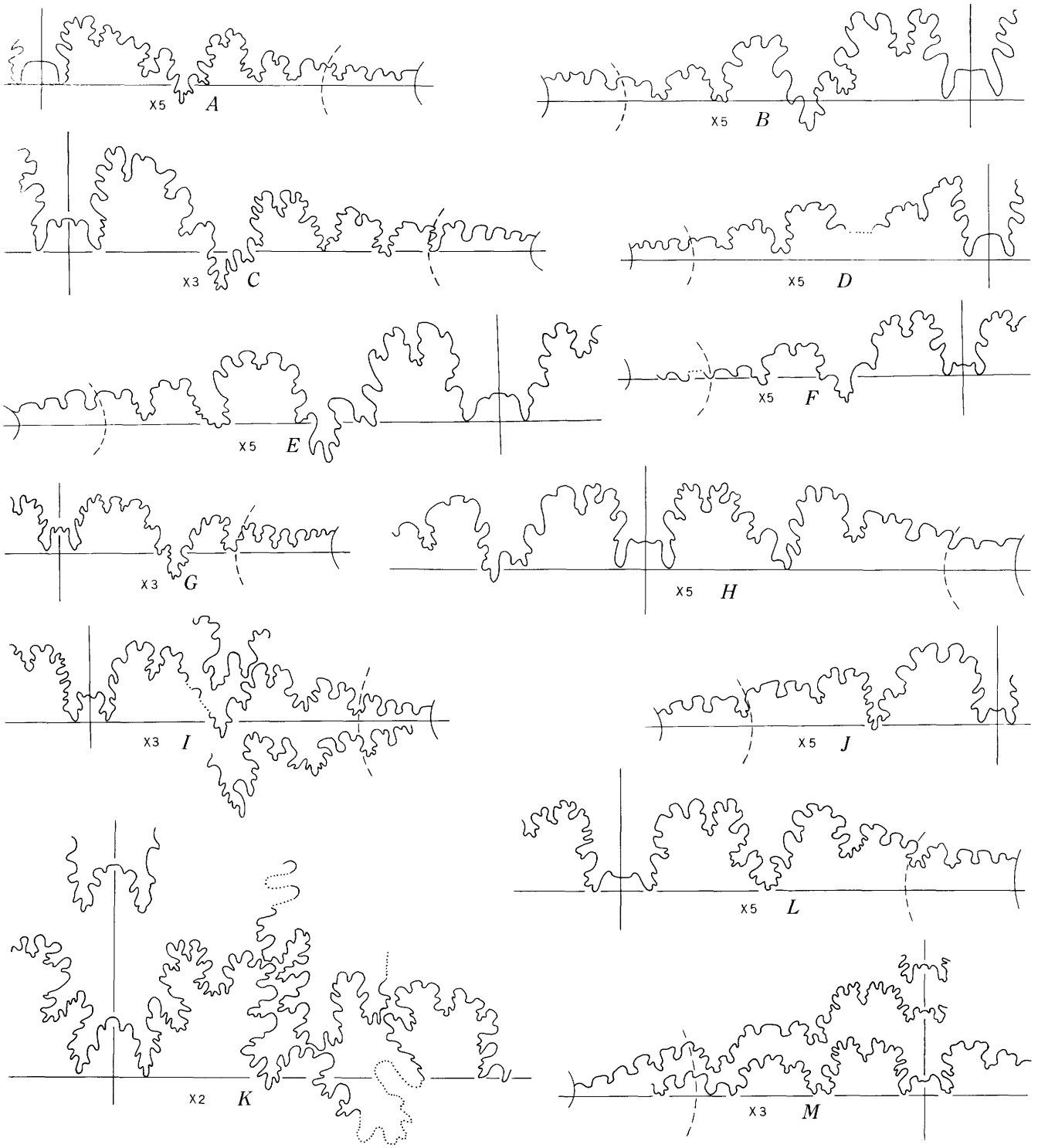

FIGURE 11.—Sutures of *Neogastroplites haasi* Reeside and Cobban, n. sp. *a*. Var. B at 19 mm diameter (× 5). *b*. Var. B at about 19 mm diameter (× 5). *c*. Var. B–C at 36 mm diameter (× 3) (see also pl. 13, figs. 2–4). *d*. Var. A at 19 mm diameter (× 5). *e*. Var. C at 20 mm diameter (× 5). *f*. Var. C–D at about 18 mm diameter (× 5). *g*. Var. E at 22 mm diameter (× 3) (see also pl. 15, figs. 10, 11, 14). *h*. Var. C at 19 mm diameter (× 5). *i*. Var. C at about 30 mm diameter (× 3). *j*. Var. D–E at about 17 mm diameter (× 5). *k*. Var. D at about 80 mm diameter (× 2) (see also pl. 14, figs. 18, 19). *l*. Var. D at 20 mm diameter (× 5). *m*. Var. F at 24 mm diameter (× 3). Figures *a–j* and *l, m* are from specimens from USGS loc. 24566, Stillwater County, Mont.; figure *k* is from a specimen from USGS loc. 26414, Big Horn County, Wyo. All specimens from the Thermopolis shale.

The overlap of proportions of the shell in the variants examined is brought out by figure 12.

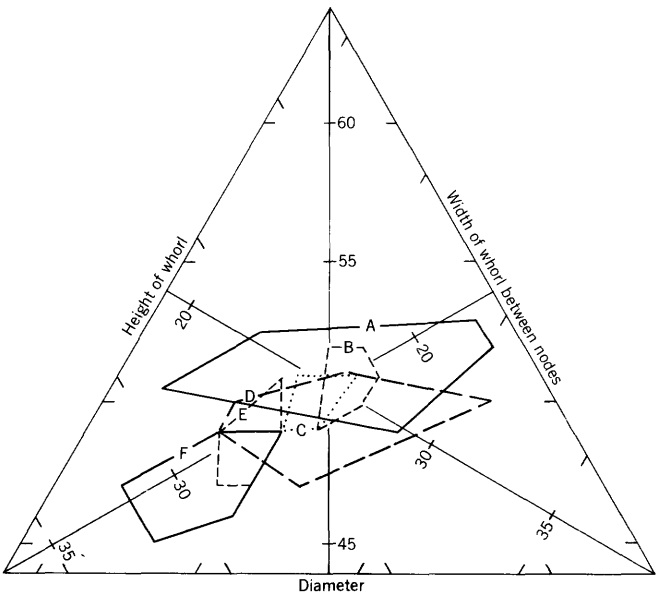

FIGURE 12.—*Neogastroplites haasi* Reeside and Cobban, n. sp. Proportions of the shell in six variants, as indicated by measurements of the diameter of the shell, the height of the whorl, and the width of the whorl between nodes. The point indicating the measurements falls within the enclosure lettered to correspond to the variant.

Occurrence.—Three localities for the species are known, in Stillwater County, Mont., and Big Horn County, Wyo. Figure 13 shows the distribution of the localities.

Type specimen.—USNM 129314 (pl. 13, figs. 19–21).

Neogastroplites haasi var. A

Plate 11, figures 1–15, 17, 19; text figure 11*d*

Neogastroplites haasi var. A is represented by 28 specimens from three localities. The largest specimen available, 35 mm in diameter, entirely septate, forms a moderately thick disk; orad part crushed. Umbilicus small.

Cross section of whorl depressed oval to about 3 mm diameter of shell; subcircular at 5 mm; high oval at 10 mm with well-defined umbilical shoulders, flattened flanks, obscure ventrolateral shoulders, and broadly rounded venter; high trapezoidal at 17 mm, continuing much the same to 35 mm, with the widest part near umbilical shoulder, flanks gently arched, venter greatly arched. Several fragments, perhaps of this variant, from 45 to 70 mm diameter of shell, show little change. Measurements of seven specimens from USGS loc. 24566 and one (72 mm) from USGS loc. 26413 are as follows:

Diameter of shell (mm)	Figure No. on pl. 11	Whorl				Width of umbilicus		Width of venter	
		Height		Width					
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
10	1–3	5	50	5	50	3±	30	3.5±	35
12	4–6	5.5	46	6	50	3.5	28	3.8	32
19	7, 13–15	11	58	8.5	45	5	26	6.5±	34
21		10	48	9	43	4	19	7	33
25	1–3	14.5	58	10	40	5±	20	7	28
26		14	54	10	39	5	19	7.5	29
35	8–10	20	57	12	34	6	17	9	26
72±	17–19	39	54	24±	33			14	19

Early whorls to 4 mm diameter of shell smooth; then faint broad ribs appear on the venter and at 6 mm have become distinct costae extending from umbilical shoulder to umbilical shoulder; some are simple, some fork from a short primary rib on the umbilical shoulder. At 8 to 10 mm diameter the primary is strong and is inclined forward; the secondary ribs extend more or less radially to the margin of the venter, where the rib is highest, and

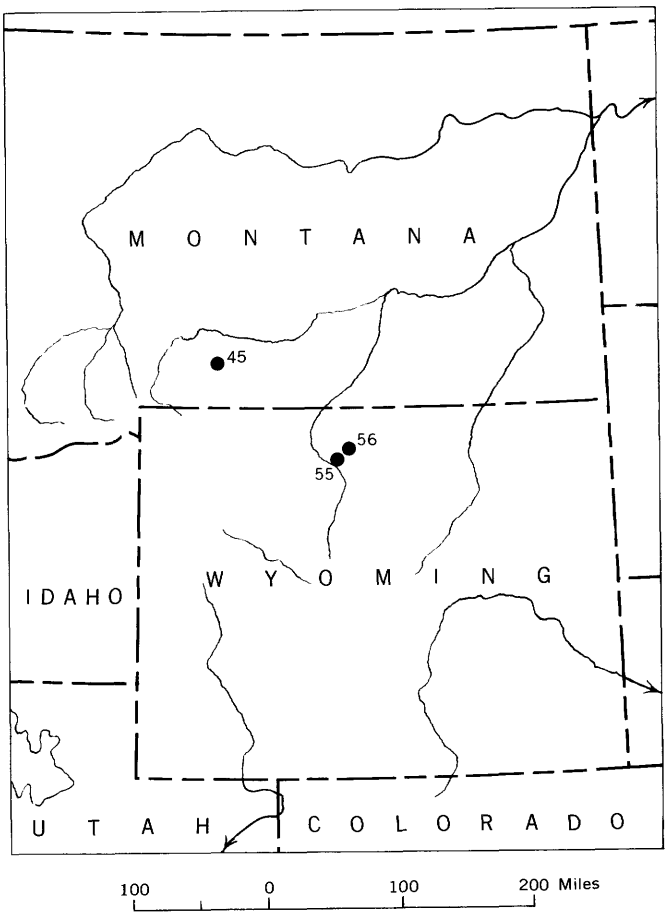

FIGURE 13.—Localities of *Neogastroplites haasi* Reeside and Cobban, n. sp.

bends diagonally forward; the lateral ribs have a shallowly sigmoid trend; on the midline of the venter the ribs are notably weak; ventral ribs strongly convex forward; umbilicus smooth. At about 15 mm diameter the midline of the venter is nearly smooth and strength of ribs elsewhere has decreased except that at the ventrolateral margin the part of the rib that bends forward is a weak node. At 20 mm diameter and above, the ribs on the flanks are weak, the ventrolateral node conspicuous, and the venter nearly smooth; umbilicus smooth. A specimen from USGS loc. 26413 at about 72 mm diameter is nearly smooth, except for the ventrolateral nodes. Rib counts are as follows:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
16	12	24	24	12	25
20	12	24	32	11	27
21	12	24			
22	12	25	Average	12	25

The suture is that of the genus (see text fig. 11*d*).

Remarks.—Neogastroplites haasi var. A is characterized by compressed whorls, weak sculpture on the venter, and early weakening of lateral ornamentation except for the ventrolateral nodes.

It differs from *N. haasi* var. B in the weakness of the sculpture. *N. cornutus* vars. A and B have even weaker and coarser sculpture and lose the primary ribs at smaller diameters. *N. americanus* var. A has stronger, finer costae and a tabulate venter. *N. muelleri* var. B has weaker sculpture. It is reminiscent of *Gastroplites allani* McLearn (1933, p. 18), but differs in its convex venter; and of *G. spiekeri* McLearn (1933, p. 21), but differs in its finer and weaker sculpture and relatively stouter whorls.

Figured specimens.—AMNH 28098: 1, 2, 3; YPM 20387; USNM 129307–129310.

Neogastroplites haasi var. B

Plate 12, figures 1–16; plate 13, figure 1; text figures 11*a*, *b*

Neogastroplites haasi var. B is represented by 83 specimens from three localities. Largest entire specimen available, 52 mm in diameter of shell and entirely septate, forms a moderately thick disk. Umbilicus small.

Cross section of whorl to about 4 mm diameter of shell depressed oval; subcircular at about 6 mm diameter; high oval at 9 mm diameter; at 14 mm diameter subtrapezoidal, with defined umbilical shoulders, flattened flanks, ventrolateral shoulders, and very gently rounded venter; later cross sections available are much like that at 14 mm diameter; at 50 mm diameter lateral nodes are present and cross section is hexagonal. A fragment from USGS loc. 24566, probably of this variant, at estimated diameter of 110 mm, suggests much the same form. A fragment from USGS loc. 26413, at estimated diameter of 140 mm, and one from USGS loc. 26414, at about 155 mm, are believed to represent this variant; they are hexagonal in cross section. Measurements of 10 specimens from USGS loc. 24566 are as follows:

Diameter of shell (mm)	Figure No. on pl. 12	Whorl				Width of umbilicus		Width of venter	
		Height		Width					
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
12	1–3	6.5	54	6	50	3	25	4.5	38
17	6, 7	9	53	8	47	5	29	6.5	38
20		10	50	9	45	6	30	7	35
22		11	50	9.5	43	6	27	6.5	30
23		11	48	10	44	5	21	7	30
27		14	52			7	30	7±	30
28	4.5	14	50	13	46	6	21	10	36
33		17	52	14	42	8	24	11	33
35	13–15	18.5	53	16	46	9	26	11	32
52	13–15	27	52	24	46	9	17	15	30

Early whorls to about 4 mm diameter of shell smooth; then first ribs appear on venter. At 7 mm diameter ribs extend from umbilicus to umbilicus, highest and strongest at ventrolateral margins and weakest on midline of venter; ribs on umbilical shoulder incline forward and mostly divide, each into two secondary ribs within the middle of the flank; a few intercalated secondary ribs; at ventrolateral margin ribs bend sharply forward and cross venter with gentle forward convexity; the lateral ribs have a shallow sigmoid trend. At 15 mm diameter the primary ribs and the forward-bending part of the secondaries at the ventrolateral margin rise into subdued nodes. Above 25 mm diameter the point of division of the primary ribs is a sharp node within the middle of the flank and the ventrolateral nodes are prominent. The largest whole specimen, at 52 mm diameter, shows strong sculpture. Umbilicus smooth. The large fragment at about 110 mm diameter shows strong ventrolateral nodes and no trace of thickening or nodes on the venter. The fragments from USGS localities noted above, at diameters of 140 and 155 mm, show strong lateral and ventrolateral nodes, with the venter only undulated. Rib counts are as follows:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
18	12	25	28	12	26
22	13	25	38	10	25
23	12	23	50	13	22
26	13	26	52	11	25
28	15	30			
28	12	26	Average	12	25

The suture is that of the genus (see text figs. 11*a*, *b*).

Remarks.—*Neogastroplites haasi* var. B is characterized by its moderately compressed whorls, fairly strong sculpture, early development and persistence of lateral nodes, and weak ribs on the middle of the venter.

It differs from *N. haasi* var. A in the slightly stouter whorls and stronger sculpture, especially the nodes on the flanks. From *N. cornutus* var. C it differs in the weaker sculpture on the flanks of the whorl, particularly in the primary nodes, and in its more compressed shell. It is reminiscent in its younger stages of *Gastroplites allani* McLearn (1913, p. 18), but has a convex venter.

Figured specimens.—AMNH 28098: 4-8; YPM 20388; USNM 129311, 129640–129642.

Neogastroplites haasi var. B-C, transitional variant

Plate 13, figures 2–4; text figure 11*c*

Neogastroplites haasi var. B-C, represented by 7 specimens, combines the relatively compressed shell of var. B and the stronger sculpture of var. C.

Figured specimens.—AMNH 28089: 9.

Neogastroplites haasi var C.

Plate 13, figures 5–24; text figures 11*e*, *h*, *i*

Neogastroplites haasi var. C is represented by 78 specimens. Larger shells a stout disk. Largest nearly complete shell perhaps 55 mm in diameter, though several fragments may represent shells up to 90 mm diameter.

Cross section of whorl to about 3 mm diameter of shell depressed oval; subcircular to about 6 mm diameter; high oval at 8 mm diameter. At 10 mm diameter well-defined umbilical shoulders, flattened flanks, ventrolateral shoulders and gently arched venter, give the cross section a trapezoidal form. At 25 to 30 mm diameter the cross section becomes hexagonal and appears to remain so in larger stages. Measurements of 13 specimens from USGS loc. 24566 are as follows:

Diameter of shell (mm)	Figure No. on pl. 13	Whorl				Width of umbilicus		Width of venter	
		Height		Width					
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
9.5	7–9	4.5	47	4.5	47	3	30	3±	30
17.5	5, 6, 12	9	51	8.5	49	5	29	5.5	31
24		12.5	52	11	46	5	21	7	30
25	13–15	12.5	50	13.5	54	7	28	10	40
26		13	50	12	46	5	19	10	40
27	16, 17, 22, 23	14	52	12	49	7	26	10	37
28		15	53	14	50	7	25	11	40
31		14	45	14	45	7	23	10	32
35	10, 11, 18	17	49	17	49	9.5	27	13	37
36		19	53	19	53	9	25	13	36
41		21	51	21	51	9.5	23	16	39
43	19–21	21.5	50	21.5	50	9.5	27	19	44
46		24	52	25	54	10	22	19	41

Early whorls to about 4 mm diameter of shell smooth; then faint, broad ribs appear on the venter and at 6 mm diameter extend to the umbilical shoulders; primary ribs divide near umbilical shoulder into two secondaries that pass across the venter with uniform strength. At 8 mm diameter primaries are higher and secondaries are higher at ventrolateral margin but lower on midline of venter; primaries incline forward, the secondaries are more or less radial on the flanks, incline forward on the ventrolateral margin and are convex forward on the venter; lateral ribs have a shallow sigmoid form. At 15 mm diameter the primaries are sharp nodes and the secondaries are weak on the midline of the venter. At 18 mm diameter the ventrolateral bends have become distinct nodes and beyond this diameter the ribs are prominent. The one specimen that seems to preserve a living chamber, at diameter of 55 mm, shows sharp lateral and ventrolateral nodes that fade out toward the aperture, and on the venter even, strong, rounded ribs without thickening or nodes, though strongly convex forward. The living chamber must be nearly complete. Several large fragments, perhaps up to 90 mm diameter, differ only in having the ventral ribs form rather high rounded ridges. Umbilicus smooth throughout. Rib counts are as follows:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
18	12	23	36	13	24
19	12	25	39	13	26
21	10	23	41	13	25
24	11	24	46	11	22
25	10	25			
26	10	22	Average	12	24
28	12	25			

The suture is that of the genus (see text figs. 11*e*, *h*, *i*).

Remarks.—*Neogastroplites haasi* var. C is characterized by moderately stout whorls, strong sculpture, including lateral and ventrolateral nodes, and even strong ribs on the venter.

It differs from *N. haasi* vars. A and B in stoutness of the shell and stronger sculpture, and from *N. haasi* var. D in its less stout shell and weaker sculpture. It resembles *N. cornutus* var. C in lateral view, but has finer sculpture, is much stouter, and lacks median ventral nodes; it is more like *N. cornutus* var. D in lateral view and in stoutness, but again has finer sculpture and lacks median ventral nodes. It resembles somewhat *N. muelleri* var. D, but is stouter and lacks median ventral nodes; it is about as stout as *N. muelleri* var. E, but again lacks median ventral nodes. In lateral sculpture and stoutness it is much like *N. americanus* var. C, but differs in being less stout at a given diameter, in having somewhat finer sculpture, and in lacking median ventral nodes. The lack of median ventral nodes recalls *N. selwyni* McLearn (1933, p. 24), but none of the present specimens is large enough to provide a satisfactory comparison.

Figured specimens.—AMNH 28098: 10–16; USNM 129312, 129313, 129314 (holotype).

Neogastroplites haasi var. C-D, transitional variant

Plate 13, figures 25–28; text figure 11*f*

Neogastroplites haasi var. C-D, represented by 20 specimens, combines the form of *N. haasi* var. C, though perhaps a little stouter, with the stronger sculpture of var. D.

Figured specimens.—AMNH 28098: 17–19.

Neogastroplites haasi var. D

Plate 14, figures 1–19; text figures 11*k*, *l*

Neogastroplites haasi var. D is represented by 57 specimens from two localities. Shell a thick disk. Largest entire specimen is about 43 mm in diameter, though fragments represent shells estimated to be about 60 mm in diameter at USGS loc. 24566 and 100 mm in diameter at USGS loc. 26414.

Cross section of whorl depressed oval to 6 mm in diameter of shell. By 9 mm diameter it has become depressed quadrate, with venter very gently arched and well-defined umbilical and ventrolateral shoulders. At 14 mm cross section is depressed hexagonal. At 25 mm diameter it is still somewhat depressed hexagonal, with well arched venter. At larger diameters the cross section is hexagonal and remains so in the largest specimens available. Measurements of 13 specimens from USGS loc. 24566 are as follows:

Diameter of shell (mm)	Figure No. on pl. 14	Whorl						Width of umbilicus		Width of venter	
		Height		Width							
				Over nodes		Between nodes					
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
7	1–3	3	43	3.5	50			2±	28		
14	1–3	6	43	8	57	7	50	5	36	6	43
17		8	47	10	59	9	53	5	29	8	47
20		9.5	48	12.5	63	11.5	58	6	30	8	40
20	4–6	10	50	10.5	52	9	45	7±	35	8	40
25		14	56	15	60	14	56	7	28	11.5	46
27	10–12	14	52	15	56			7	26	12	44
29		16	55	16.5	57	15.5	53	8.5	29	12.5	43
30		17	57	17.5	58	16	53	9	30	13.5	45
31		16	52	17	55			7	23	12	39
31.5	7–9	16	51	17.5	55	15±	48	8	25	12.5	40
42	13–15	23	55	33	79			8	20	19	45
54	16, 17	33	61	30±	56	20±	37	12	22	20±	37

Early whorls to 3 mm diameter of shell smooth; then faint swellings appear near the umbilicus and in a half whorl extend across the venter as faint rounded ribs; a distinct umbilical shoulder is present. At 6 mm diameter the ribs are very distinct, each primary forking near the umbilicus into two secondaries and there are few or no intercalated ribs. At 8 mm diameter the primary ribs are a subdued node and the ribs have thickened at the margin of the venter. At 9 to 10 mm diameter the primary nodes, just outside the umbilical shoulder, and the ventrolateral nodes are well defined; in these stages ribs are nearly straight on flanks and are convex forward with even strength across the venter. In later stages from USGS loc. 24566 the primary nodes become spinelike and move out a little from the umbilicus; the ventrolateral nodes become elongated and trend diagonally forward; and the ventral ribs rise to a high level on the venter, but

do not form a node; the ribs on the flanks weaken and are nearly obsolete. In the large specimen from USGS loc. 26414 the nodes are high and blunt. Umbilicus small and smooth throughout. Rib counts are as follows:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
17	11	23	31	12	22
21	11	20	36±	12	20
23	10	21	43	11	19
26±	10	20			
27	11	23	Average	11	21
30	10	21			

The suture is that of the genus (see text figs. 11*k*, *l*).

Remarks.—Neogastroplites haasi var. D is characterized by stout whorls, strong sculpture with early development of lateral and ventral nodes, later spinose lateral nodes, and persistence of strong convex ribs on the venter.

It differs from *N. haasi* var. C in its stouter shell and stronger sculpture, including lateral spinelike nodes. It differs from the stout variants of most other species of *Neogastroplites* in the lack of median ventral nodes. In the strong nodes on the flank and lack of ventral nodes it recalls *N. selwyni* McLearn (1933, p. 24), but none of the present specimens is large enough to provide a satisfactory comparison.

Figured specimens.—AMNH 28089: 20–23; YPM 20389; USNM 129315, 129316, 129639.

Neogastroplites haasi var. D-E, transitional variant

Plate 14, figures 20–22; text figure 11*j*

Neogastroplites haasi var. D-E, represented by 4 specimens, is somewhat stouter and more strongly ornamented than *N. haasi* var. D and somewhat less stout and more weakly ornamented than var. E.

Figured specimens.—AMNH 28089: 24; USNM 129317.

Neogastroplites haasi var. E

Plate 15, figures 1–18; text figure 11*g*

Neogastroplites haasi var. E is represented by 51 specimens. Shell a very thick disk. Largest entire specimen is about 45 mm in diameter. A few fragments with ventral sculpture at larger diameters may represent this variant.

Cross section of whorl depressed oval to 6 mm diamter for shell. By 8 mm diameter it has become depressed quadrate, with gently arched venter and well-defined umbilical and ventrolateral shoulders. At 10 mm diameter it is depressed hexagonal and remains so to the largest diameter available. Measurements of 11 specimens from USGS loc. 24566 are as follows:

Diameter of shell (mm)	Figure No. on pl. 15	Whorl						Width of umbilicus		Width of venter	
		Height		Width							
				Over nodes		Between nodes					
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
9.5	7–9	4.5	47	4.5	47			3	32	3±	32
13		6	46	8	61	7.5	58	4	31	6.5	50
15	1–3	7	47	8.5	57	7.5	47	5	33	6.5	43
22		11.5	52	18	82	13.5	61	7.5	34	13	59
24		11.5	48	18	75	14	58	6	28	13	54
24		12	50	19	79	14	58	7	29	13	54
24	4–6	12	50	15	62	12.5	52	7	29	11.5	48
25		13	52	17	68	15	60	7	28	13	52
25	10, 11, 14	13	52	18	72	14	56	8	32	12	50
26	16–18	14	54	19	73	15	60	6	23	12	46
43	12, 13, 15	22	51	28	65	23	54	8	19	18	44

Early whorls to 3 mm diameter for shell smooth; then faint swellings appear near umbilicus and rapidly extend across venter to make rounded ribs; a distinct umbilical shoulder is present. Ribs very distinct at 5 mm diameter, with each primary rib dividing into two secondary ribs, a faint ventrolateral shoulder showing, and the ventral ribs arching forward gently. At about 7 mm diameter the primary ribs begin to sharpen and the ventrolateral shoulder begins to thicken into a node. At about 15 mm diameter the primary ribs are sharp tubercles, the ventrolateral tubercles are well defined, and ribs cross the venter with even strength and are gently convex forward. At larger diameters the primary ribs pass into blunt spines and move out a little on the flanks, and the ventrolateral nodes become elongated diagonally forward across the ribs; the last three ribs on the largest specimen begin to rise on the venter into a

crest that slopes evenly toward the ventrolateral nodes; and the ribs connecting the lateral and ventrolateral nodes become weak. Umbilicus smooth throughout. Rib counts are as follows:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
14	12	21	27	9	21
16	11	21	29	8	19
22	9	19	42	9	19
24	8	19			
26	9	20	Average	9	20
26	9	20			

The suture is that of the genus (see text fig. 11*g*).

Remarks.—*Neogastroplites haasi* var. E is characterized by its very stout whorls, with depressed hexagonal whorls above 10 mm diameter for the shell, and blunt spines in the later stages.

It differs from *N. haasi* var. D in its stouter whorls, broader venter, spines on the flanks, short and weak secondary ribs between the spines and the ventrolateral nodes. It differs from the stout variants of most of the other species of *Neogastroplites* in the lack of ventral nodes. *N. selwyni* McLearn (1933, p. 24) appears to be a more slender shell, but is otherwise similar.

Figured specimens.—AMNH 28089: 25–29; USNM 129318.

Neogastroplites haasi var. F

Plate 15, figures 19–27; plate 16, figures 22–24; text figure 11*m*

Neogastroplites haasi var. F is represented by 16 specimens. Shell subglobular, one specimen about 85 mm in diameter, others up to 26 mm in diameter.

Cross section of whorl depressed oval to 10 mm diameter for shell, then depressed quadrate to about 15 mm diameter; at later stages the cross section like a thick biconvex lens. Measurement of eight specimens from USGS loc. 24566 are as follows:

Diameter of shell (mm)	Figure No. on pl. 15	Whorl						Width of umbilicus		Width of venter	
		Height		Width							
				Over nodes		Between nodes					
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
17	22–24	9	53	13	76	10.5	62	4	24	8	47
17		8	47	17	100	11	65	6.5	38	10.5	62
21.5	25–27	10	46	16.5	76	12	56	7	33	11	51
22		12	55	17	77	14	64	6.5	33	12	55
22		11	50	18	82	16	73	7	32	12	55
26	19–21	13	50	20±	77	14	54	5	19	15	58
27		12	44	24	89	18	67	7	28	14	52
85[1]		44	52	62	73	50	59	13	15	41±	48

[1] Figures 22–24 on plate 16.

Early whorls to 3 mm diameter for shell smooth; then faint nodes appear near umbilicus and in a half whorl extend as ribs across the venter, each primary giving rise to two secondaries. At 10 mm diameter the primary ribs are distinct nodes on the umbilical shoulder and thickenings have appeared on the ventrolateral shoulder; the ventral ribs cross the venter with equal strength and are faintly convex forward. In later stages the primary ribs become blunt spines and the ventrolateral nodes become sharp and high and are inclined diagonally forward; lateral ribs connecting the nodes nearly obsolete and the ventral ribs rise high on the midline of the venter, with a gentle slope toward the ventrolateral nodes; ventral ribs appear to lie a little behind the ventrolateral nodes. Umbilicus smooth throughout. Rib counts are as follows:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
17	8	19	27	9	18
21	9	18	85	8±	18±
22	8	18			
24	8	17	Average	8	18
26	9	19			

The suture is that of the genus (see text fig. 11*m*).

Remarks.—*Neogastroplites haasi* var. F is characterized by its subglobose whorls, with lenticular cross section of whorl and its blunt spines from about 15 mm diameter on.

It differs from *N. haasi* var. E in its still stouter shell and strong ornamentation. It differs from the other stout variants of species of *Neogastroplites* in the lack of ventral nodes.

Figured specimens.—AMNH 28089: 30–34.

Neogastroplites cornutus (Whiteaves)

Plate 9, figures 3–8; plate 10, figures 1–4; plate 16, figure 1; text figures 14–17

1885. *Buchiceras? cornutum* Whiteaves, Royal Soc. Canada Proc. Trans., v. 2, sec. 4, p. 239–240.

1931. *Neogastroplites cornutus* (Whiteaves). McLearn, Royal Soc. Canada Trans., ser. 3, v. 25 sec. 4, p. 7.

1931. *Kanabiceras wyomingense* Reeside and Weymouth, U. S. Nat. Mus. Proc., v. 78, art. 17, p. 12, pl. 1, fig. 14 (inadvertently called *aspenanum* in plate description).

1931. *Metoicoceras whitei* Reeside and Weymouth (not Hyatt), idem, p. 22, pl. 4, fig. 4 (not figs. 1–3, 5–7).

1931. *Metoicoceras sp.* Reeside and Weymouth, idem, p. 23, pl. 2, fig. 1.

1933. *Neogastroplites cornutus* (Whiteaves). McLearn, Royal Soc. Canada Trans., ser. 3, v. 27, sec. 4, p. 22, pl. 2, fig. 4; pl. 4.

1945. *Neogastroplites cornutus* (Whiteaves). McLearn, Canada Geol. Survey Paper 44–7 (2d ed.), pl. 9, fig. 3.

1951. *Neogastroplites wyomingensis* (Reeside and Weymouth). Cobban and Reeside, Am. Assoc. Petroleum Geologists Bull., v. 35, p. 1893.

1957. *Neogastroplites cornutus* (Whiteaves). Wright, *in* Arkell and others, Treatise on invertebrate paleontology, pt. L, Mollusca 4, Cephalopoda, Ammonoidea, p. L400.

As in the other species of *Neogastroplites* here considered, the range in *N. cornutus* of form and ornamentation precludes any simple statement of characters. The most distinctive features are its relatively coarse sculpture, weak near the umbilicus; gently convex venter; in the costate forms, rapid loss of ornamentation and development of smooth whorls; in all the stouter forms, lateral, ventrolateral, and median ventral nodes; and almost complete lack of subglobose forms.

Neogastroplites cornutus differs from *N. haasi* Reeside and Cobban in its sparser and weaker sculpture, position of the lateral nodes on the flank rather than the umbilical shoulder, and in the lack of subglobose forms. It differs from *N. muelleri* Reeside and Cobban in having weaker sculpture near the umbilicus; in the compressed forms by the more rapid disappearance of the sculpture with increase in size; in stout forms by the stronger lateral nodes; and by the lack of subglobose forms. It differs from *N. americanus* (Reeside and Weymouth) and *N. maclearni* Reeside and Cobban in its coarser and weaker sculpture; its arched, nontabulate venter; and its lack of subglobose forms.

The writers have found it convenient to recognize six variants, to which the letters A to F are applied. It is notable that the subglobose spinose group of variants, composing nearly half the assemblage with *N. haasi* (44 percent), is so reduced as to be nearly missing with *N. cornutus* (0.3 percent), whereas the stout nodose group of variants has expanded from a minor part with *N. haasi* (26 percent) to more than half the assemblage with *N. cornutus* (64 percent). The compressed costate group has changed little (from 30 percent to 36 percent). Six lots in addition to the large lot (23021) can be said to provide fair samples of the assemblage and in each the proportion of subglobose spinose forms is small or they are missing and the proportion of stout nodose forms is high (as much as 80 percent), which implies that this general composition of its assemblages is normal. Table 7 shows the distribution of the variants.

TABLE 7.—*Distribution of specimens of* Neogastroplites cornutus *by locality, variant, and size*

USGS Mesozoic locality No.	Map No.	Diameter of shell (mm)	Number of specimens for indicated character group and variant											Total
			Compressed costate				Stout nodose						Subglobose spinose	
			A	B	B–C	C	C–D	D	D–E	E	E–F	F	G	
Montana														
23411	4	<25								0				0
		25–50								1				1
		>50								0				0
Total										1				1
23410	8	<25		2		10		15		25	0	4	2	58
		25–50		1		3		8		24	1	4	0	41
		>50		0		0		0		3	0	4	0	7
Total				3		13		23		52	1	12	2	106
24603	12	<25				3		0		1		4	0	8
		25–50				5		4		4		9	0	22
		>50				0		1		1		10	1	13
Total						8		5		6		23	1	43
24921	46	<25						1		1				2
		25–50						0		0				0
		>50						0		0				0
Total								1		1				2

TABLE 7.—*Distribution of specimens of* Neogastroplites cornutus *by locality, variant, and size*—Continued

USGS Mesozoic locality No.	Map. No.	Diameter of shell (mm)	Number of specimens for indicated character group and variant											Total
			Compressed costate				Stout nodose						Sub-globose spinose	
			A	B	B-C	C	C-D	D	D-E	E	E-F	F	G	
9653	47	<25						0		0				0
		25–50						2		3				5
		>50						0		2				2
Total								2		5				7
20932	50	<25				3								3
		25–50				2								2
		>50				2								2
Total						7								7
Total, Montana				3		28		31		64	1	35	3	166
Wyoming														
24569	62	<25		4		2		0		0		0		6
		25–50		2		5		9		6		0		22
		>50		3		0		5		4		5		17
Total				9		7		14		10		5		45
23021	65	<25	20	129	9	162	13	172	12	97	45	28	5	692
		25–50	22	118	38	343	76	472	78	320	58	22	0	1,547
		>50	5	30	4	27	0	68	10	69	4	15	0	232
Total			47	277	51	532	89	712	100	486	107	65	5	2,471
17173, 18137, 24558	72	<25				3		21		14		6		44
		25–50				1		10		22		6		39
		>50				0		1		8		2		11
Total						4		32		45		14		94
25360	74	<25				0		0						0
		25–50				1		1						2
		>50				0		0						0
Total						1		1						2
6713	75	<25								0				0
		25–50								1				1
		>50								0				0
Total										1				1
23581	77	<25						1						1
		25–50						1						1
		>50						0						0
Total								2						2
6680	79	<25				4		0		0				4
		25–50				5		1		0				6
		>50				1		0		1				2
Total						10		1		1				12
20670	84	<25						1						1
		25–50						1						1
		>50						0						0
								2						2
23217	87	<25		0				1		1				2
		25–50		0				1		3				4
		>50		1				0		0				1
Total				1				2		4				7
24500	88	<25		0						0				0
		25–50		1						1				2
		>50		0						0				0
Total				1						1				2
24570	89	<25		6		15		2						23
		25–50		4		5		0						9
		>50		0		0		0						0
Total				10		20		2						32
14719, 24550	116	<25		4		1		0		1				6
		25–50		4		2		14		2				22
		>50		1		1		0		1				3
Total				9		4		14		4				31
793	117	<25				1								1
		25–50				0								0
		>50				0								0
Total						1								1

TABLE 7.—*Distribution of specimens of* Neogastroplites cornutus *by locality, variant, and size*—Continued

USGS Mesozoic locality No.	Map. No.	Diameter of shell (mm)	Number of specimens for indicated character group and variant											Total
			Compressed costate				Stout nodose						Subglobose spinose	
			A	B	B-C	C	C-D	D	D-E	E	E-F	F	G	
17834	118	<25		1										1
		25–50		0										0
		>50		0										0
Total				1										1
Total, Wyoming			47	307	51	579	89	782	100	551	107	84	5	2,702
South Dakota														
26342	119	<25						1						1
		25–50						3						3
		>50						0						0
Total								4						4
Total, South Dakota								4						4
Utah														
988	120	<25				1								1
		25–50				0								0
		>50				0								0
Total						1								1
26223	122	<25		1										1
		25–50		1										1
		>50		0										0
Total				2										2
Total, Utah				2		1								3
Grand total			47	313	51	608	89	817	100	616	108	119	8	2,876

The suture line of the species is that of the genus. External sutures of all of the variants and several internal sutures are shown in figures 14 and 15.

The overlap in proportions of the shell in the variants is brought out by figure 16.

Occurrence.—Besides the Canadian localities and as shown in table 7, *Neogastroplites cornutus* is known in the United States from 25 localities in Teton, Cascade, Judith Basin, Sweet Grass, Carbon, and Big Horn Counties, Mont.; Park, Johnson, Teton, Sublette, Natrona, and Uinta Counties, Wyo.; Pennington County, S. Dak.; and Summit County, Utah. Figure 17 shows the distribution of the localities.

Type specimen.—GSC 5039, selected by McLearn as lectotype. Shaftesbury formation on Peace River near Fort St. John, British Columbia. This specimen is assigned by the writers to their var. E.

Figured specimen.—USNM 129319.

Neogastroplites cornutus var. A

Plate 5, figures 1–3; plate 16, figures 2–16, 20, 21; text figures 14*b*, *e*

Neogastroplites cornutus var. A is represented by 47 specimens at one locality. The largest specimens available, all crushed, are about 60 mm in diameter and apparently formed a much compressed disk.

Cross section of whorl up to about 3 mm diameter for shell depressed oval, subcircular at 5 mm diameter, high oval at 8 mm diameter, with flanks tending to flatten. At 12 mm diameter the umbilical and ventrolateral shoulders are defined and cross section of whorl is high trapezoidal, venter gently arched. For available shells of larger diameter the form is much the same, except that whorls are proportionately higher. Measurements of 14 specimens from USGS loc. 23021 are as follows:

Diameter of shell (mm)	Figure No. on pl. 16	Whorl				Width of umbilicus		Width of venter	
		Height		Width					
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
10.5		5.5	52	4	38	2±	20	3±	29
11	5–7	5.5	50	4.5	41	2.5	23	3±	27
16		9	56	6	37	4	25	3.5	22
18		10.5	58	7	39	4	22	4	22
19	8, 9, 16	10	53	7	37	4	21	4.5	24
20		11	55	7.5	37	4	20	4	20
20		11.5	58	7	35	4.5	23	5	25
23		13	56	9	39	5	22	6	26
26	10–12	14	54	10	38	5	19	6.5	25
27		15	55	10	37	6	22	7	26
27		16	59	10	37	6	22	7	26
38	13–15	21	56	13	34	7	18	7.5	20
38.5	20, 21	23	60	14	36	8.5	22	8	21
39		22	56	14	36	8	21	9	23

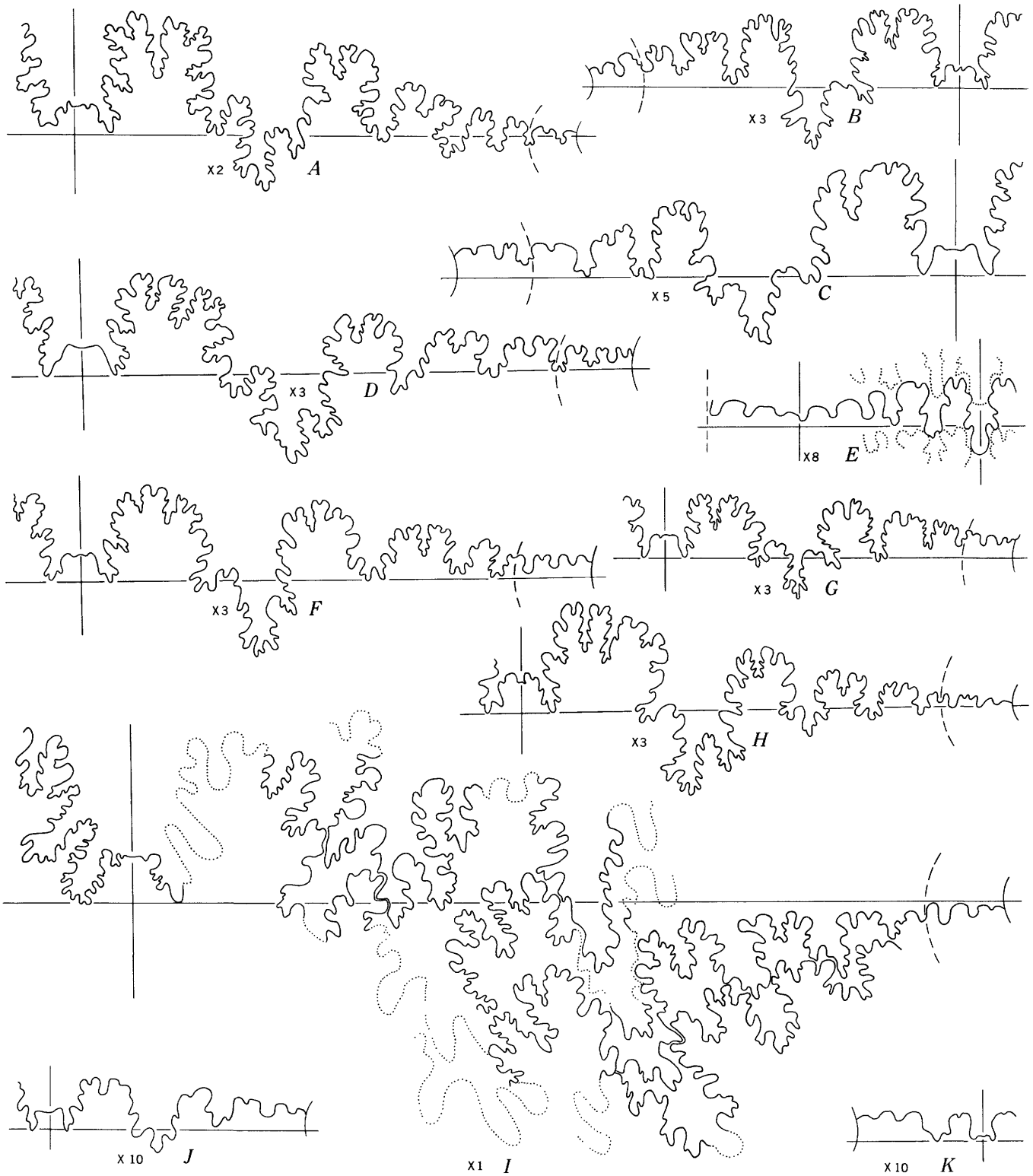

FIGURE 14.—Sutures of *Neogastroplites cornutus* (Whiteaves) vars. A, B, C, C–D, and D. *a*. Var. B at 70 mm diameter (× 2) (see also pl. 17, fig. 18). *b*. Var. A at 32 mm diameter (× 3) (see also pl. 16, figs. 13–15). *c*. Var. B at 26 mm diameter (× 5) (see also pl. 17, figs. 19–21). *d*. Var. C–D at 48 mm diameter (× 3) (see also pl. 22, figs. 18–20). *e*. Var. A, internal suture at 21 mm diameter (× 8). *f*. Var. C at 44 mm diameter (× 3). *g*. Var. C at 31 mm diameter (× 3) (see also pl. 22, figs. 7–9). *h*. Var. B–C at 43 mm diameter (× 3) (see also pl. 20, figs. 5–7). *i*. Var. B at 220 mm diameter, second to fifth from last sutures (× 1) (see also pl. 19). j. Var. D at 7 mm diameter (× 10) (same specimen as fig. 14*c*). *k*. Var. D at 3.5 mm diameter (× 10). All specimens from Mowry shale at USGS loc. 23021, Park County, Wyo.

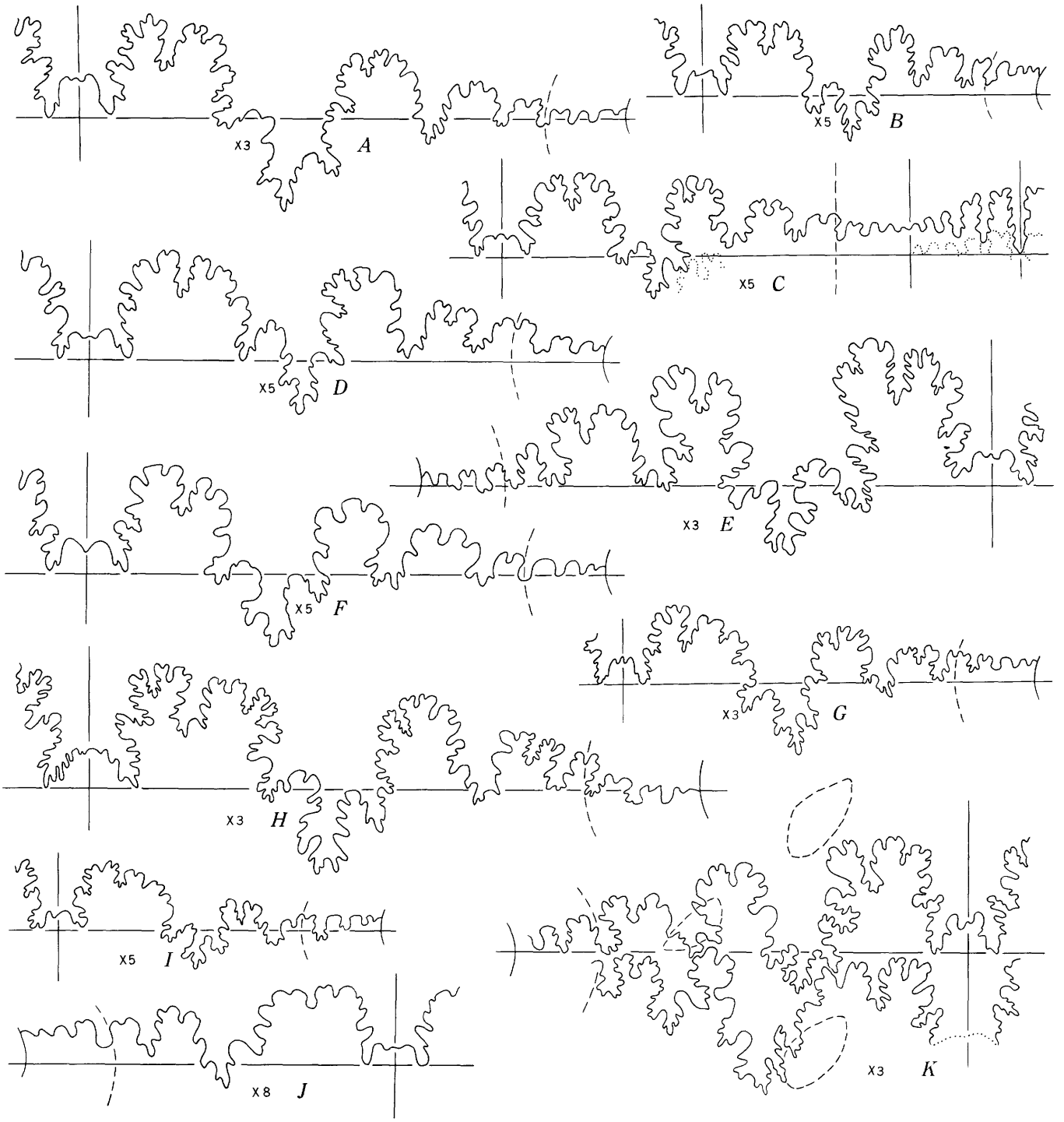

FIGURE 15.—Sutures of *Neogastroplites cornutus* (Whiteaves) vars. D, D–E, E, E–F, F, and G. *a*. Var. D at 46 mm diameter (× 3). *b*. Var. E at 16 mm diameter (× 5) (see also pl. 25, figs. 1–3). *c*. Var. D, complete suture at 22 mm diameter (× 5) (same specimen as fig. 13*j*). *d*. Var. D–E at 28 mm diameter (× 5). *e*. Var. D–E at 54 mm diameter (× 3). *f*. Var. E–F at 29 mm diameter (× 5). *g*. Var. D at 34 mm diameter (× 3). *h*. Var. E at 56 mm diameter (× 3). *i*. Var. G at 16 mm diameter (× 5). *j*. Var. F at 16 mm diameter (× 8). *k*. Var. F at 39 mm diameter (× 3). All specimens from Mowry shale at USGS loc. 23021, Park County, Wyo., except that of figure *a*, which is from USGS loc. 17173, Park County, Wyo.

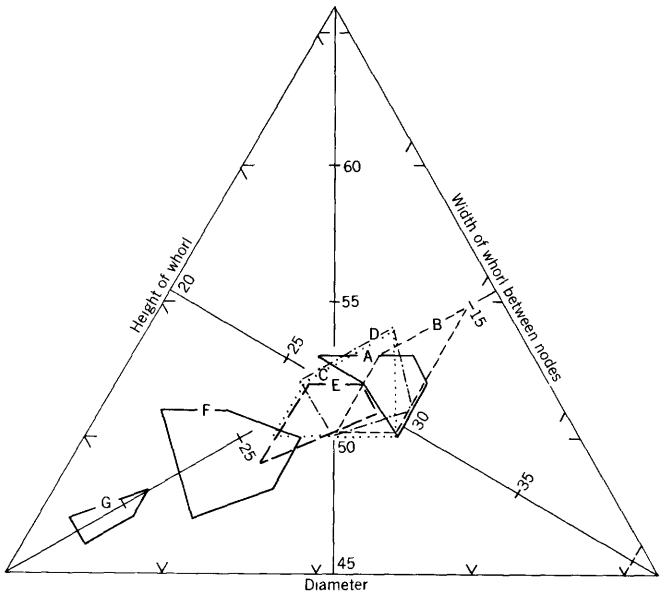

FIGURE 16.—*Neogastroplites cornutus* (Whiteaves). Proportions of the shell in seven variants as indicated by measurements of the diameter of the shell, the height of the whorl, and the width of the whorl between nodes. The point indicating the measurements falls within the enclosure lettered to correspond with the variant.

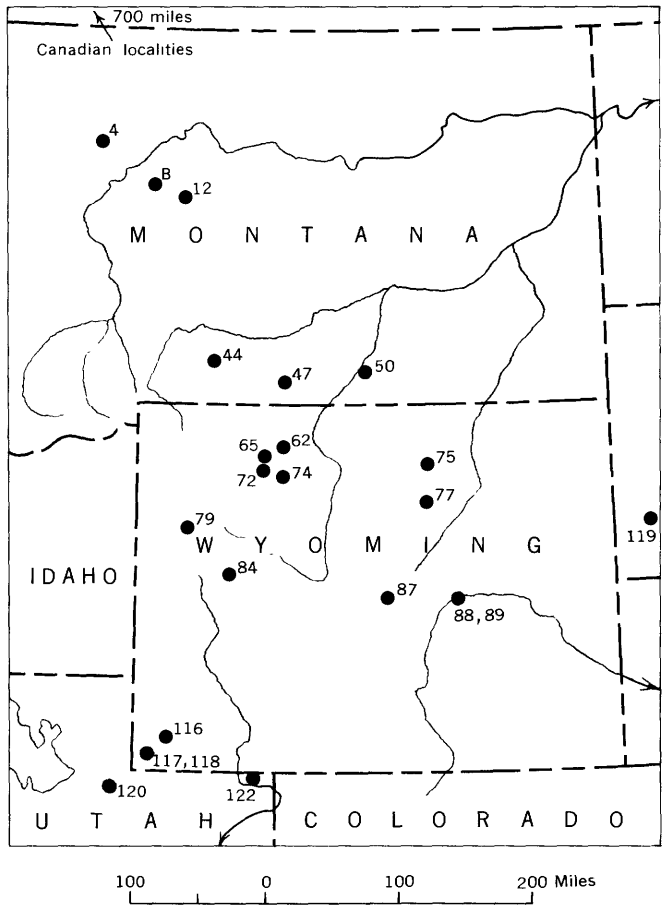

FIGURE 17.—Localities of *Neogastroplites cornutus* (Whiteaves).

Early whorls to about 4 mm diameter for shell smooth. Then faint low rounded ribs appear on the flanks; venter smooth and umbilicus smooth. At 8 mm diameter these ribs are distinct and extend with a shallow sigmoid curvature from the margin of the umbilicus across the flank to the margin of the venter, where they bend forward and across the venter with a forward convexity; most of the ribs divide into two near the umbilical shoulder and are highest at the margin of the venter and weakest at the middle of the venter. In immediately succeeding stages the part of the ribs near the umbilicus, the primary ribs, become weak and in many individuals are practically absent; the ventrolateral bend becomes a node and the ventral ribs remain weak. At 25 mm diameter there is a nearly smooth band near the umbilicus, the ribs on the outer part of the flank are distinct, the ventrolateral nodes are prominent, and the midventral ribs are very weak. At 45 mm diameter the ribs on the flanks are scarcely visible, the ventrolateral nodes are prominent, and the ventral ribs have vanished. Fragments representing larger individuals to perhaps 60 mm diameter show only rather weak ventrolateral nodes. Presumably larger individuals would be smooth rounded disks nearly if not entirely, indistinguishable from those of *N. cornutus* var. B. Rib counts of specimens from USGS loc. 23021 are:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
10	?	19±	25	12	25
10	12±	23	27	12	24
18	?	24	30	12	24
18	?	25	30	12	24
19	13±	27	33	12±	24
20	12	23	35	13	25
20	11	25	40	12	24±
21	11±	26	47	?	24
24	10±	23			
24	11	23	Average	12	24

The suture is that of the genus (see text figs. 14*b*, *e*).

Remarks.—*Neogastroplites cornutus* var. A is characterized by the much compressed whorls, gently convex venter, weakness of the ornamentation at all stages and disappearance from the shell, except for the ventrolateral nodes, of all ornamentation at an early stage (less than 40 mm diameter). It has somewhat weaker and less persistent sculpture and a somewhat narrower venter than *N. cornutus* var. B.

Figured specimens.—USNM 129320a, 129321–129328.

Neogastroplites cornutus var. B

Plate 5, figures 4–6; plate 16, figures 17–19; plate 17, figures 1–22; plate 18; plate 19; plate 20, figures 1–4; plate 21, figure 1; text figures 14*a*, *c*, *i*

Neogastroplites cornutus var. B is represented by 313 specimens from 9 localities. The largest specimen available, a crushed individual, is estimated at 540 diameter (plate 18). Another crushed individual, almost entirely septate, is 260 mm in diameter (plate 19). Several natural molds, not collectable but associated with small individuals of this variant and apparently of it, are reported by W. R. Hansen (written communication) to be more than 600 mm in diameter (pl. 21, fig. 1). The larger shells in hand form a compressed disk with rounded margins.

Cross section of whorls to 3 mm diameter for shell depressed oval, at 6 mm diameter subcircular, at 10 mm diameter compressed oval, with flanks and venter tending to flatten. At 15 mm diameter umbilical and ventrolateral shoulders defined and cross section of whorl high trapezoidal. Though all large specimens are crushed, the form appears to remain much the same, except that the whorls become proportionately higher. At about 70 mm diameter venter is still gently arched; at 100 mm diameter, a half whorl later, venter is evenly rounded and relatively narrow, with flanks only slightly convex. At larger diameters venter is broadly rounded and flanks gently convex, with a faint pinching near the venter. Umbilicus very small throughout. Measurements of 20 specimens from USGS loc. 23021 are as follows:

Diameter of shell (mm)	Figure No. on pl. 17	Whorl				Width of umbilicus		Width of venter	
		Height		Width					
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
10		5.5	55	4.5	46	2.5	25	3	30
12	4–6	6.5	54	5	42	3±	25	3±	25
14	7–9	8	56	6	43	3±	21	4±	28
16		9	56	7	44	4	25	5	31
18		10	56	7	39	4.5	25	5	28
21		11	52	8	38	5	24	6	29
24		13	54	8	33	5	21	6	25
26		14.5	54	9	35	5.5	21		
26		14	54	9.5	35	6	23	6.5	25
27		16	59	11	41	6	22	7	26
28	13, 14	15.5	56	10	36	5.5	20	6.5	23
30	19–21	17.5	58	11	37	6	20	6	20
30		17	57	11	37	6	20	7	23
37	10–12	21	57	12.5	34	7	19	7	19
40		23	58	14.5	36	9	23	10	25
48		27	56	17	37	9	19	10±	20
54		31	57	19	35	8.5	16	9	17
75		41	57	22	29	13	17	12	16
150		85±	63	45±	30	15±	10	15±	10
260[1]		145	56	70±	27	20	8	40±	16

[1] Figure 1 plate 19.

Early whorls to about 5 mm diameter for the shell smooth. Then faint rounded ribs, inclined forward, appear on the flanks; venter smooth, umbilicus smooth. In about a half whorl, to 10 mm diameter, the ribs extend from the umbilical region across the venter, turning sharply forward at the ventrolateral margin and crossing the venter with a marked forward convexity and a marked weakening on the midventral line; some of the ribs divide into two near the umbilical margin and there are some simple ribs; the lateral ribs have a shallow sigmoid trend. At about 15 mm diameter the ribs begin to thicken at the ventrolateral margin to form a node and they are weak near the umbilicus and on the midline of the venter. At 20 mm diameter the inner part of the flank is smooth, the ventrolateral nodes have elongated diagonally forward, and the venter is nearly smooth. The ribs progressively weaken until at about 50 mm diameter the ribs on the outer part of the flank are only broad undulations and the sculpture consists essentially of the strong ventrolateral nodes. Between 50 and 100 mm diameter the ventrolateral nodes fade into weak undulations and above 100 mm diameter the whorls are essentially smooth. Rib counts of specimens from USGS loc. 23021 are as follows:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
10	10	24±	27	10	25
11	11	26	27	13	28
12	?	26	30	12±	26±
17	11	23	40	11±	21
18	12±	25	48		21
18	13	27			
22	12	23	Average	12	25
22	12	24			

The suture is that of the genus (see text figs. 14*a*, *c*, *i*).

Remarks.—*Neogastroplites cornutus* var. B is characterized by compressed whorls, distinct sculpture of the earlier stages that weakens progressively until at diameters above 50 mm only the ventrolateral nodes persist, and these fade out at about 100 mm diameter. It differs from *N. cornutus* var. A in the stronger and more persistent ornamentation and somewhat stouter shell. It is less stout and more weakly ornamented than *N. cornutus* var. C. The weakness of the ornamentation at any given diameter distinguishes it from most forms of *Neogastroplites*.

Figured specimens.—USNM 129320b, 129329–129344.

Neogastroplites cornutus var. B-C, transitional variant

Plate 5, figures 7–9; plate 20, figures 5–9; text figure 14*h*

Neogastroplites cornutus var. B-C is represented by 51 specimens from one locality. It is somewhat stouter and somewhat more strongly ornamented than *N. cornutus* var. B and is thus transitional to var. C.

Measurements of three specimens from USGS loc. 23021 are as follows:

Measurements of three specimens

Diameter of shell (mm)	Whorl				Width of umbilicus		Width of venter	
	Height		Width					
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
26	14	54	11	42	5	19	6	23
26.5 [1]	15	57	11	42	6	23	7	27
42	25	60	17	40	8	19	11	26

[1] Figures 8 and 9 on plate 20.

Rib counts

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
20	15	25
29	?	23
30	?	24
32	0	26
Average		24

Figured specimens.—USNM 129320c, 129345–129347.

Neogastroplites cornutus var. C

Plate 5, figures 10–12; plate 21, figures 2–4; plate 22, figures 1–17; text figures 14*f*, *g*

1931. *Metoicoceras whitei* Reeside and Weymouth (not Hyatt), U. S. Natl. Mus. Proc., v. 78, art. 17, p. 22, pl. 4, fig. 4 (not figs. 1–3, 5–7).

1931. *Metoicoceras* sp. Reeside and Weymouth, idem, p. 23, pl. 2, fig. 1.

Neogastroplites cornutus var. C is represented by 608 specimens at 11 localities. The largest available shells, crushed, are about 80 mm in diameter, though it is doubtful that larger individuals could be separated readily from *N. cornutus* var. B. Shell at 60 mm diameter a compressed disk with truncated venter.

Cross section of whorl to 3 mm diameter for shell depressed oval. At about 6 mm diameter cross section is subcircular; at 9 mm diameter high oval; at 10 mm diameter flanks and venter are tending to flatten; and at 12 mm diameter cross section is trapezoidal, with umbilical and ventrolateral shoulders distinct, flanks and venter gently arched, umbilical wall steep. Cross section in available individuals to 60 mm diameter remains much the same except that height increases proportionately and ventrolateral shoulders become sharp; umbilicus remains narrow and deep. Measurements of 15 specimens from USGS loc. 23021 are as follows:

Diameter of shell (mm)	Figure No. on pl. 22	Whorl				Width of umbilicus		Width of venter	
		Height		Width					
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
10.5	1–3	5.5	52	5	48	2±	19	3	29
14		8	57	6	43	4.5	32	4	28
16	4–6	9	56	7	44	4	25	5	31
18	10, 11	9	50	7.5	42	5	28	6	33
20		11	55	8	40	4.5	23	5	25
21		11	52	9.5	45	5.5	26	6.5	31
25		15	60	10	40	5	20	7	28
26		14	54	10	38	7	27	7	27
27		15	56	10	37	6	22	7.5	28
31	7–9	17	55	11	36	7	23	7	23
33		18	55	13	39	9	27	8	24
35	12–14	18	51	12	34	8	23	8	23
39		21	54	15	38	8	21	9	23
45	15–17	25	56	16	36	10	22	11	24
45		24	53	17	38	11	25	11	25

Early whorls to about 5 mm diameter for shell smooth. Then low nodes appear on the flanks and at 6 mm diameter extend diagonally forward and across the venter as low rounded ribs. At 9 mm diameter the ribs thicken at the ventrolateral margin into a subdued node and cross the venter with gentle forward convexity and with the lowest point at the midventer; umbilicus smooth. The ribs appear on the umbilical margin as low primary ribs that divide immediately into two secondaries, though there are scattered simple ribs and a few intercalated secondary ribs; their trend is shallowly sigmoid. At 15 mm diameter the ventrolateral swellings have become distinct nodes inclined diagonally forward and well-preserved shells show fine striation parallel to the ribs. At 40 mm diameter the primary ribs have nearly disappeared near the umbilical shoulder but have become almost a radially elongated node near the middle of the flank; in the zone between the primary and the ventrolateral nodes the secondary ribs become very weak; on the venter, between the ventrolateral nodes, the ribs have become low rounded undulations. In the largest specimens available, about 60 to 80 mm in diameter, the ventrolateral nodes are still present, the venter appears to be merely undulated and without midventral thickenings, and the flanks are nearly smooth. The suggestion is strong that still larger forms of var. C would be nearly smooth shells like those of var. B, but perhaps thicker and with the ventrolateral tubercles more persistent. Rib counts of specimens from USGS loc. 23021 are as shown in table on the following page.

The suture is that of the genus (see text figs. 14, *f*, *g*).

Remarks.—*Neogastroplites cornutus* var. C is characterized by its only moderately compressed whorls,

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
15	12	23	33	12	23
19	12	24	35	11	22
20	13	24	38	14	24
21	12	23	44	13	22
23	12	22	48	11	20
26	12	23	50	14±	24
32	14	23	Average	13	23
32	13	23			

the strength of the primary ribs and their persistence as weak nodes to a diameter of 40 mm, and the lack of more than undulations on the venter at 60 mm diameter. It resembles *N. cornutus* var. B at similar diameters but is somewhat stouter and more strongly ornamented. It resembles *N. haasi* vars. A and B in form and weak ventral ornament but is more weakly sculptured on the flanks than either variety of *N. haasi*. In some features it suggests *Gastroplites spiekeri* McLearn (1933, p. 21, pl. 3, figs. 2, 3) but differs in its weaker ribs on the flanks and its stronger ventrolateral nodes. It also suggests in some features *G. allani* McLearn (1933, p. 18, pl. 1, figs. 6–8) but is more compressed and has weaker ribs and a gently arched venter.

Figured specimens.—USNM 73778, 129320*d*, 129348–129357.

Neogastroplites cornutus var. C-D, transitional variant

Plate 5, figures 13–15; plate 22, figures 18–20; text figure 14*d*

Neogastroplites cornutus var. C-D is represented by 89 specimens from one locality. It differs from var. C in the stronger primary ribs, which acquire strength at an earlier stage and persist longer. In the largest specimens available (50 mm diameter) a well-defined median ventral tubercle appears, which feature is transitional to var. D, and in which feature it differs from all variants of *N. haasi* and from all species of *Gastroplites*. Measurements of six specimens from USGS loc. 23021 are as follows:

Measurements of six specimens

Diameter of shell (mm)	Whorl				Width of umbilicus		Width of venter	
	Height		Width					
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
19	10	53	8	42	4	21	5	26
20	11	55	7.5	38	4.5	23	5	25
27	13.5	50	10.5	39	7	26	8	29
30	16.5	55	13	43	8	27	9	30
36	19	53	15	42	9	25	11	31
50 [1]	29	58	19	38	10	20	12	24

[1] Figures 18–20 on plate 22.

Rib counts

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
19	12	26
20	11	24
27	12	23
30	12	24
36	12	20
50	11	19
Average	12	23

Figured specimens.—USNM 129320*e*, 129358, 129359.

Neogastroplites cornutus var. D

Plate 5, figures 16–18; plate 10, figure 1; plate 22, figures 21–25; plate 23, figures 1–19; plate 24, figures 10, 11, 14; text figures 14*j*, *k*, 15*a*, *c*, *g*

Neogastroplites cornutus var. D has been identified by 817 specimens at 16 localities. The largest shells available are 60 to 70 mm in diameter, much crushed, and would apparently have been stout disks. The largest uncrushed specimen available is 52 mm in diameter.

Cross section of whorl to about 3 mm diameter for shell depressed oval; at 6 mm diameter subcircular. At 8 to 9 mm diameter venter and flank tend to flatten, and at 10 mm diameter the cross section of the whorl is trapezoidal, with umbilical and ventrolateral shoulders distinct, flanks and venter gently arched, umbilical wall steep. At about 17 mm diameter the venter begins to rise on the median line and the ventrolateral shoulders are sharp. At 30 mm diameter the cross section shows a sharp elevation on the median ventral line, and at 50 mm diameter the cross section is a high trapezoid, the ventrolateral shoulders sharp, and the umbilical wall steep. Measurements of 18 specimens from USGS loc. 23021 are as shown in the table on the following page.

Whorls to 3 mm diameter for shell smooth; then low nodes appear on flanks and at 5 to 6 mm diameter have become low rounded ribs extending diagonally forward on the flanks and across the venter with a gentle forward convexity and weakening on the median line of the venter. At 10 mm diameter ribs are strong, mostly dividing into two near the umbilicus, inclining forward on the flanks, bending forward sharply at the margin of the venter, and crossing the venter with forward convexity; ribs highest at ventral margin and weakest on median ventral line. At 12 mm diameter ribs begin to thicken at the ventral margin, and at 15 mm diameter have developed an inclined node there, and the ventral ribs begin to show a swelling on the median ventral line. At 30 mm diameter the ventral rib has a distinct rounded node on the median line. At 25 to 30 mm diameter

Diameter of shell (mm)	Figure No. on pl. 23	Whorl						Width of umbilicus		Width of venter			
		Height		Width									
				Over nodes		Between nodes				Over nodes		Between nodes	
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
11	1, 3, 5	6	55	5	45			3±	27	3±	27		
18		10.5	58	8.5	47			4.5	25	6	33		
19		10	53	8	42			4	21	6	32		
20		10	50	9	45	8	40	5	25	7	35	6.5	33
24	4, 7, 8	12.5	52	10	42	9	37	5	21	8	33	6.5	27
26	14, 15	14	54	12	46	11	43	7	27	9	35	7	27
27		15	56	12	44	10.5	39	6	22	9	33	8	30
27	2, 6, 9	15	56	12	44	10.5	39	6	22	9	33	8	30
27		14	52	10	37	9	33	6	22	7	26	6	22
27		15	56	11	41			6	22	7.5	28		
30		17	57	13.5	45	12	40	7.5	25	9	30	8	27
32	11–13	18	56	15	47	3	41	7	22	10	31	9	28
32		18	56	15	47	14	44	7.5	23	10	31	9	28
34		19	56	15	47	14.5	43	8	24	12	35	10.5	31
34		19	56	15	44	13	38	7	21	10	29	8.5	25
37		20	54	18	49			8	22	12	32		
41		21	51	18	44			9	22	12	29		
51	10, 17	30	59	20	39	18.5	36	10	20	12	24	10.5	21

the primary ribs move out on the flank and begin to rise into a radial node. In the subsequent stages to the largest available the lateral and ventrolateral nodes become high and well-marked, the median ventral nodes become high and somewhat elongated in the direction of the rib, and the primary and secondary ribs disappear. This ornamentation is nearly that of the type of *Neogastroplites cornutus* (see pl. 24, figs. 10, 11) and it is strongly suggested that larger shells would be much like that specimen, but perhaps more slender and less strongly ornamented. Rib counts of specimens from USGS loc. 23021 are as follows:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
18	11	22	32	12	22
19	11	26	32	12	20
20	12	20	34	10	20
24	12	24	34	13	21
26	11	20	37	12	22
26	12	22	41	12	21
27	13	22	51	11	19
28	12	23			
30	13	23	Average	12	22

The suture is that of the genus (see text figs. 14*j*, *k*, 15*a*, *c*, *g*).

Remarks.—*Neogastroplites cornutus* var. D is characterized by its only moderately stout whorls, the appearance of the lateral nodes at about 25 mm diameter for the shell and their persistence through the largest stage available (60 to 70 mm diameter), and the early appearance (at about 25 mm diameter) of nodes at the middle of the ventral ribs, in the larger specimens elongated parallel to the rib. It resembles *N. cornutus* vars. B and C in general form but differs in the greater strength of the ornamentation and particularly in the presence of the median ventral nodes. It is more compressed and less strongly sculptured than *N. cornutus* vars. E and F. It resembles *N. americanus* var. B and *N. maclearni* var. B in general form but differs in its more compressed shell, weaker ornamentation, and the presence of lateral nodes. It differs from all species of *Gastroplites* in sculpture, particularly in the ventral nodes.

Figured specimens.—USNM 129320*f*, 129360–129379.

Neogastroplites cornutus var. D-E, transitional variant

Plate 5, figures 19–21; plate 24, figures 7, 12, 13; text figures 15*d*, *e*

Neogastroplites cornutus var. D-E is represented by 100 specimens from one locality. It is intermediate between vars. D and E in stoutness of shell and strength of sculpture. The largest specimens available are about 60 mm in diameter and much crushed. Measurements of seven specimens from USGS loc. 23021 are as follows:

Diameter of shell (mm)	Whorl						Width of umbilicus		Width of venter			
	Height		Width									
			Over nodes		Between nodes				Over nodes		Between nodes	
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
17	9.5	56	8	47	7	41	4.5	26	6	33		
20	11	55	9.5	48	8	40	5	25	7	35	6	30
29	16	55	14	48	11.5	40	6.5	22	9	31	8	28
35[1]	19	54	16	46	12.5	36	8.5	24	11	31	9	26
40	22.5	56	18	45	15	38	8.5	21	13	33	11	28
40	22	55	18.5	46	16	40	9	23	13.5	34	10	25
55	30	55	25±	45	21±	38	14.5	26	15±	27	13±	24

[1] Figures 12 and 13 on plate 24.

Rib counts

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
17	12	20
20	11	24
29	13	22
35	11	20
40	12	20
50±	11	20
55	11	19
Average	12	21

Figured specimens.—USNM 129320*g*, 129380–129383.

Neogastroplites cornutus var. E

Plate 5, figures 22–27; plate 9, figures 3–8; plate 10, figures 2–4; plate 24, figures 1–6, 8, 9; plate 25, figures 1–16; plate 26, figures 1–4; text figures 15*b*, *h*

1885. *Buchiceras? cornutum* Whiteaves, Royal Soc. Canada Proc. and Trans., v. 2, sec. 4, p. 239.

1931. *Neogastroplites cornutus* (Whiteaves). McLearn, Royal Soc. Canada Trans., ser. 3, v. 25, sec. 4, p. 7.

1931. *Kanabiceras wyomingense* Reeside and Weymouth, U. S. Natl. Mus. Proc., v. 78, art. 17, p. 12, pl. 1, fig. 14 (inadvertently called *aspenanum* in plate description).

1933. *Neogastroplites cornutus* (Whiteaves). McLearn, Royal Soc. Canada Trans., ser. 3, v. 27, sec. 4, p. 22–24, pl. 2, fig. 4; pl. 4.

1951. *Neogastroplites wyomingensis* (Reeside and Weymouth). Cobban and Reeside, Am. Assoc. Petroleum Geologists Bull., v. 35, p. 1893.

1957. *Neogastroplites cornutus* (Whiteaves). Wright, *in* Arkell and others, Treatise on Invertebrate Paleontology, pt. L, Mollusca 4, Cephalopoda, Ammonoidea, p. L400.

Neogastroplites cornutus var. E is represented by 617 specimens from 13 localities. The largest uncrushed shell available in the collections under study is about 70 mm in diameter, but fragments and crushed shells suggest a maximum diameter of 110 mm. The Canadian type specimen of the species (McLearn, 1933, fig. 4; this paper, pl. 9, fig. 6), which the writers refer to var. E, is about 70 mm in diameter, but another specimen figured by McLearn (1933, pl. 4; this paper, pl. 10, fig. 4) is about 150 mm in diameter.

Cross section of whorl up to 5 mm diameter for shell depressed oval; at 7 mm diameter venter and flanks begin to flatten; at 10 mm diameter cross section is trapezoidal, with umbilicus and ventrolateral shoulders defined. At 15 mm diameter cross section is approaching hexagonal, with lateral angles sharp and venter well arched. At 30 mm diameter it is hexagonal and apparently remains so at larger diameters, with the angles rising higher and the inner spaces concave. Umbilicus small and umbilical wall steep throughout. Measurements of 22 specimens from USGS loc. 23021 are as shown in table on the following page.

Whorls to about 3 mm diameter for shell smooth; then low nodes appear on the flanks and at 4 mm diameter extend across the venter as dim rounded ribs; these rapidly become distinct and at 10 mm diameter are short primary ribs on the umbilical shoulder that mostly divide into two secondary ribs inclined forward on the flanks, bent sharply forward at the margin of the venter, and crossing the venter with forward convexity. At 12 mm diameter the ribs begin to rise into nodes at the ventrolateral margin and at 15 mm diameter the primary ribs begin to rise into lateral nodes. Between 15 and 30 mm diameter the primary nodes move outward on the flanks and the ventrolateral nodes become high and elongated diagonally

Diameter of shell (mm)	Whorl						Width of umbilicus		Width of venter			
	Height		Width									
			Over nodes		Between nodes				Over nodes		Between nodes	
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
12	6	50	6.5	54	5.5	46	3.5	29	5	42	4.5	37
16	8.5	53	8	50	7	44	4	25	6	38	5	31
16.5	8.5	51	9	55	8	48	5	30	6	36	5.5	33
17	8.5	50	9	53	7	41	5	29	6.5	38	6	35
18	9	50	9	50	8	44	5.5	31	6.5	36	6	33
18	9	50	9.5	53	8	44	5	28	6.5	36	6	33
19	10	53	11	58	9.5	50	6	32	7.5	39	6.5	34
24	13	54	12.5	52	11	46	7	29	9.5	40	8±	33
25	13.5	54	13	52	11	44	7	28	9.5	38	8.5	34
27	14	52	13	48	12	44	7	26	9	33	7.5	28
30 [1]	16	53	14	47	12	40	8	27	9	30	7	23
39	21	54	19	49	16	41	10	26	13.5	35	11.5	29
40	21	53	19	48	16	40	9	23	13.5	34	11	29
42	22	53	19	52	16	38	9.5	23	15	36	13	31
46	25	56	23	51	19	42	8.5	19	17	38	13	28
46 [2]	25	54	22	48	18	39	9	20	16	35	12	27
49 [3]	27	55	27	55	20	45	10	20	19	39	13	27
50	26	52	27	54	22	44	11	22	19	38	13	26
54	30	56	27	50	21	39	11	20	19	35	15	28
54	29	54	26	48	21	39	11	20	18	33	15	28
56	31	55	28	50	24	43	12	21	21	37	17	30
59	31	53	28	48	24	41	12	20	23	39	17	29

[1] Figures 1–3 on plate 25.
[2] Figures 4–6 on plate 25.
[3] Figures 10 and 11 on plate 25.

forward. At 30 mm diameter there is a nearly smooth zone near the umbilical shoulder and the secondary ribs on the outer part of the flanks have become weak; the ventral ribs are broad undulations with a distinct low node on the median ventral line. At larger diameters the nodes become accentuated and the intervening ribs weaker. On the largest individuals available the lateral nodes are subpyramidal, with a sharply truncated anterior face; the ventrolateral nodes are long compressed diagonal elevations, with a truncated anterolateral face; and the median ventral nodes rise somewhat like the end of a finger, compressed parallel to the rib, with a flat posterior face, and lie behind the growth lines that connect the pairs of ventrolateral nodes. In some individuals the lateral and ventrolateral nodes are connected by "lautiform" ribs that form a zigzag pattern. (see particularly pl. 25, figs. 10, 11). Rib counts of specimens from USGS loc. 23021:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
12	12	21	40	10	18
16	11	21	40	13	21
16	12	21	45	12	19
16.5	11	22	48	11	19
17	12	21	48	11	17
18	11	22	50	10	17
18	11	21	53	11	16
19	12	22	54	11	16
24	12	22	58	11	16
25	12	23	62	11	16
28	10	20	70	11	17
30	12	20	85	10	15
35	13	21			
40	10	20	Average	11	19

The suture is that of the genus (see text figs. 15*b*, *h*).

Remarks.—*Neogastroplites cornutus* var. E is characterized by its stout whorls, the appearance of lateral nodes at a diameter of 12 mm and of ventral nodes at 20 mm diameter. It differs from *N. cornutus* var. D in its stouter shell and stronger sculpture, and from var. F in its less stout shell. Shells of var. E are indistinguishable from the type specimen of *N. cornutus*. It resembles somewhat *N. americanus* var. C at similar diameters but differs in its weaker and more distant ribs and its stronger median ventral nodes. It resembles in form *N. muelleri* var. E but differs in its stronger sculpture.

Figured specimens.—USNM 73773, 129320*h*, *i*, 129384–129395, 129523.

Neogastroplites cornutus var. E-F, transitional variant

Plate 5, figures 28–33; plate 26, figures 5–12; text figure 15*f*

Neogastroplites cornutus var. E-F is represented by 107 specimens from two localities. It differs from *N. cornutus* vars. E and F in that it is intermediate in stoutness of shell and strength of ornament. The largest specimens available are about 50 mm in diameter and all have the latest part more or less crushed. Measurements of five specimens from USGS loc. 23021 and one (40 mm) from USGS loc. 23410 are as follows:

Diameter of shell (mm)	Whorl						Width of umbilicus		Width of venter			
	Height		Width									
			Over nodes		Between nodes				Over nodes		Between nodes	
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
19	10	53	11.5	65	9.5	50	5	26	8	42	6.5	34
26	14	54	17	65	13	50	7	25	10	38	8	31
35	19.5	56	18	51	15	43	8	23	13	37	10.5	30
39	21	54	21	54	18	46	8	25	13±	33	10±	26
40 [1]	22	55	21	52	17	43	9	22	15	38	13	32
41 [2]	22	54	22	54	16	40	10	24	14	34	11	27
44	24.5	56	22	50	18	41	11	25	18	41	13	29

[1] Figures 11 and 12 on plate 26.
[2] Figures 5–7 on plate 26.

Rib counts

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
19	11	20	41	12	20
26	10	20	44	11	19
35	11	18			
39	8	15	Average	10.5	17
40	11	19			

Figured specimens.—USNM 129320*j*, *k*, 129396–129400.

Neogastroplites cornutus var. F

Plate 5, figures 34–39; plate 26, figures 13–23; plate 27; plate 28, figures 1–4, 7; text figures 15*j*, *k*

Neogastroplites cornutus var. F is represented by 119 specimens from five localities. The largest individuals, all more or less crushed and imperfect, reach a measurable diameter of 120 mm, but must have been as much as 150 mm in life. Shell a very stout disk in general form.

Cross section of whorl depressed oval to 7 mm diameter for shell; at 9 mm diameter the flanks and venter are distinctly flattened and the cross section is a low trapezoid; at 11 mm diameter the cross section is a somewhat depressed hexagon. At larger diameters the cross section of the whorl remains much the same, except that the hexagon becomes more depressed, the angles prominent, the sides between the angles concave, and the development of the median ventral node adds an additional angle as growth proceeds. Umbilicus small and umbilical wall steep throughout. Measurement of 13 specimens from USGS loc. 23021 are as follows:

Diameter of shell (mm)	Figure No. on pl. 26	Whorl						Width of umbilicus		Width of venter			
		Height		Width									
				Over nodes		Between nodes				Over nodes		Between nodes	
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
9.5	13, 14	4	42	5.5	58	5	53	3	32	3.5	37	3±	32
14		6.5	46	8	57	7	50	4	27	6.5	46	5.5	39
16	18–20	7.5	47	10	63	8.5	53	5	31	6.5	41	6	37
20		10.5	53	13.5	68	11	55	5.5	28	9	45	7.5	38
23		10.5	46	14	61	12	52	7	30	10	42	8	35
24	15–17	12	50	15.5	69	13	54	8	33	12	50	10	42
25		13	52	19	76	15	60	7	28	12	48	10	40
27		14	52	18	67	14	52	8	30	12	45	10	37
29		16	55	20±	69	15±	52	8	28	12.5	43	10	34
33		17.5	53	21	64	15	45	8	24	14±	42	11	33
40		21.5	54	29	73	22	55	11.5	29	17.5	44	14	35
44	21–23	24	55	27	61	21.5	49	10	23	18.5	42	14	32
63		33.5	53	36	57	30	48	13	21	26.5	42	19	30

Whorls to about 3 mm diameter for shell smooth; at 4 mm diameter lateral nodes and dim ventral ribs are present; at 7 mm diameter the ribs are broad but distinct folds from the umbilical shoulders across the venter; at 9 mm diameter the primary ribs are nodelike swellings on the umbilical shoulder, from each of which two ribs pass diagonally across the flank and with forward convexity across the venter and are somewhat weaker on the venter. At about 10 mm diameter the ribs acquire a weak node at each margin of the venter and at 15 mm diameter the primary ribs have moved outward on the flank and become sharp nodes and the ventrolateral nodes have become high and distinct. At about 20 mm diameter

the ventral ribs acquire a thickening on the middle of the venter. At larger diameters the chief changes are the weakening of the ribs, the strengthening of the lateral and ventrolateral nodes into sharp protuberances, and the development of strong nodes compressed parallel to the ribs at the middle of the venter. In the largest specimens the lateral elevations are subpyramidal, with a truncated anterior face; the ventrolateral elevations are elongated diagonally, with a truncated anterior face; and the median ventral elevations are high and elongated parallel to the ribs, with a truncated posterior face, and lie behind the growth lines that connect the ventrolateral elevations. Rib counts of specimens from USGS loc. 23021:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
14	12	20	33	9	16
16	11	20	40	8	14
20	9	21	44	8	13
23	11	20	63	9	15
24	10	19	115±	9±	15±
25	8	17			
27	10	20	Average	9	17
29	9	18			

The suture is that of the genus (see text figs. 15*j*, *k*).

Remarks.—*Neogastroplites cornutus* var. F is characterized by its very stout whorls, the appearance of the lateral nodes at a diameter of 9 mm and of the median ventral nodes at about 15 mm diameter. It differs from var. E in its greater stoutness, earlier appearance of the nodes, and stronger ornamentation. It is much like the type of *N. cornutus* but is stouter. It resembles somewhat *N. americanus* var. C, but differs greatly in its weaker and more distant ribs and its stronger median ventral nodes. It differs from *N. muelleri* var. F in its coarser ribs, stronger and more elongated median ventral nodes, and less distinct ribs at equal diameters.

Figured specimens.—USNM 129320*l*, *m*, 129401–129409.

Neogastroplites cornutus var. G

Plate 5, figures 40–42; plate 28, figures 5, 6, 8–10; text figure 15*i*

Neogastroplites cornutus var. G is extremely rare, only a few individuals from 3 localities being known, but its presence testifies to the existence in the *N. cornutus* assemblage of an apparently attenuated subglobose spinose element. The largest individual is about 25 mm in diameter.

Cross section of whorl to 5 mm diameter for shell depressed oval. At larger diameters it is like the cross section of a biconvex lens. Measurements of two specimens from USGS loc. 23021 (16 and 22 mm) and two from loc. 23410 (15 and 22 mm):

Diameter of shell (mm)	Whorl						Width of umbilicus		Width of venter	
	Height		Width							
			Over nodes		Between nodes					
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
15	7	47	13	86	10.5	70	5	33	8	33
16	8	50	12.5	78	10	63	5.5	34	8	50
22 [1]	10	45	19	86	15	68	8	36	11.5	52
22	10.5	48	16.5	75	13	59	7.5	34	11	50

[1] Figures 5, 6 and 8 on plate 28.

Whorl to 2 or 3 mm diameter for shell apparently smooth; between 3 and 4 mm diameter ribs appear on the flanks. At 5 mm diameter, the earliest stage at which the venter is shown, strong ribs extend from the umbilical shoulder across the venter, inclining forward on the flanks and crossing the venter with even height and strong forward convexity. At 10 mm diameter the primary ribs on the flanks and the ribs on the ventrolateral shoulders have risen into subdued nodes. At 15 mm diameter the primary ribs are blunt spines, the ventrolateral nodes are distinct elevations inclined diagonally forward, and a weak node has appeared on the rib at the median ventral line. At the largest diameters known (22 to 25 mm) the primary spines have moved out on the flanks and the outer part of the flank is nearly continuous with the venter, so that the two make a broad curved outer surface from lateral node to lateral node from which the ventrolateral and median ventral nodes rise. Rib counts:

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
15	9	20
16	11	19
22	8	18
22	9	20
Average	9	19

The suture is that of the genus (see text fig. 15*i*).

Remarks.—*Neogastroplites cornutus* var. G is characterized by its subglobose shell, with broad ventral aspect, and its blunt lateral spines. Its form separates it from other variants of *N. cornutus*. It is somewhat similiar to *N. americanus* vars. D and E but differs in its coarser and much stronger sculpture at the same diameters; it is also similar to *N. muelleri* var. G,

but is broader ventrally at the same diameters, develops the median ventral node much earlier, and has more arcuate ribs. It differs from *N. haasi* var. F in the position of the lateral spines, the coarser ribs, and the median nodes; it differs from *N. maclearni* var. E in its coarser ribs and less stout shell.

Figured specimens.—USNM 129320*n*, 129410–129413.

Neogastroplites muelleri Reeside and Cobban, n. sp.

Plate 30, figures 10–12; plate 40, figure 7; plate 42, figures 11, 12; text figures 18–22

As is true of other species of *Neogastroplites* here considered, the range in *N. muelleri* of form and ornamentation precludes any simple statement of characters. The most distinctive features are its relatively coarse sculpture, weak on the middle of the flank, and gently convex venter with weak ribs convex forward; in the compressed costate variants relative persistence of traces of the primary ribs and median ventral elevations, but eventual development of smooth whorls; in stout nodose variants weakness of the lateral and ventral nodes; and in subglobose spinose variants the moving outward of the lateral nodes until the outer part of the flank and the venter are a nearly flat surface and the weakness of the median ventral nodes.

Neogastroplites muelleri differs from *N. haasi* Reeside and Cobban in its weak sculpture, presence of median ventral nodes in all but the most compressed variants, and in subglobose variants the moving out of the lateral nodes toward the venter. It differs from *N. cornutus* (Whiteaves) in the costate variants by stronger sculpture near the umbilicus and weaker sculpture on the middle of the flank, in the stout variants by weakness of the lateral and ventral nodes, and in the subglobose forms by their relative abundance at most localities. It differs from *N. americanus* (Reeside and Weymouth) in the much weaker and coarser sculpture, in the arched nontabulate venter with weak ribs, and in the stout and subglobose variants in the coarser sculpture. It differs from *N. maclearni* Reeside and Cobban in the weaker sculpture and arched venter.

The writers have found it convenient to describe below seven variants, to which the letters A to G are applied. Because of the large number of specimens available, some of the variants include subvariants numerous enough to deserve record. It is notable that the compressed costate portion of the assemblage has expanded to three-quarters of the total (75 percent), whereas the stout nodose portion has shrunk to a small amount (9 percent) as compared with *N. cornutus*, and the subglobose spinose portion has again appeared in some strength (16 percent). One very large lot is available and four others provide samples that suggest that this general composition is probably near the normal one. Table 8 shows the distribution of the variants.

The suture line of the species is that of the genus. External sutures of all the variants and several internal sutures are shown in figures 18, 19, and 20.

TABLE 8.—*Distribution of Montana specimens of* Neogastroplites muelleri *by locality, variant, and size*

USGS Mesozoic locality No.	Map No.	Diameter of shell (mm)	Number of specimens for indicated character group and variant																Total
			Compressed costate							Stout nodose					Subglobose spinose				
			A	A–B	B			B–C	C	C–D	D			D–E	E	E–F	F	F–G	G	
					Normal	Coarse	Stout				Normal	Weak	Stout							
24705	7	<25			1				4						4		0			9
		25–50			5				20						7		6			39
		>50			0				2						0		0			2
		Total			6				26						11		6			50
24917	16	<25			2				3		0				1				0	6
		25–50			0				2		5				4				2	13
		>50			1				0		0				0				0	1
		Total			3				5		5				5				2	20
24601	17	<25			0												1			1
		25–50			3												0			3
		>50			0												0			0
		Total			3												1			4
26224	18	<25			5				1								4			10
		25–50			6				5								1			12
		>50			2				2								0			4
		Total			13				8								5			26
24065	20	<25	105	11	472	15	0	0	73	0	41	0	1	1	82	7	195	28	117	1,148
		25–50	70	8	1,035	185	5	25	418	11	67	2	0	11	26	4	66	56	111	2,100
		>50	1	1	162	15	5	18	185	8	40	2	0	4	3	2	3	0	11	460
		Total	176	20	1,669	215	10	43	676	19	148	4	1	16	111	13	264	84	239	3,708
24417	21	<25									0						1			1
		25–50									2						0			2
		>50									0						0			0
		Total									2						1			3
24418	22	<25			1				0		0				1		2		2	6
		25–50			0				2		0				1		0		1	4
		>50			0				2		1				0		0		0	3
		Total			1				4		1				2		2		3	13
24419	23	<25			0															0
		25–50			0															0
		>50			1															1
		Total			1															1
24605	32	<25			1				0		3				1				1	6
		25–50			2				5		1				2				0	10
		>50			1				1		0				1				0	3
		Total			4				6		4				4				1	19
Grand total			176	20	1,700	215	10	43	725	19	160	4	1	16	133	13	279	84	246	3,844

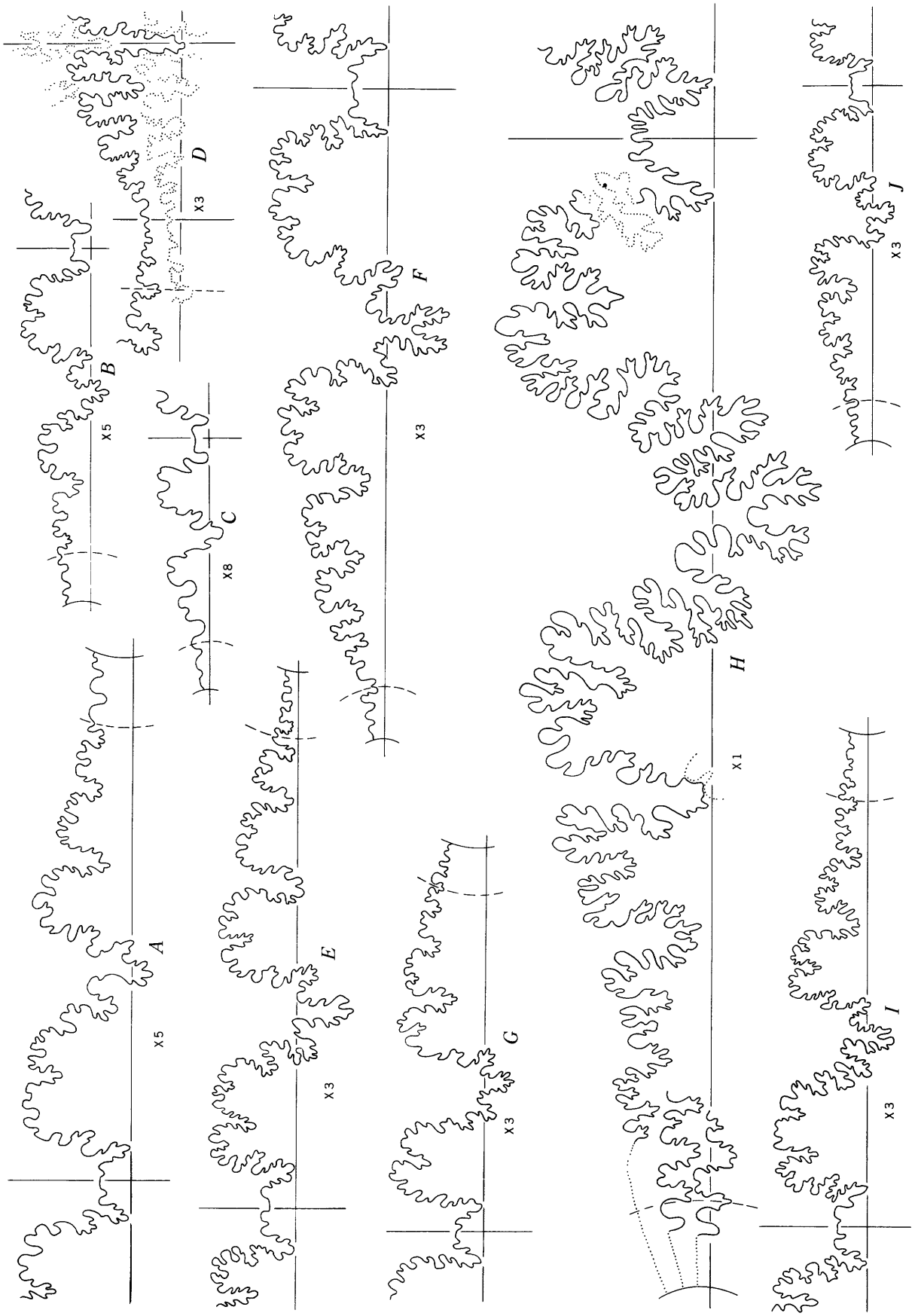

FIGURE 18.—Sutures of *Neogastroplites maclearni* Reeside and Cobban, n. sp., vars. A, A–B, B, and B–C. *a*. Var. A–B at 27 mm diameter (× 5). *b*. Var. A at 19 mm diameter (× 5). *c*. Var. B, normal, at 10 mm diameter (× 8) (see also pl. 29, figs. 15–17). *d*. Var. B, normal, internal and part of external suture at 55 mm diameter (× 3). *e*. Var. B, stout, at 48 mm diameter (× 3) (see also pl. 35, figs. 1, 2, 6). *f*. Var. B, normal, at 56 mm diameter (× 3) (see also pl. 31, figs. 4–6). *g*. Var. B, normal, at 33 mm diameter (× 3) (see also pl. 30, figs. 6, 7, 9). *h*. Var. B, normal, at 260 mm diameter (× 1). *i*. Var. B–C at 39 mm diameter (× 3) (see also pl. 36, figs. 1, 5, 10). *j*. Var. A at 32 mm diameter (× 3) (see also pl. 28, figs. 21–23). All specimens from the Colorado shale at USGS loc. 24065, Petroleum County, Mont.

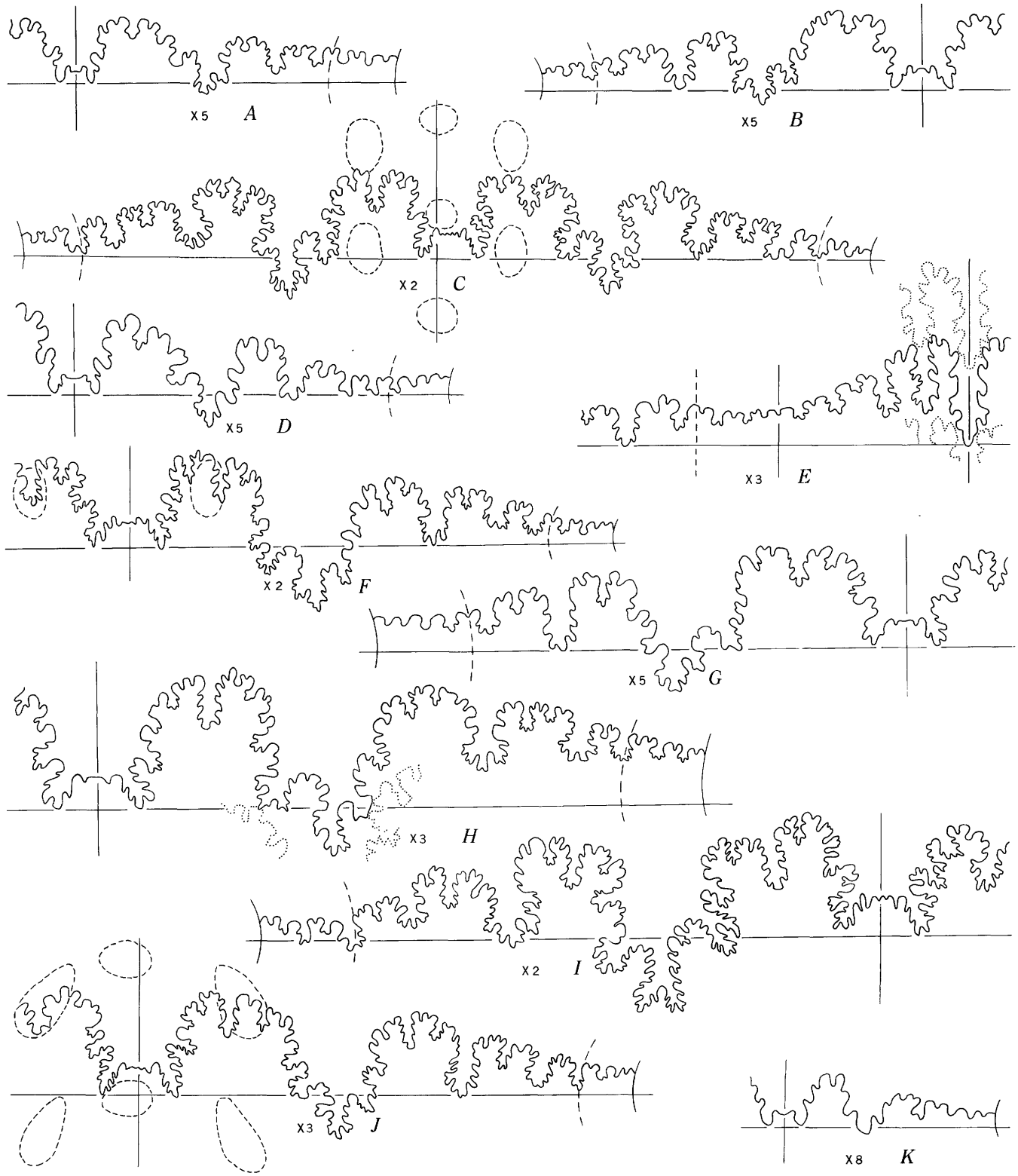

FIGURE 19.—Sutures of *Neogastroplites muelleri* Reeside and Cobban, n. sp., vars. C, C–D, D, D–E, and E. *a*. Var. D at 18 mm diameter (× 5); (see also pl. 38, figs. 10–12). *b*. Var. C at 20 mm diameter (× 5) (see also pl. 37, figs. 16, 17, 19). *c*. Var. C–D at 56 mm diameter (× 2); external suture displaced with respect to shell. *d*. Var. E at 18 mm diameter (× 5) (see also pl. 41, figs. 19–21). *e*. Var. C, internal and part of external suture at 50 mm diameter (× 3). *f*. Var. C at 65 mm diameter (× 2) (see also pl. 38, figs. 1–3). *g*. Var. C–D at 30 mm diameter (× 5) (see also pl. 38, figs. 16–18). *h*. Var. D at 53 mm diameter (× 3) (see also pl. 39, figs. 16–19). *i*. Var. E at 78 mm diameter (× 2) (see also pl. 42, figs. 6, 7, 9, 10). *j*. Var. D–E at 45 mm diameter (× 3) (see also pl. 41, figs. 4, 5, 11). *k*. Var. D at 6.5 mm diameter (× 8) (see also pl. 38, figs. 7–9). All specimens from the Colorado shale at USGS loc. 24065, Petroleum County, Mont.

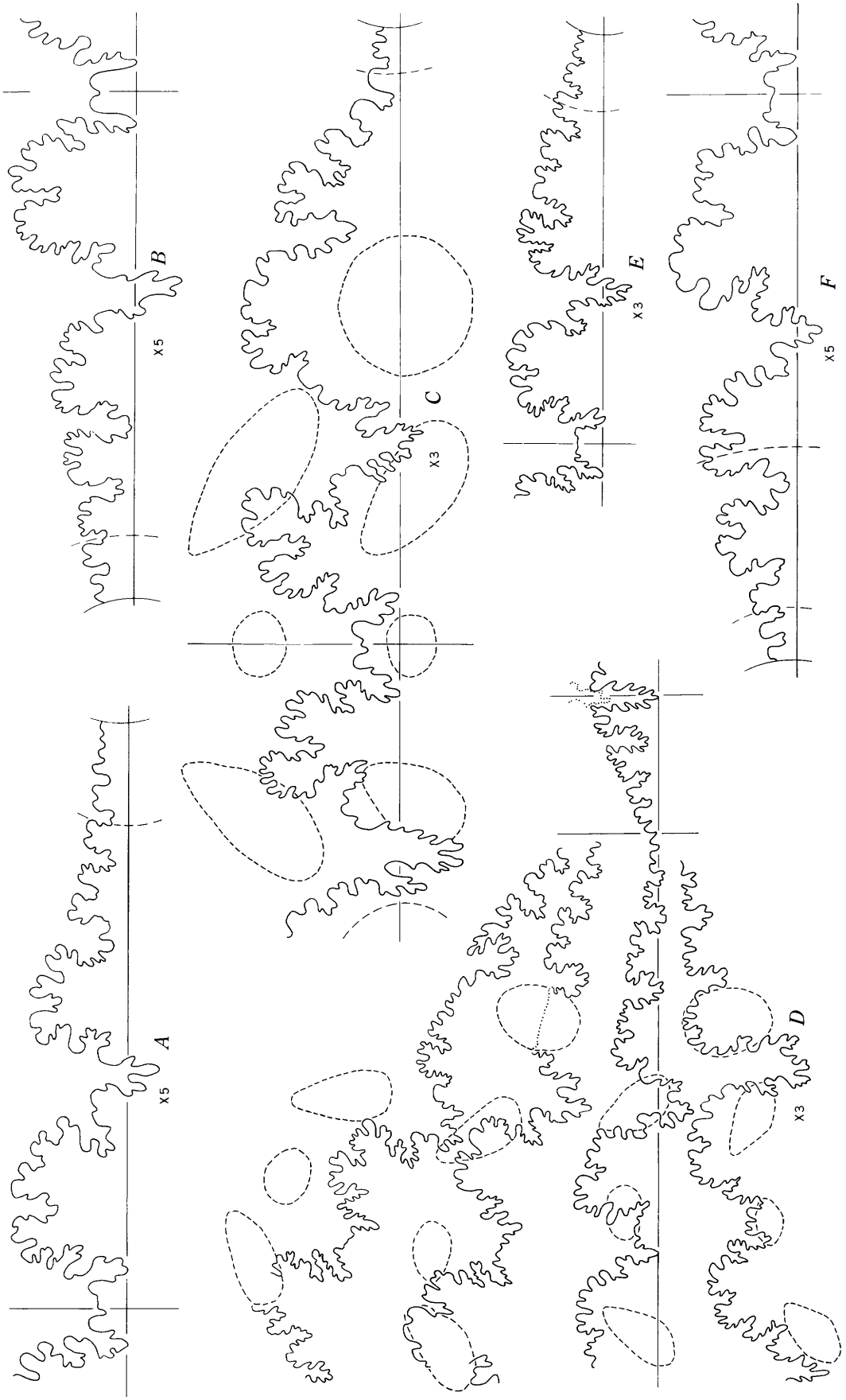

FIGURE 20.—Sutures of *Neogastropilites muelleri* Reeside and Cobban, n. sp., vars. E–F, F, F–G, and G. *a*. Var. F at 26 mm diameter (× 5). *b*. Var. G at 24 mm diameter (× 5) (see also pl. 44, figs. 16–18). *c*. Var. G at 45 mm diameter (× 3) (see also pl. 45, figs. 13, 16, 17). *d*. Var. G at about 35 mm diameter (× 3); external and internal suture and three other external sutures illustrating accommodation of the sutures to the sculpture of the shell. *e*. Var. E–F at 35 mm diameter (× 3) (see also pl. 42, figs. 1, 2). *f*. Var. F–G at 28 mm diameter (× 5), last suture of specimen. All specimens from the Colorado shale at USGS loc. 24065, Petroleum County, Mont.

The overlap of proportions of the shell in the variants is brought out in figure 21.

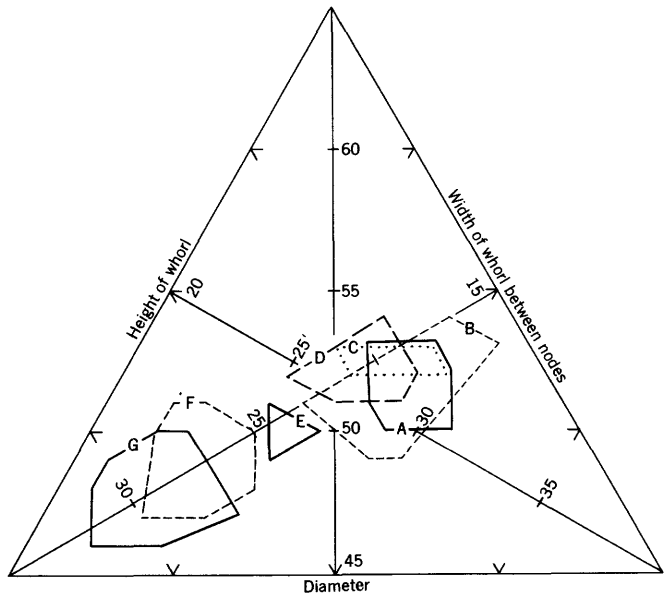

FIGURE 21.—*Neogastroplites muelleri* Reeside and Cobban, n. sp. Proportions of the shell in seven variants as indicated by measurements of the diameter of the shell, the height of the whorl, and the width of the whorl between nodes. The point indicating the measurements falls within the enclosure lettered to correspond with the variant.

Occurrence.—As shown in table 8, *Neogastroplites muelleri* is known from 9 localities in Cascade, Fergus, Petroleum, and Wheatland Counties, Mont. Figure 22 shows the distribution of the localities.

Type specimen.—USNM 129432 (pl. 30, figs. 10–12).
Figured specimens.—USNM 129414, 129415.

Neogastroplites muelleri var. A

Plate 6, figures 1–6; plate 28, figures 11–23; plate 29, figures 1, 2, 7; text figures 18*b*, *j*

Neogastroplites muelleri var. A is represented by 176 specimens at one locality. The largest individual available, about 70 mm diameter, is probably nearly complete but crushed. Largest uncrushed individual, entirely septate, is about 55 mm in diameter. Shell a compressed disk. Umbilicus small. It is likely that shells above 75 mm diameter could not be distinguished from *N. muelleri* var. B.

Cross section of whorl to about 2.5 mm diameter for shell depressed oval, at 4 mm diameter subcircular, at 7 mm diameter high oval with flanks beginning to flatten. At 18 mm diameter the ventrolateral shoulders are distinct and the venter gently arched; umbilical shoulders poorly defined. At 20 mm diameter cross section of whorl is a high trapezoid, and this form continues into the largest shells available. Measurement of 15 specimens from USGS loc. 24065 are as follows:

Diameter of shell (mm)	Figure No. on pl. 28	Whorl				Width of umbilicus		Width of venter	
		Height		Width					
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
14		8	57	6	43	3	22	4	29
18		10	56	7	39	3.5	19	5	28
19.5		11	57	8	41	4	21	5	26
20		11	55	8	40	4	20	5.5	28
22		11.5	52	8	36	5	23	5.5	25
22	18–20	12.5	57	9	41	5	23	6	27
27		14	52	10	37	6	22	7	26
27		15	56	10	37	5	19	7	26
28		17	61	10.5	38	5.5	20	8	30
30		16.5	55	11	37	6	20	8	27
31		17	55	11.5	37	6	19	8	26
31	11, 12, 15	17	55	11	36	5	16	6.5	21
35		19	54	12	35	7	20	8	23
45	21–23	26	58	16	36	8	18	9.5	21
45	13, 14	26	58	15	33	7.5	17	9±	20

Whorls to about 9 mm diameter for shell smooth; then very faint ribs appear near the umbilicus and on the ventrolateral margin; at 12 mm diameter these are distinct, though weak on the middle of the flank and at the middle of the venter. At 20 mm there are well-defined primary ribs and ventrolateral swellings, but ribs on the middle part of the flank and middle

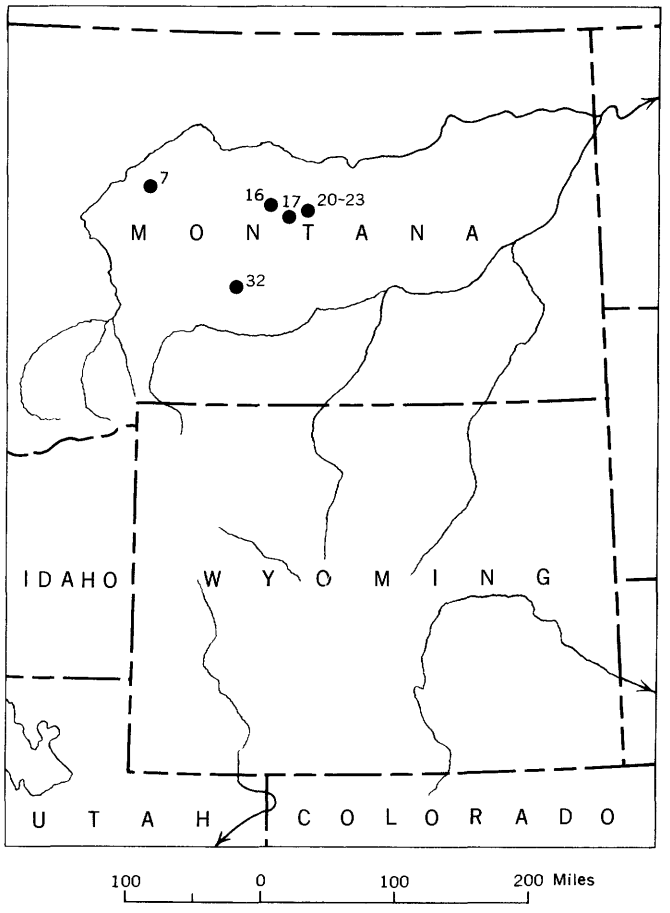

FIGURE 22.—Localities of *Neogastroplites muelleri* Reeside and Cobban, n. sp.

of the venter are weak. The primary ribs seem to divide mostly into two, though there are some intercalated ribs. Ornamentation remains much the same to the largest individual available—distinct though not strong primary ribs inclined forward, a nearly smooth zone on the middle of the flank, distinct though not strong ventrolateral nodes, and weak ventral ribs, convex forward and very weak at the middle of the venter. Large individuals would probably be smooth. Rib counts:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
20	13±	26±	31	11	30
22	11±	26	32	12	28
22	12	28	37	12	27
27±	10	23	46	12	26
27	12	30	53	13	26
27	13	27	70	12±	25±
27	13	28			
30	10	24	Average	12	27

The suture is that of the genus (see text figs. 18*b*, *j*).

Remarks.—*Neogastroplites muelleri* var. A is characterized by its much compressed form and weak ornamentation, particularly on the middle of the flank. It resembles *N. cornutus* var. A, but differs in the stronger ornamentation of the inner part of the flank. It differs from all the variants of *N. haasi*, *N. americanus*, and *N. maclearni* in its weaker ornamentation and from the last two in its gently arched nontabulate venter. It suggests somewhat *Gastroplites spiekeri* McLearn (1933, p. 21), but differs in its more compressed form and weaker sculpture.

Figured specimens.—USNM 129416*a*, *b*, 129417–129424.

Neogastroplites muelleri var. A-B, transitional variant

Plate 6, figures 7–9; plate 29, figures 3–5, 10, 11, 14; text figure 18*a*

Neogastroplites muelleri var. A-B is represented by 20 specimens at one locality. It differs from var. A in its stronger ornamentation at similar diameters, particularly on the flanks and venter, and from var. B in its weaker ornamentation. The largest available specimen is 70 mm in diameter and much crushed. The three variants A, A-B, and B are much alike and probably all pass into larger individuals with smooth shells that could not readily be separated. Measurements of six specimens from USGS loc. 24605 are as follows:

Measurements of six specimens

Diameter of shell (mm)	Whorl				Width of umbilicus		Width of venter	
	Height		Width					
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
16	9	56	7	44	3	19	4.5	28
23	12.5	54	9	39	4.5	20	6	26
28	16.5	57	10	34	5.5	19	8	28
31	18	58	11	35	6	19	8.5	27
33 [1]	18	55	13	39	6.5	20	8	29
37	22	59	14	38	8	21	9	24

[1] Figures 3–5 on plate 29.

Rib counts

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
16	12	29
23	11	25
28	13	31
31	11	27
32	11	27
37	13	27
Average	12	27

Figured specimens.—USNM 129416*c*, 129425–129428.

Neogastroplites muelleri var. B, normal

Plate 6, figures 10–12; plate 29, figures 6, 8, 9, 12, 13, 15–30; plate 30, figures 1–12; plate 31, figures 1–6; plate 32; plate 33, figure 1; plate 34; text figures 18*c*, *d*, *f–h*

Neogastroplites muelleri var. B, normal form, is represented by 1700 specimens from eight localities. It is accompanied by a small number of specimens with coarser sculpture and by a small number with relatively stout shells; these are described separately below. The largest specimen available of the normal var. B is a living chamber at a diameter of 500 mm. Another at 330 mm diameter is entirely septate, but apparently retains the last septum; proportionately a living chamber half a whorl in length would have made the shell nearly 500 mm in diameter. Several incomplete shells represent individuals 250 to 300 mm in diameter. The large shells form a smooth compressed-oval disk. Umbilicus small.

Cross section of whorl depressed oval to about 4 mm diameter for shell; subcircular at 8 mm diameter; high oval at 12 mm diameter, with flattened flanks, arched venter, umbilical and ventrolateral shoulders defined but well rounded, umbilical wall steep and flat. High oval cross section continues to about 25 mm diameter, increasing proportionately in height, the outer part of the flank nearly flat, the ventrolateral shoulders becoming sharper, and the venter well arched. At 40 mm diameter the cross section of the

whorl has a high subtrapezoidal form, with ventrolateral shoulders sharp, outer part of flanks slightly pinched to make a shallow depressed band on the shell, inner half of whorl rounded into the umbilicus, umbilical wall steep, venter well arched. This cross section of whorl continues to a diameter of about 100 mm, after which the ventrolateral shoulders become more rounded, the pinched outer zone of the flank more marked, the flanks gently arched, and the whole cross section again a high oval. This general form continues into the largest individuals available, with the modification that the whorl becomes proportionately wider. Measurements of 23 specimens from USGS loc. 24605 are as follows:

Diameter of shell (mm)	Figure No. on—					Whorl				Width of umbilicus		Width of venter	
						Height		Width					
	Pl. 29	Pl. 30	Pl. 31	Pl. 32	Pl. 33	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
9						4.5	50	4	45	2	22		
13						7.5	58	4	31	3	23	3.5	27
13						7.5	58	5	39	3	23	3.5	27
15						9	60	6.5	43	2.5	17	4.5	30
17						10	59	8	47	3	18	5	29
21	12, 13, 18					11	52	8	38	5	24	5	24
24	22–24					13.5	56	9	38	4.5	19	6	25
25	25–27					14	56	10	40	5	20	7	28
30						16.5	55	12	40	6	20	7.5	25
31						17	55	12.5	40	6	19	8	26
32						16.5	52	12	38	6.5	20	8	25
34						19	56	13	38	7	21	8	24
35						19.5	56	13	37	7	20	9	26
42						24	57	16	35	8	19	10	24
45		6, 7, 9				26	58	15	33	9	20	10	22
55		2, 4, 8				30	55	18	33	12	22	11	20
59			4–6			33	56	20	34	12	20	11.5	19
82		1, 3, 5				46	50	28	34	16	20	15	18
110		10–12				62	56	37	34	14	13	16.5	15
130						75	58	45	35	21	16	23	18
150			1–3			86	57	51	34	21	14	22±	15
260				1	1	140	54	80±	31	26	10		
330				1	1	185	56	120±	36	40	12		

Sculpture variable in earliest stages; in some specimens whorls to 15 mm diameter for shell are smooth, in others obscure sigmoid ribs appear on the flanks at 8 mm diameter but venter remains smooth. In most specimens at 15 to 18 mm diameter weak ribs rise on the inner part of the flank, incline gently forward and near the middle of the flank divide into two radially directed secondary ribs; these pass to the ventrolateral margin and bend sharply forward, then pass on to the venter with a gentle forward inclination but nearly disappear at the middle of the venter; the whole rib on the flank is sigmoid in trend and there are a few intercalated secondary ribs. At 20 mm diameter the ventrolateral bend begins to thicken and at 25 mm has become a distinct node; at the same stage the primary ribs become stronger and the ribs on the outer part of flank weaker. At 35 mm diameter the ventral ribs are distinct and remain so to a diameter of 120 mm, but do not acquire a median ventral node. The ribs on the flanks gradually weaken until at 100 to 120 mm diameter they are only broad obscure undulations connected with still distinct ventrolateral nodes. At about 150 mm diameter the ventrolateral nodes have nearly disappeared and the larger stages are entirely smooth. Throughout all stages a slightly depressed band near the outer edge of the flank is a distinctive feature, and there are no median ventral nodes at any stage. Rib counts of specimens from USGS Mes. loc. 24065 are:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
14	?	24±	35	9	26
15	?	29±	39	12	23
17	14	27	44	12	24
25	13	29	45	10	24
26	12	28	61	13	25
27	12	31	61	11	23
28	11	28	61	12	22
29	12	24	63	13	24
29	13	28	110	13±	26
30	14	25	150	13±	26
31	12	25			
32	11	26	Average	12	26
34	11	25			

The suture is that of the genus (see text figs. 18*c*, *d*, *f–h*).

Remarks.—Neogastroplites muelleri var. B is characterized by its compressed form, relatively weak sculpture in the early and middle stages, and by large smooth adults; by its lack of median ventral and primary nodes at any stage, though ribs are distinct on the inner flank and the venter in early and middle stages. It differs from var. A in its stronger sculpture and somewhat stouter whorls in early stages (perhaps

to 50 mm diameter). It resembles *N. cornutus* var. B, *N. americanus* var. A, and *N. maclearni* var. A in developing large smooth adults, but differs from the first in stronger sculpture on the inner part of the flank and weaker on the outer part in the earlier stages and stronger sculpture in the later stages, with the depressed band on the flank; it differs from the second and third in the much weaker sculpture and more highly arched venter. It somewhat resembles at similar diameters *Gastroplites spiekeri* McLearn (1933, p. 21) in its compressed whorls, weak sculpture, and arched venter, but differs in the weaker ribs on the flanks, more compressed whorls, and wider venter. It differs from *N. muelleri* var. C, *N. americanus* var. B, *N. cornutus* var. C, and similar forms in the lack of a median ventral node.

Figured specimens.—USNM 129416*d*, 129429–129446.

Neogastroplites muelleri var. B with coarser sculpture

Plate 35, figures 3–5

This variant of *N. muelleri* var. B is represented by 25 specimens from one locality. It differs from the normal var. B chiefly in the possession of slightly stronger and coarser sculpture at equal diameters, particularly in the early whorls to 50 mm diameter. There are such almost insensible gradations, however, that it seems worth while only to note that such a variant exists. The difference from the normal form is best shown by rib counts of 11 specimens from USGS loc. 24065.

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
23	12	27	50	10	22
23	11	25	57	11	21
26	10	22	60	11	22
33	12	23	75	12	23
34	10	22			
35	11	24	Average	11	23
49	10	25			

Figured specimens.—USNM 129447, 129448.

Neogastroplites muelleri var. B with stouter shell

Plate 35, figures 1, 2, 6, 7; plate 36, figures 9, 11; text figure 18*e*

This variant of *N. muelleri* var. B is represented by 10 specimens from one locality. It differs from the normal var. B chiefly in the relative stoutness of the shell at equal diameters, particularly in the earlier whorls. It is as stout as *N. muelleri* var. D but has no trace of a median ventral node. The difference from the normal form is best shown by measurements of six specimens from USGS loc. 24065, as follows:

Diameter of shell (mm)	Whorl				Width of umbilicus		Width of venter	
	Height		Width					
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
30	14.5	48	13.5	45	7	23	11	37
36	17.5	49	14	39	8.5	24	8.5	24
45	26	54	21	44	11	23	11	23
52 [1]	28.5	55	21.5	41	12	23	12.5	24
135 [2]	78	58	52	39	15	11	23	17
155±	90±	58	57	37	15	10	30	19

[1] Figures 1, 2, and 6 on plate 35.
[2] Figure 7 on plate 35 and figures 9 and 11 on plate 36.

Figured specimens.—USNM 129449–129451.

Neogastroplites muelleri var. B-C, transitional variant

Plate 6, figures 13–18; plate 36, figures 1–5, 10; text figures 18*i*

Neogastroplites muelleri var. B-C is represented by 43 specimens from one locality. It differs from var. B chiefly by the appearance at diameters of 30 to 40 mm of weak median ventral nodes, which in well-marked development are a distinctive character of var. C. Possibly some of the smaller individuals placed in var. C would be better placed here, but gradations make such distinctions difficult. The largest individuals available are about 90 mm in diameter and these suggest that larger shells would be nearly smooth. Measurements of seven specimens from USGS loc. 24065 are as follows:

Measurements of seven specimens

Diameter of shell (mm)	Figure No. on pl. 36	Whorl				Width of umbilicus		Width of venter	
		Height		Width					
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
27		15	56	10	37	5.5	20	7	26
37		21	57	15	41	7.5	20	9.5	26
43		25	58	16	37	8	19	10.5	24
48	2–4	27	56	18.5	39	9	19	11.5	24
54		31.5	58	20	37	9.5	18	14	26
79		45	57	29	37	14	18	16	20
90	1, 5, 10	51	57	32	36	11	12	18	20

Rib counts

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
37	11	24
43	12	27
51	12	25
54	12	24
79	12	23
90	12	25
Average	12	25

Figured specimens.—USNM 129416*e*, *f*, 129452–129454.

Neogastroplites muelleri var. C

Plate 6, figures 19–21; plate 36, figures 6–8; plate 37, figures 1–22; plate 38, figures 1–3; text figures 19*b*, *e*, *f*

Neogastroplites muelleri var. C is represented by 725 specimens from six localities. The largest individual available, about 100 mm in diameter and somewhat crushed, has about one-third of the last whorl unseptate and forms a thick disk.

Cross section of whorl depressed oval to about 3 mm diameter for shell, subcircular at about 5 mm diameter; high oval at 13 mm diameter, with somewhat flattened flanks and arched venter, umbilical and ventrolateral shoulders defined but rounded, umbilical wall steep and smooth. At about 20 mm diameter cross section becomes high trapezoidal; at 35 to 40 mm diameter high subhexagonal, with widest part below the middle of the flank, venter well arched, outer part of flank flat, ventrolateral shoulders well marked. At larger diameters up to 70 mm this general form is maintained, with accentuation of a pinching just below the ventrolateral shoulder. In some larger individuals with weaker primary ribs the cross section is more nearly a high oval than a high hexagon. Measurements of 27 specimens from USGS loc. 24065 are as follows:

Diameter of shell (mm)	Figure No. on pl. 37	Whorl						Width of umbilicus		Width of venter			
		Height		Width									
				Over nodes		Between nodes				Over nodes		Between nodes	
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
12		6	50	6.5	54			3	25	4±	33		
15		8	53	7	47			3.5	23	5±	33		
19	5–7	9.5	50	8.5	45	7.5	39	4.5	24	6.5	34	5.5	29
20	8–10	11	55	8	40			5	25	6	30	5.5	27
24		12.5	52	10	42	9.5	40	5	21	6.5	27	6	25
26		14	54	10.5	40	10	38	5	19	7.5	29	7	27
28.5		15.5	54	11	39	10	35	6.5	23	8	28	6.5	23
29		15	52	13.5	47	12	41	7.5	26	8	28	7	24
31	16, 17, 19	16	52	12	39	11	36	7	21	8	26	7	23
36		19	54	14.5	40	13	36	8.5	24	9	25		
37		20	54	14	38	13.5	36	9	24	9	24	7.5	20
45		24	53	17.5	39	16	36	9.5	21	11	24	9	20
47		26	55	19	40	18	38	9.5	20	12	26	10	21
48		25	52	18.5	39	16.5	34	10	21	11.5	24	10	21
50		27.5	55	20	40	18	36	11	22	12	24		
51		29	57	20	39	18	35	10	20	12	24	10.5	21
54		30	56	20	37	18	33	11	20	13	24	11	20
55	11–13	30	55	20	36	18.5	34	10	18	13	24	11	20
60		33	55	23	38	21.5	36	12.5	20	13.5	27	12	20
63		36	57	23	36			12	19	17	27		
66		36.5	55	26.5	40	24	36	13	20	17.5	27	15	23
72		40	56	29	40			13	18	18	25		
74		41	55	29	39	26	35	13.5	18	20	27	17	23
76 [1]		42	55	29.5	39	27	36	13	17	23	30	18	24
82		43	52	32	39			16	19	20	24		
83		45	54	33	40	30	36	13.5	16	22	27	18	22
100	20–22	60±	60					17±	17				

[1] Figures 1–3 on plate 38.

Sculpture somewhat variable in early stages; up to about 8 mm diameter for shell whorl is smooth; then faint primary ribs appear near umbilicus and on margins of venter; middle of venter smooth. At about 10 mm diameter ribs are distinct but low and rounded, inclined strongly forward near umbilicus, mostly dividing at the middle of the flank into two more or less radially directed secondary ribs that bend forward at the ventrolateral margin, cross the venter with distinct forward convexity, and are weak on the median line of the venter. At 17 to 18 mm diameter the primary ribs have become sharp and high at the point of division and the secondary ribs have risen on the margin of the venter into an incipient node, though still weak on the middle of the venter. Sculpture remains much the same to about 40 mm diameter, except that it becomes weaker on the outer fourth of the flank, the ventrolateral tubercles are distinct and elongated diagonally forward, and the ventral ribs are of even strength across the venter. At about 40 mm, though this is somewhat variable, a distinct tubercle appears on the rib at the middle of the venter. In later stages the sculpture on the flanks becomes progressively weaker and the ventrolateral and midventral tubercles progressively stronger. On the largest individuals available, up to 100 mm diameter, the primary ribs remain distinct, though never forming a node, the outer part of the flank is nearly smooth and the venter is a transverse platform from which rise the conical midventral tubercles. There is no suggestion whatever that the ventral nodes are likely to disappear at larger stages and the shell becomes a large smooth disk as in *N.*

muelleri var. B. Rib counts of specimens from USGS loc. 24065:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
12	14	25	48	10	23
15	13	24	50	11	22
17	13	26	54	12	24
19	13	27	55	13	24
19	12	26	55	12	23
20	11	27	60	12	24
24	11	24	62	12	23
25	12	26	65	14	23
26	13	29	66	12	23
28.5	11	27	74	11	23
29	11	24	75	13	26
31	12	25	83	12	20
36	12	26	84	12	22
42	12	22	100	15	21
45	11	23			
47	11	25	Average	12	24

The suture is that of the genus (see text figs. 19*b*, *e*, *f*).

Remarks.—*Neogastroplites muelleri* var. C is characterized by its relatively compressed form, strong primary ribs on the flanks, and particularly by the appearance at 40 mm diameter and persistence on the largest individuals available of strong median ventral nodes. It differs markedly from vars. A and B in the stronger primary ribs and the median ventral nodes and from var. D in the slimmer shell and lack of a definite node on the flank at any stage. It resembles *N. americanus* var. B somewhat, but differs in the much coarser and weaker sculpture at all stages available. It resembles somewhat *N. cornutus* vars. C and D, but differs from the first in the weaker sculpture of its flanks, particularly near the umbilicus; and from the second in the compressed whorls and the weaker sculpture, particularly the lack of lateral nodes. It differs from *N. haasi* and all species of *Gastroplites* in the possession of median ventral nodes.

Figured specimens.—USNM 129416*g*, 129455–129466.

Neogastroplites muelleri var. C-D, transitional variant

Plate 6, figures 22–24; plate 38, figures 16–21; text figures 19*c*, *g*

Neogastroplites muelleri var. C-D is represented by 19 specimens from one locality. It differs from var. C in its stouter shell and the first appearance of true nodes on the flanks near the end of the living chamber of the largest shells available (115 mm diameter), but it is not as stout and does not acquire the lateral nodes at as early a stage as var. D. The largest shell available has about one-fourth of the last whorl unseptate. Small shells are not readily separable from either var. C or var. D . Measurements of seven specimens from USGS loc. 24065 are as follows:

Measurements of seven specimens

Diameter of shell (mm)	Whorl						Width of umbilicus		Width of venter			
	Height		Width									
			Over nodes		Between nodes				Over nodes		Between nodes	
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
35	18.5	53	15	43	14	40	7	20	10	29	9	26
41 [1]	22.5	55	17	41	16	39	8	20	11	27	9.5	23
41	23	56	18	44	16	39	8	20	11.5	28	9.5	23
46	25	54	19	41	17	37	9.5	21	12	26	10	22
61	32	52	25	41	20	33	12	20	18	30	15	24
80	43	54	32	40	29	36	14	18	24±	30	20	25
87 [2]	47	54	37	43	32.5	37	17.5	20	27	31	22.5	26

[1] Figures 16–18 on plate 38.
[2] Figures 19–21 on plate 38.

Rib counts

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
35	12	24
41	11	21
46	11	21
61	12	23
80	13	23
102	14	20
Average	12	22

Figured specimens.—USNM 129416*h*, 129467–129470.

Neogastroplites muelleri var. D, normal

Plate 6, figures 25–27; plate 38, figures 4–15; plate 39, figures 1–19; plate 40, figures 4–6; text figures 19*a*, *h*, *k*

Neogastroplites muelleri var. D, normal form, is represented by 160 specimens at five localities. It is accompanied by a few specimens with weak sculpture and by one with relatively stout form; these are described separately below. The largest individual available is about 130 mm in diameter, much crushed

but nearly complete; it would be a thick disk in general form.

Cross section of whorls to about 7 mm diameter for shell depressed oval; at about 12 mm diameter it is subcircular, with flanks and venter beginning to flatten; at 20 mm diameter it is subtrapezoidal; at 30 mm diameter it is subhexagonal and at larger diameters becomes hexagonal, with venter well arched, outer flanks flat to concave, umbilical shoulder rounded but fairly well defined; umbilical wall flat and steep. Measurements of 26 specimens from USGS loc. 24065 are as follows:

Diameter of shell (mm)	Figure No. on pl. 39	Whorl						Width of umbilicus		Width of venter			
		Height		Width									
				Over nodes		Between nodes				Over nodes		Between nodes	
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
18.5		9	49	9	49	8	43	4	22	6	32	5	27
19.5		10	51	8.5	44	8	41	3.5	18	5.5	28	5	26
22.5		12	53	10.5	47	9.5	42	5	22	7.5	33	6.5	29
23.5		13	55	10	43	9	38	5	21	7	30	6	25
26		14	54	12.5	48	11.5	44	6	23	8.5	33	7	27
26.5		14	53	11	42	10	38	6.5	25	8	30	7	26
29		15	52	12	41	11	38	7	24	8	28	7	24
33	1–3	17	52	13	39	12	36	8	24	8	24	7	21
35		18	52	16	46	14	40	8.5	24	10	29	8	23
39		21	54	17	44	15	38	9	23	10	26		
41		21.5	52	17.5	43	16	39	9	22	10	24	9	23
41		22	54	16.5	40	15	37	11	27	11.5	28	9.5	23
44		23	52	18	41	16	36	9	20	11.5	26	9.5	22
45		25	56	21	47	18	40	10	22	13	29	12	27
46	4–6	25	54	19	41	17.5	38	11	24	13	28	11.5	25
48		26	54	19.5	41	18	38	10	21	12.5	26	11.5	24
55		31	56	21.5	39	20	36	10	18	15	27	12.5	23
55	7, 10, 11	30	55	25	45	22.5	41	12	22	14	26	12.5	23
57		31	54	23	40	21.5	38	11	19	15	26	12.5	22
57		31	54	23	40	21	37	12	21	13.5	24	12	21
60	8, 9, 12	32	53	24	40	22.5	38	13	23	16	27	13.5	23
66		35	53	27	41	26	39	12.5	19	17	26	15	23
70		39	56	29	41	27	39	13	19	21	30	17	24
75	16–19	37	50	28.5	38	24	32	14	19	20	27	16	21
79		41	52	34	43	29	37	16	20	24	30	19.5	22
87		48	55	47	54			15	18	33	38		

Sculpture somewhat variable in early stages; up to about 3 mm diameter for shell whorl is smooth; at 5 mm diameter weak but distinct primary ribs are present on the flanks and margin of the venter, but the venter is smooth. At 8 mm diameter the ribs extend from the umbilical shoulder diagonally forward, then more or less radially across the flank to the margin of the venter, where they bend gently forward and cross the venter in an arc convex forward; they are weakest on the midline of the venter and strongest near the umbilicus and at the margin of the venter; most of the primary ribs divide into two secondary ribs. At 12 to 15 mm diameter the primary ribs become sharp and high and the ventrolateral bend rises to form an incipient node. At 25 mm diameter the ventral ribs are strong and at 30 mm diameter, though somewhat variably, a median ventral tubercle appears and the rib on the outer part of the flank becomes weaker. The sculpture to about 50 mm diameter remains about the same, with strong sharp primary ribs highest near the middle of the flank, a zone of weak sculpture on the outer part of the flank, strong ventrolateral nodes transverse to the ribs, arcuate ventral ribs rising into a strong rounded node on the median ventral line. At about 50 mm diameter the primary rib begins to rise into a radially elongated node at the middle of the flank and quickly forms a conspicuous feature of most specimens. In the largest specimens available the sculpture consists essentially of the primary ribs and their tubercles, the ventrolateral tubercles, and the median ventral tubercles; the ribs have nearly vanished from the outer flank and the venter. Rib counts of specimens from USGS loc. 24605:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
18.5	11	24	46	11	21
19	11	24	48	12	23
22.5	12	26	48	13	22
23.5	12	24	55	13	22
26	14	27	57	11	22
26.5	11	27	57	12	20
29	11	23	66	13	22
33	11	22	70	12	20
35	11	21	79	13	21
39	12	23	87	12	17
41	11	23	130	12	17
41	12	22			
44	13	23	Average	12	23
45	12	20			

The suture is that of the genus (see figs. 19*a*, *h*, *k*).

Remarks.—Neogastroplites muelleri var D is characterized by moderately stout whorls and vigorous sculpture, particularly the appearance of rounded median ventral nodes at 30 mm diameter and of lateral nodes at 50 mm diameter and the persistence of these

into the largest stages available. It differs from var. C in its stouter whorls and stronger sculpture, particularly the lateral nodes. It differs from var. E in its less stout whorls and weaker sculpture, particularly in the earlier whorls. Larger individuals (80 mm diameter) of *N. muelleri* var. D resemble in sculpture smaller individuals (50 mm diameter) of *N. cornutus* var. E very much, but differ in the more compressed shell and the weaker rounded rather than elongated median ventral node. At equal diameters smaller individuals (50 mm diameter) of *N. muelleri* var. D resemble *N. cornutus* var. D but differ in the stouter shell and primary ribs that extend to the umbilical shoulder. *N. muelleri* var. D differs from *N. americanus* var. C in its more slender form and much weaker and coarser sculpture and from *N. maclearni* var. B in its more slender form and weaker sculpture. It differs from all variants of *N. haasi* and all species of *Gastroplites* in the median ventral node.

A pathologic specimen with ventrolateral nodes and ribs on one side missing is illustrated in plate 39, figures 13–15.

Figured specimens.—USNM 129416*i*, 129471–129482.

Neogastroplites muelleri var. D, with weak sculpture

Plate 40, figures 1–3

This variant is represented at one locality by four specimens up to 77 mm diameter that are as stout as normal *N. muelleri* var. D but are nearly as weakly sculptured as var. B. The median ventral nodes are present but are very weak. Measurements of two specimens from USGS loc. 24506 are as follows:

Measurements of two specimens

Diameter of shell (mm)	Figure No. on pl. 40	Whorl				Width of umbilicus		Width of venter	
		Height		Width					
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
59		32.5	55	26	44	11	19	16	27
77	1–3	43	56	34	44	14	18	22	29

Rib counts

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
59	13	23
77	15	23

Figured specimens.—USNM 129483, 129484.

Neogastroplites muelleri var. D, with stout shell

Plate 41, figures 1–3

A single small specimen from USGS Mes. loc. 24605 has about the strength of sculpture of normal *N. muelleri* var. D but is nearly as stout as var. E. It has 13 primary ribs and 23 secondary ribs on the last whorl. Its measurements are:

Measurements of one specimen

Diameter of shell (mm)	Figure No. on pl. 41	Whorl				Width of umbilicus		Width of venter	
		Height		Width					
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
23	1–3	13	57	12	52	6	26	8	35

Figured specimen.—USNM 129485.

Neogastroplites muelleri var. D-E, transitional variant

Plate 6, figures 28–30; plate 41, figures 4–6, 9–11; text figure 19*j*

Neogastroplites muelleri var. D-E is represented at one locality by 16 specimens. It differs from var. D in possessing stronger sculpture, like that of var. E, in the earlier whorls, and it differs from var E in possessing slimmer whorls, like those of var. D, though it is a little stouter than var. D. The largest specimen available has an uncrushed septate part 67 mm in diameter plus about one-third of the living chamber in crushed condition; it is estimated that a complete specimen would be about 120 mm in diameter. Measurements of eight specimens from USGS loc. 24065 are as follows:

Diameter of shell (mm)	Whorl						Width of umbilicus		Width of venter			
	Height		Width									
			Over nodes		Between nodes				Over nodes		Between nodes	
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
20	10.5	53	10.5	53	9	45	3.5	18	6.5	33	5.5	28
23	11	48	12	52	10.5	46	4	17	8	35	7	30
32	16.5	52	15.5	48	13	41	9	28	10.5	33	8	25
32.5	16.5	51	16	49	14	43	7	21	10	31	8	25
47	24.5	52	20	43	18.5	39	10	21	13	28	11	23
55±[1]	30	55	25	45	22.5	41	11	20	16	29	13.5	25
63	34	54	26.5	42	24	38	10.5	17	17	27	15	24
66[2]	36	55	30	46	26	39	14	21	20.5	31	17	26

[1] Figures 4, 5, and 11 on plate 41.

[2] Figures 6, 9, and 10 on plate 41.

Rib counts

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
20	11	23	63	13	22
23	12	24	66	11	20±
32	12	22			
32.5	11	22			
47	11	22	Average	12	22

Figured specimens.—USNM 129416*j*, 129486–129488.

Neogastroplites muelleri var. E

Plate 6, figures 31–36; plate 41, figures 7, 8, 12–23; plate 42, figures 6, 7, 9, 10; text figures 19*d*, *i*

Neogastroplites muelleri var. E is represented by 133 specimens from five localities. The largest individual available is about 90 mm in diameter and preserves about one-sixth of the living chamber, suggesting that the complete shell would have been about 120 mm in diameter. The general form is that of a stout nodose disk.

Cross section of whorl to about 8 mm diameter for shell a much depressed oval; to about 11 mm diameter it is a depressed oval. Then venter and flanks flatten and whorl is subtrapezoidal to about 15 mm diameter; then hexagonal at about 20 mm diameter, remaining so to the end of the largest individual available. Measurements of eight specimens from USGS loc. 24065 are as follows:

Diameter of shell (mm)	Whorl						Width of umbilicus		Width of venter			
	Height		Width									
			Over nodes		Between nodes				Over nodes		Between nodes	
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
15	8	53	9	60			5	33	6	40		
25 [1]	13	52	15	60	12.5	50	6	24	9	36	8	32
27	13	48	14	52	12.5	46	6.5	24	10.5	39	9	33
29	14	48	18	62	13.5	47	6.5	22	11.5	39	10	35
31.5	17	54	18	57	16	51	7.5	24	12.5	40	10	32
35	17.5	47	18±	49	16±	46	9	26	13±	37	11	31
44 [2]	23	52	24	55	20.5	47	11	25	12	30	11	25
90 [3]	49	55	52	58	42	47	14	16	34	38	28	31

[1] Figures 19–21 on plate 41.
[2] Figures 18, 22, and 23 on plate 41.
[3] Figures 6, 7, 9, and 10 on plate 42.

Whorls smooth to about 4 mm diameter for shell; then broad faint rounded primary ribs appear near the umbilicus; at 7 mm diameter the ribs have extended almost to the median line of the venter, but they do not cross it. At 10 mm diameter each primary divides below the middle of the flank into two secondary ribs and there are a few intercalated secondary ribs; the primary ribs are inclined forward and the secondary ribs are more or less radial on the flanks, incline forward at the margin of the venter and are convex forward on the venter. At about 15 mm diameter the primary ribs and the secondary ribs on the ventrolateral area begin to rise into nodes and the ventral ribs are distinct. At 25 to 30 mm diameter the primary ribs form high sharp nodes at the middle of the flank, the ribs of the outer part of the flank are weak, the ventrolateral nodes are inclined diagonally forward, and a weak rounded node appears on the median line of the venter. The sculpture of this sort–primary ribs rising into sharp nodes at the middle of the flank, weakly ornamented concave outer part of the flank, ventrolateral nodes inclined diagonally forward, and a line of weak rounded nodes on the midline of the venter—persists to the end of the largest specimen available. Rib counts of specimens from USGS loc. 24065:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
16	12	20	39	10	21
21	12	23	45±	12	21
24	13	23	90	12	18
27	12	22			
29	10	19	Average	11	21
32	10	20			

The suture is that of the genus (see text figs. 19 *d*, *i*).

Neogastroplites muelleri var. E is characterized by its stout shell with hexagonal cross section of whorl, and its nodose sculpture with early development of lateral and rounded median ventral nodes. It is stouter than var. D and more vigorously ornamented, and it is less stout, has proportionately higher whorls, and somewhat weaker ornament than var. F. It resembles *N. americanus* var. C, but is stouter, has weaker and fewer ribs, stronger nodes on the flanks

at similar diameters, and develops a stronger median ventral node. It is not as stout as *N. americanus* var. D, has weaker and fewer ribs, and the median ventral node is rounded rather than elongated parallel to the rib. It resembles *N. maclearni* vars. C and D; it has about the same number of ribs per whorl as these forms, but is stouter at similar diameters than the first and more strongly ornamented, and it is much less stout than the second and has about the same strength of ornamentation or perhaps slightly weaker sculpture. It resembles *N. cornutus* var. E considerably, but is much stouter at similar diameters; and *N. cornutus* var. F, but is less stout and has finer and weaker sculpture. It resembles *N. haasi* var. E in general form and ornamentation, but differs in possessing median ventral nodes. It differs from all species of *Gastroplites* in the presence of nodes.

Figured specimens.—USNM 129416*k*, *l*, 129489–129495.

Neogastroplites muelleri var. E-F, transitional variant

Plate 6, figures 37–39; plate 42, figures 1–5, 8; text figure 20*e*

Neogastroplites muelleri var. E-F is represented at one locality by 13 specimens. It differs from var. E in its stouter whorls and stronger ornamentation, and from var. F in its less stout whorls and weaker ornamentation. The largest specimen available is a septate fragment attached to the inner whorls, estimated to be at a diameter of about 70 mm; if the last septum preserved is the last septum formed, the complete shell was about 120 mm in diameter. The largest nearly complete specimen retains about two-thirds of the living chamber, somewhat crushed and is about 60 mm in diameter; the complete shell must have been about 70 mm in diameter. Measurements of seven specimens from USGS loc. 24065 are as follows:

Measurement of seven specimens

Diameter of shell (mm)	Whorl						Width of umbilicus		Width of venter			
	Height		Width									
			Over nodes		Between nodes				Over nodes		Between nodes	
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
24	13.5	56	13.5	56	11	46	5.5	23	9	38	7.5	31
24	12	50	14.5	60	13	54	5.5	23	10	42	8.5	35
26	14	54	14.5	56	12.5	48	6	23	9.5	37	8	31
28	14	50	16	57	15	54	6	21	11	39	9	32
30	17	50	19	57	15	54	6	21	11	39	9	30
39	21	54	24	62	18.5	47	9	23	14	36	11	28
50 [1]	25	50	34±	68	28±	56	10	20	20±	40	----	----

[1] Figures 1 and 2 on plate 42.

Rib counts

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
24	12	20
24	10	22
26	10	20
28	10	21
43±	11	21
60±	9	17
Average	10	20

Figured specimens.—USNM 129416*m*, 129496–129498.

Neogastroplites muelleri var. F

Plate 6, figures 40–45; plate 43, figures 1–17, 19–24, 27, 28; text figure 20*a*

Neogastroplites muelleri var. F is represented by 279 specimens from six localities. The largest individual available, much crushed, is estimated to be 80 mm in diameter. It is a stout subspinose disk, septate to about 70 mm diameter and suggesting that the complete shell would be 110 to 120 mm in diameter. Largest uncrushed specimen is 45 mm in diameter.

Cross section of whorl much depressed oval to about 10 mm diameter for shell; then venter and outer part of the flank begin to flatten, and cross section at 15 mm diameter becomes depressed hexagonal. This form continues to the end of the largest uncrushed specimen at 45 mm diameter. Form at larger diameters is conjectural but is probably much the same as at 45 mm. Measurements of 26 specimens from USGS loc. 24065 are shown in the table on the following page.

Whorls to a diameter of 4 mm for the shell smooth; then faint broad rounded ribs appear near the umbilicus and gradually become stronger and longer until at 7 mm diameter they have reached almost to the midline of the venter. At 10 mm diameter they are distinct, with each primary rib dividing into two secondary ribs; the primary ribs incline slightly forward, the secondary ribs are nearly radial to the margin of the venter, where they bend gently forward

Diameter of shell (mm)	Figure No. on pl. 43	Whorl						Width of umbilicus		Width of venter			
		Height		Width									
				Over nodes		Between nodes				Over nodes		Between nodes	
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
16	4–6	7.5	47	11	69	9	56	4	25	8	50	6.5	41
16.5		8	49	12	73	10	61	4.5	27	7.5	45	6.5	39
17		8.5	50	11	65			5	29	6	35		
19		9.5	50	13	68	10	53	4.5	24	9	47	6.5	39
21		9	43	14	67	11.5	55	5.5	26	9.5	45	7.5	36
21	1–3	10.5	50	13	62	12	57	5.5	26	9.5	45	7.5	36
22.5		10.5	47	16	71	12	53	5.5	24	10	44	7.5	33
23		11.5	50	16	70	13	57	5.5	24	10	43	7.5	32
23		12	52	16	70	13	57	6	26	10	43	7.5	32
24	7–9	12	50	14	58	12	50	6	25	9.5	40	7.5	31
25.5		12	47	20	78	15	59	6	27	12.5	56	9	35
29		15	52	21	84			8	32	11	44		
29		15	52	18	62			7	24	11	44		
30		16	53	21	70	17	56	6.5	22	12.5	42	9.5	32
31		15	48	20	65	17.5	56	7	23	12	39	9	29
31		14	45	22	71	16	52	8	26	14	45	10	32
31		15	48	21	68	17.5	56	8.5	27	15	48	11	36
31.5		16	51	22.5	71	18	57	7	22	15	48	11	35
31.5		15	48	21	67	17	54	8	25	14	44	10	32
33		15	45	25	76	17.5	53	8.5	26	14.5	44	11	33
34	13–15	19	56	23	68	19	56	9	26	16	47	13	38
34		15	44	24	71	18.5	54	9	26	14	41	11	32
37		18	49	27±	73	19	51	8	22	16	43	12	32
40		20	50	30±	75	25	63	9	25	19	48	15	32
43	16, 17, 19	23	54	30	70	25	58	11	26	20	47	17	39
48		21	44	31	65	25	52	9.5	20	19	40	13	27

and cross the venter in an arc convex forward and weak on the midventral line. At 13 mm diameter the primaries begin to rise into nodes on the flank and the secondary ribs begin to rise at the margins of the venter; the secondary ribs display about equal strength across the venter. With increase in size of shell the primary nodes continue to increase in height and to move outward on the flank to the middle or just beyond it, and the ventrolateral nodes become stronger and are inclined forward, both persisting to the end of the largest specimens available. At about 20 mm diameter a rounded node appears on the rib at the median line of the venter; it does not increase in size as rapidly as the other nodes and on the largest individuals is still rather weak. In the largest shells all of the ribs have become weak, but the lateral and ventrolateral nodes are strong. Rib counts of specimens from USGS loc. 24065:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
16.5	12	22	31	10	18
19	12	24	31.5	11	20
21	11	22	31.5	12	21
21	10	21	33	10	19
22.5	10	23	34	11	22
23	11	23	37	11	20
23	12	20	40	10	17
25.5	10	20	44	12	18
30	9	19	48	10	17±
31	10	19			
31	10	18	Average	11	20

A small pathologic individual of this variant (pl. 43, figs. 23, 24) shows damage to the ventral sculpture that apparently subsequently healed.

The suture is that of the genus (see text fig. 20*a*).

Remarks.—*Neogastroplites muelleri* var. F is characterized by its very stout shell with depressed hexagonal cross section of whorl, strong lateral and ventrolateral nodes, becoming subspinose in the larger specimens, and by its relatively weak median ventral nodes. It resembles var. E, but is stouter and more strongly sculptured. It differs from var. G in being less stout and in larger specimens in the persistence of the lateral spines near the middle of the flank and the distinctness of the flank and venter. It resembles *N. americanus* var. D and *N. haasi* var. E in general character, but differs from the first in its coarser sculpture and in the round rather than elongated form of the ventral nodes, and from the second in the possession of the ventral nodes. It resembles *N. cornutus* vars. E and F, but is more finely ribbed, has weaker and rounded ventral nodes, and at equal diameters shows the ribs more distinctly. It strongly resembles *N. maclearni* var. D at similar diameters but has slightly more coarse ornamentation on the average and is perhaps not quite as stout.

Figured specimens.—USNM 129416*n*, *o*, 129499–129509.

Neogastroplites muelleri var. F-G, transitional variant

Plate 6, figures 46–48; plate 43, figures 18, 25, 26; plate 44, figures 1–3; text figure 20*f*

Neogastroplites muelleri var. F-G is represented by 84 specimens from one locality. It has the general character of var. F, but is stouter at any given diameter, acquires strong sculpture at a smaller diameter, and the spines in the larger individuals move out nearly to the level of the venter. It differs from var.

G in its less stout shell and somewhat weaker sculpture. The largest shell available is about 50 mm in diameter. Measurements of nine specimens from USGS loc. 24065 are as follows:

Diameter of shell (mm)	Whorl						Width of umbilicus		Width of venter			
	Height		Width									
			Over nodes		Between nodes				Over nodes		Between nodes	
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
15	7	47	10	67	8.5	57	4	27	7	47	5	31
19	9.5	50	13	68	11.5	61	4.5	26	9	47	6	32
23.5	10	43	17.5	75	14	60	7	30	10	42	7	30
27	14	52	21	78	16	60	8	30	12.5	46	9	33
30	14	47	22	73	18	60	8	27	13	44	9.5	32
34	17	50	24	71	20	59	8	24	15.5	46	12	35
37	18	49	25	68	21	57	8	22	17	46	13	35
38.5	20	52	27.5	71	19.5	51	8.5	22	15	47	11.5	30
48 [1]	25	52	34	71	----	----	13	21	20	42	----	----

[1] Figures 18, 25, and 26 on plate 43.

Rib counts

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
15	10	19	37	11	18
19	10	21	38.5	10	20
23.5	9	19	48	9	17
27	9	19			
30	10	21	Average	10	19
34	10	19			

Figured specimens.—USNM 129416*p*, 129510–129513.

Neogastroplites muelleri var. G

Plate 6, figures 49–51; plate 44, figures 4–24; plate 45, figures 13–21; text figures 20*b–d*

Neogastroplites muelleri var. G is represented by 246 specimens from five localities. The largest individual available, 60 mm in diameter, is a very thick disk, approaching subglobular in form. One specimen 60 mm in diameter preserves much of the aperture; another, 53 mm in diameter and entirely septate, must have reached a diameter of 80 mm when complete; other fragments though crushed suggest that they would also have attained 80 mm in diameter.

Cross section of whorl much depressed oval to about 8 mm diameter for the shell. At that diameter the outer part of the flank and the venter begin to flatten and at 12 mm diameter the cross section of the whorl is depressed hexagonal. At 20 mm diameter the cross section of the whorl suggests that of a thick biconvex lens. At about 30 mm diameter it has become a wide trapezoid with the longest side ventral and this form persists to the largest size available. Two fragments assigned to this variant preserve the rostrum. Measurements of 31 specimens from USGS loc. 24065 are as follows:

Diameter of shell (mm)	Figure No. on pl. 45	Whorl						Width of umbilicus		Width of venter			
		Height		Width									
				Over nodes		Between nodes				Over nodes		Between nodes	
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
13.5	----	6.5	48	9.5	69	8.5	63	4.5	33	6±	44	5±	37
14	----	6	43	9.5	68	8.5	61	4	29	6	43	----	----
15	----	6.5	43	10.5	70	9.5	63	4	27	7	47	5	33
17	----	9	53	13	78	10.5	62	4	24	8	47	5.5	32
19	----	8.5	45	15	79	11	58	6	32	8	42	----	----
20	----	10.5	53	15	75	12	60	5.5	27	9.5	48	7.5	37
20	----	9.5	48	15	75	12	60	6	30	9.5	48	7	35
20	----	9.5	48	16±	80	14±	70	5.5	27	9	45	7	35
20	----	9.5	48	16	80	12.5	63	6.5	33	9.5	48	7	35
24	----	12	50	19	79	15	63	6	25	11.5	48	8.5	35
24	----	11.5	48	21	88	14	58	6.5	27	11.5	48	8	33
26 [1]	----	13	50	21	81	18	69	9	35	11	42	9	34
27	----	13	48	19	70	15.5	57	6.5	24	13.5	50	9	33
30	----	14	47	25	83	20	67	7	23	13.5	45	9	30
32	----	16	50	27.5	86	21	64	9	28	16	50	11	34
33	----	15	45	31	94	21	64	9	27	15	45	----	----
35	----	17	49	25.5	73	20	57	8.5	24	15	43	11	32
36	----	18	50	37±	103	20	56	10	28	16.5	46	11	31
36.5	----	16.5	45	29±	80	22.5	62	10	31	17.5	54	12	33
37	----	18	49	31±	84	20	54	10	27	18	49	11.5	31
39	----	18	46	32±	86	23	59	9	23	17.5	45	12.5	32
41	----	19	46	32±	78	21.5	52	10.5	26	17	41	11	27
43	----	24	56	34	79	25	58	11	26	19	44	12.5	29
44	----	21	48	30±	68	25	57	10.5	24	21	48	14	32
44	----	21.5	49	36±	82	24	55	9.5	22	21.5	49	14	32
44.5	----	22	49	35	79	25	56	9	20	20	45	15	34
45	----	21	47	33±	74	27	60	9.5	21	21	47	15	33
51	13, 16, 17	25	49	42±	82	29	57	12	24	24	47	17	33
53	----	27	51	40±	75	30	57	9	17	24	45	19	36
53	14, 15, 18	23	43	42	80	30	57	14	26	24	45	18	34
54	----	27	50	38±	70	30	56	9	17	24	44	16	30

[1] Figures 16–18 on plate 44.

Whorls smooth to a diameter of 4 mm for shell; then faint ribs appear near the umbilicus and become larger and stronger until at 6 mm diameter they extend across the venter, though weak on the median line. At 10 to 12 mm diameter the primary ribs incline forward and divide on the flank into two secondary ribs that pass nearly radially to the margin of the venter and cross the venter with gentle forward convexity and a weakening on the median line of the venter. Then the primary ribs begin to rise into nodes at the middle of the flank and the secondary ribs form nodes at the margin of the venter. At 15 mm diameter the primary ribs have become blunt spines and the nodes at the ventrolateral margins are strong and inclined gently forward; the ventral ribs cross the venter with nearly even height. At about 25 mm diameter a weak rounded node appears on the secondary rib at the middle of the venter. With growth the lateral spines move outward on the flank until they are nearly flush with the venter and increase in prominence, the ventrolateral nodes become sharper and elongated diagonally forward, and the rounded median ventral node appears to be slightly behind the growth lines connecting the pairs of ventrolateral nodes. The umbilicus is smooth. This ornamentation persists to the end of the largest individuals available. Rib counts of specimens from USGS Mes. loc. 24065:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
8.5	14		36	10	18
14	11	22	36.5	10	19
14	11	21	37	8	16
15	11	20	39	8	17
17	10	22	39	9	19
19	10	18	40	10	17
20	11	22	41	8	18
20	11	20	44	8	17
20	10	19	44	8	17
20	10	20	44.5	10	18
24	9	18	45	9	18
24	9	18	46	9	17
26	10	18	51	9	16
27	10	19	53	9	16
30	10	18	53	9	18
30	9	18	54	9	16
32	9	18			
35	10	18	Average	10	21
35	9	20			

The suture is that of the genus (see text figs. 20*b-d*).

Remarks.—*Neogastroplites muelleri* var. G is characterized by its spinose subglobose shell with broad ventral aspect that includes the venter and the outer part of the flank, conspicuous lateral spines nearly out to the venter in the larger shells, and weak rounded median ventral nodes. It differs from var. F in its much stouter shell, broader ventral aspect, and the placement of the lateral spines. It resembles *N. americanus* var. E but differs in having less numerous ribs, the ventral nodes rounded rather than elongated parallel to the rib, and in the placement of the lateral spines nearly out to the venter in larger individuals. It resembles *N. haasi* var. F but differs in having small discrete nodes on the middle of the venter rather than raised secondary ribs extending across the venter. Small specimens of *N. muelleri* var. G (20 mm diameter or less) resemble specimens of *N. cornutus* var. G at similar diameters but differ in the absence of a median ventral node, narrower venter, and less arcuate ventral ribs. *N. muelleri* var. G resembles very much *N. maclearni* vars. D and E, of which only small specimens are available (25 to 30 mm diameter); from var. D it differs at similar diameters in its less numerous ribs; from var. E it differs in its less stout whorls. No previously recorded Canadian forms resemble it.

Figured specimens.—USNM 129416*q*, 129514–129522, 129524–129526.

Neogastroplites americanus (Reeside and Weymouth)

Plate 45, figures 10–12; plate 49, figure 8; text figures 23–26

1931. *Acompsoceras americanum* Reeside and Weymouth, U. S. Natl. Mus. Proc., v. 78, art. 17, p. 18, pl. 3, figs. 1–4.

1931. *Metoicoceras whitei* Reeside and Weymouth (not Hyatt), idem, p. 22, pl. 3, fig. 8; pl. 4, figs. 1–3, 5–7 (not fig. 4).

1951. *Gastroplites americanus* (Reeside and Weymouth). Cobban and Reeside, Am. Assoc. Petroleum Geologists Bull., v. 35, p. 1893.

As is true of other species of *Neogastroplites* here considered, the range in *N. americanus* of form and ornamentation precludes any simple statement of characters. The most distinctive features are its strong and relatively fine sculpture, with the ventral ribs strong in the early stages, and its tabulate or only faintly arched venter; in compressed variants the early ribs on the flanks are strong, but the sculpture is rapidly lost and the shell becomes smooth; in moderately compressed variants a weak median ventral node appears; in stout variants the lateral and median ventral nodes become strong; in subglobose variants the lateral nodes move out on the flanks until the outer part of the flank and the venter form nearly one gently arched surface, though the median ventral nodes remain weak.

Neogastroplites americanus differs from *N. haasi* Reeside and Cobban in its finer and stronger sculpture, its median ventral nodes in most variants, its tabulate rather than rounded venter, in the position of the lateral nodes on the flanks, and in subglobose forms in the merging of the outer part of the flank with the venter. It differs from *N. cornutus* (Whiteaves) in its finer and stronger sculpture, its tabulate venter, its weaker ventral nodes in the larger individuals, and in the development of subglobose forms.

It differs from *N. muelleri* Reeside and Cobban in its finer and stronger sculpture in all variants. From *N. maclearni* Reeside and Cobban it differs in its finer sculpture, though otherwise it is rather similar. The most compressed, and most abundant, variant of *N. americanus* in its earlier stages strongly resembles in general form and ornamentation some of the species of the older genus *Gastroplites*, particularly the type of the genus, *G. canadensis* (Whiteaves) (McLearn, 1933, p. 15, pl. 1, figs. 4, 5), and *G. kingi* McLearn (1933, p. 19, pl. 3, figs. 4, 5), but it differs from them sharply in its relatively narrower venter, smaller umbilicus, and finer ribbing. In the larger stages its loss of ornamentation separates the compressed variant from *Gastroplites*.

The writers have found it convenient to describe below five variants, to which the letters A to E are applied. It is notable that the compressed costate portion of the assemblage has expanded numerically even beyond that of *N. muelleri* and forms more than four-fifths of the total (84 percent), whereas the stout nodose portion is little changed (10 percent), but the subglobose portion has decreased (6 percent). The contrast is perhaps greatest with the assemblage of *N. cornutus*, which has nearly no subglobose forms, but a large portion of stout nodose forms. One large lot is available but five or more other lots provide samples that indicate the composition of the large lot is probably near the normal one for the species. Table 9 shows the distribution of the variants.

TABLE 9.—*Distribution of specimens of* Neogastroplites americanus *by locality, variant, and size*

USGS Mesozoic locality No.	Map No.	Diameter of shell (mm)	Number of specimens for indicated character group and variant									Total
			Compressed costate			Stout nodose		Subglobose spinose				
			A	A–B	B	B–C	C	C–D	D	D–E	E	
Alberta												
GSC 24693	3	<25	0				2		1			3
		25–50	3				0		0			3
		>50	0				0		0			0
Total, Alberta			3				2		1			6
Montana												
23042	28	<25	413	1	77	6	36	2	20	2	11	568
		25–50	483	3	78	7	23	5	21	4	23	647
		>50	34	2	34	0	0	0	0	1	0	71
Total			930	6	189	13	59	7	41	7	34	1,286
23043	29	<25	3									3
		25–50	1									1
		>50	0									0
Total			4									4
24608	30	<25	34		19		9	0	4		2	68
		25–50	16		23		11	1	3		2	56
		>50	0		2		0	0	0		0	2
Total			50		44		20	1	7		4	126
4612	35	<25	0									0
		25–50	1									1
		>50	0									0
Total			1									1
4645	36	<25	0									0
		25–50	1									1
		>50	0									0
Total			1									1
4610	37	<25	0									0
		25–50	1									1
		>50	0									0
Total			1									1
24502	48	<25	0						0		0	0
		25–50	1						1		1	3
		>50	0						0		0	0
Total			1						1		1	3
10443	49	<25	0		0							0
		25–50	2		1							3
		>50	0		0							0
Total			2		1							3
Total, Montana			990	6	234	13	79	8	50	7	39	1,426
Wyoming												
17934, 24555	53	<25	9		4		2		0		2	17
		25–50	32		30		8		3		2	75
		>50	16		4		4		1		0	25
Total			57		38		14		4		4	117

TABLE 9.—*Distribution of specimens of* Neogastroplites americanus *by locality, variant, and size*—Continued

USGS Mesozoic locality No.	Map No.	Diameter of shell (mm)	Number of specimens for indicated character group and variant									Total
			Compressed costate			Stout nodose		Subglobose spinose				
			A	A–B	B	B–C	C	C–D	D	D–E	E	
Wyoming—Continued												
20370	54	<25	0									0
		25–50	0									0
		>50	1									1
Total			1									1
10415	57	<25	0									0
		25–50	1									1
		>50										0
Total			1									1
23465	58	<25	2				0				0	2
		25–50	7				3				1	11
		>50	8				2				0	10
Total			17				5				1	23
24565	60	<25	3		1	0	1				1	6
		25–50	10		13	0	3				0	26
		>50	3		7	1	1				0	12
Total			16		21	1	5				1	44
24554	61	<25	2		0		0		0	0		2
		25–50	17		14		3		0	1		35
		>50	5		4		1		1	0		11
Total			24		28		4		1	1		48
24567	63	<25	14		0	0	2		0		0	16
		25–50	19		10	2	1		4		1	37
		>50	12		4	1	1		0		0	18
Total			45		14	3	4		4		1	71
24568	64	<25	40		27	0	21	0	7	1	1	97
		25–50	29		25	5	20	2	6	0	4	91
		>50	4		3	1	4	0	0	0	1	13
Total			69		55	6	45	2	13	1	6	201
24561	68	<25	142		34	0	13	0	1			190
		25–50	242		108	20	24	3	2			399
		>50	4		6	0	6	0	1			17
Total			388		148	20	43	3	4			606
24564	71	<25	20		4	0	0		0			24
		25–50	44		26	2	20		11			103
		>50	11		7	3	10		0			31
Total			75		37	5	30		11			158
8535	78	<25	0									0
		25–50	2									2
		>50	0									0
Total			2									2
6735	81	<25	1									1
		25–50	0									0
		>50	0									0
Total			1									1
14718, 22989, 24539	105	<25	0		1							1
		25–50	8		11							19
		>50	1		4							5
Total			9		16							25
22980, 24545	111	<25	0									0
		25–50	5									5
		>50	0									0
Total			5									5
Total, Wyoming			714		347	35	150	5	37	2	13	1,303
Utah												
25586	121	<25	1									1
		25–50	0									0
		>50	0									0
Total, Utah			1									1
Colorado												
11665	123	<25	0				0					0
		25–50	1				1					2
		>50	0				0					0
Total, Colorado			1				1					2
Grand total			1,709	6	581	48	232	13	87	9	52	2,737

The suture line is that of the genus. External sutures of all of the variants are shown in figures 23 and 24.

The overlap in proportions of the shell in the variants examined is brought out by figure 25.

Occurrence.—As shown in table 9, *N. americanus* is known from a locality in central western Alberta and from 24 localities in Wheatland, Yellowstone, and Carbon Counties, Montana; Crook, Park, Hot Springs, Natrona, and Lincoln Counties, Wyoming; Moffat County, Colorado; and Uintah County, Utah. Figure 26 shows the distribution of the localities in the United States.

Type specimen.—USNM 73775; Aspen shale, near top, in NW¼ sec. 32, T. 21 N., R. 115 W., Lincoln County, Wyo. (pl. 45, figs. 10–12). This specimen was called *Acompsoceras americanum* by Reeside and Weymouth and is assigned by the writers to their var. A.

Figured specimen.—USNM 129527.

Neogastroplites americanus var. A

Plate 7, figures 1–6; plate 45, figures 1–12; plate 46, figures 1–30; plate 47, figures 1–6; plate 48; plate 49, figures 2, 5, 6, 9–11; text figures 23*a*, *b*, *e*, *f*

1931. *Acompsoceras americanum* Reeside and Weymouth, U. S. Nat. Mus. Proc., v. 78, art. 17, p. 18, pl. 3, figs. 1–4.

1931. *Metoicoceras whitei* Reeside and Weymouth (not Hyatt), idem, p. 22, pl. 3, fig. 8; pl. 4, figs. 1–3, 5–7 (not fig. 4).

1951. *Gastroplites americanus* (Reeside and Weymouth). Cobban and Reeside, Am. Assoc. Petroleum Geologists Bull., v. 35, p. 1893.

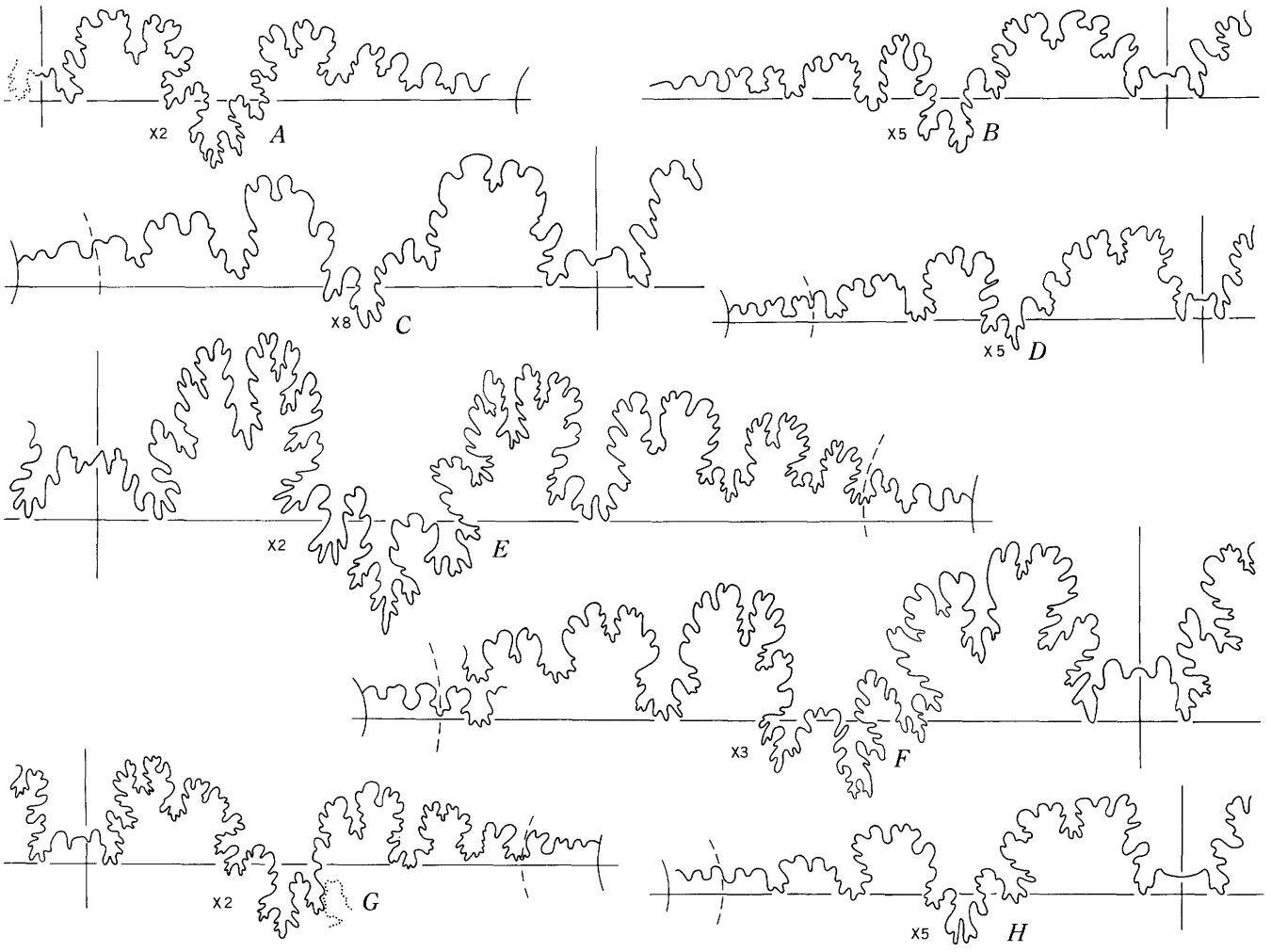

FIGURE 23.—Sutures of *Neogastroplites americanus* (Reeside and Weymouth) vars. A, A–B, and B. *a*. Var. A at about 50 mm diameter (× 2); the holotype, with suture somewhat weathered and distorted; (see also pl. 45, figs. 10–12). *b*. Var. A at 22 mm diameter (× 5) (see also pl. 46, figs. 20–22). *c*. Var. B at 15 mm diameter (× 8) (see also pl. 50, figs. 7–9). *d*. Var. A–B at 19 mm diameter (× 5). *e*. Var. A at 88 mm diameter (× 2) (see also pl. 47, figs. 4–6). *f*. Var. A at 56 mm diameter (× 3). *g*. Var. B at 55 mm diameter (× 2) (see also pl. 50, figs. 22, 27, 28). *h*. Var. B at 23 mm diameter (× 5) (see also pl. 50, figs. 15, 25, 26). All specimens from USGS loc. 23042, Wheatland County, Mont., except figure *a*, which is from USGS loc. 14718, Lincoln County, Wyo., and figure *e*, which is from USGS loc. 17934, Park County, Wyo.

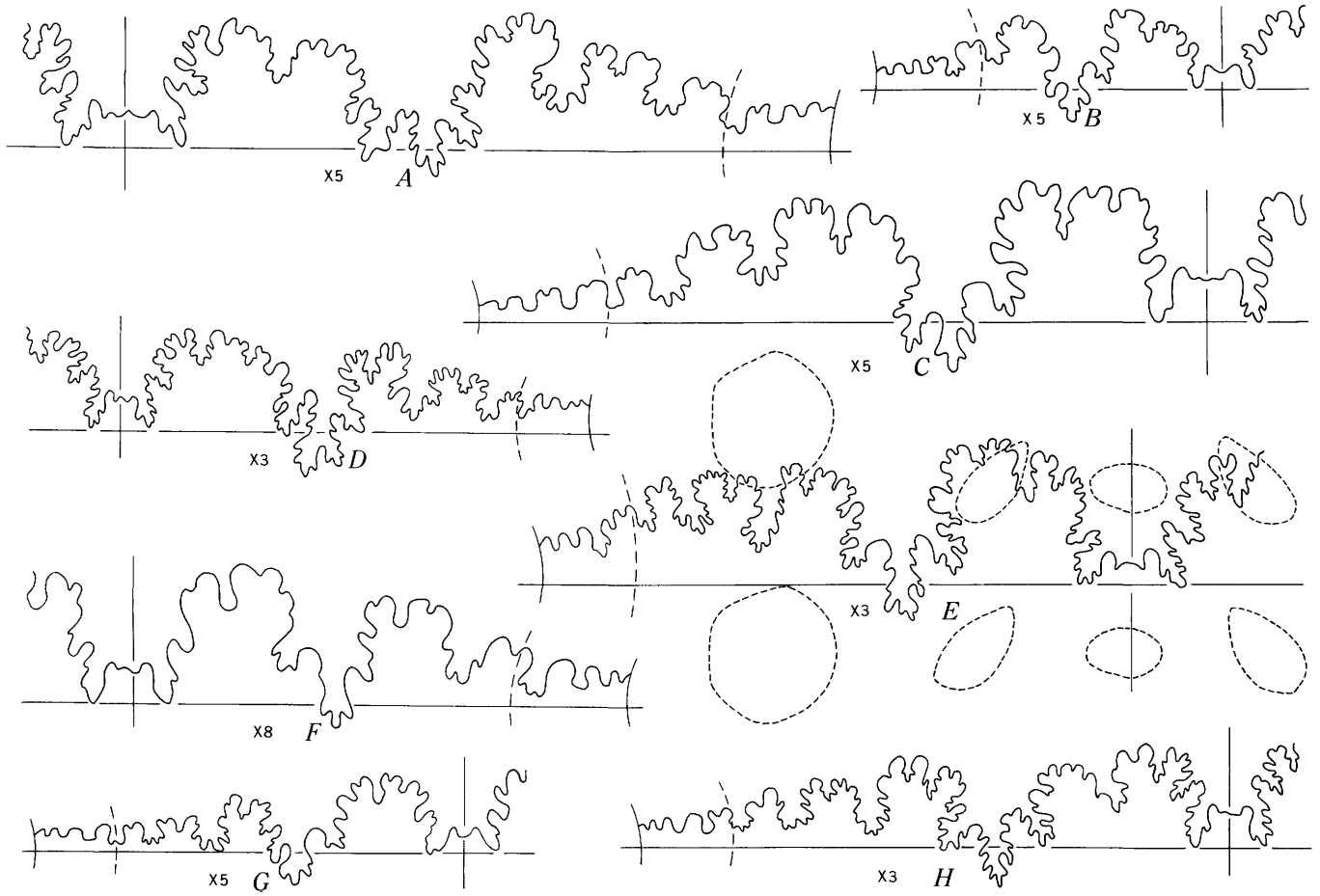

FIGURE 24.—Sutures of *Neogastroplites americanus* (Reeside and Weymouth) vars. B–C, C, C–D, D, D–E, and E. *a*. Var. B–C at 28 mm diameter (× 5). *b*. Var. E at 16 mm diameter (× 5). *c*. Var. D at 28 mm diameter (× 5) (see also pl. 54, figs. 1–3). *d*. Var. C–D at 31 mm diameter (× 3) (see also pl. 53, figs. 3–4). *e*. Var. E at 36 mm diameter (× 3). *f*. Var. D at 13 mm diameter (× 8). *g*. Var. D–E at 16 mm diameter (× 5) (see also pl. 54, figs. 7–9). *h*. Var. C at 40 mm diameter (× 3). All specimens from USGS loc. 23042, Wheatland County, Mont., except figure *h*, which is from USGS loc. 24555, Park County, Wyo.

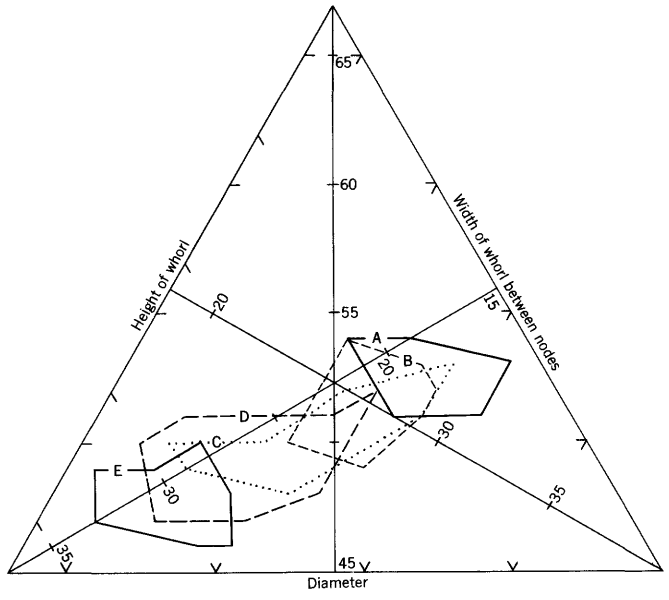

FIGURE 25.—*Neogastroplites americanus* (Reeside and Weymouth). Proportions of the shell in five variants as indicated by measurements of the diameter of the shell, the height of the whorl, and the width of the whorl between nodes. The point indicating the measurements falls within the enclosure lettered to correspond with the variant.

Neogastroplites americanus var. A is represented by 1,709 specimens from 25 localities. The largest individual available that is well preserved is entirely septate and 270 mm in diameter. Fragments suggest individuals as large as 400 mm in diameter. The mature shell is a moderately thick smooth disk.

Cross section of whorl depressed oval to 3.5 mm diameter for shell; subcircular at 5 mm diameter; high oval at 10 mm diameter, with outer part of flanks flattened, umbilical and ventral shoulders vague, venter broadly rounded. At 12 mm diameter the umbilical shoulders are fairly well defined; at 15 mm diameter the ventrolateral shoulder is well defined and the venter gently arched; at 20 mm diameter the cross section of whorl is high subtrapezoidal, with flanks gently arched and venter nearly flat. In later stages to 90 mm diameter, height of whorl increases more rapidly than the width, with widest part near the umbilical shoulder, and the width of the venter and of the umbilicus increases very slowly; the flank is faintly pinched on the outer fourth, serving to help

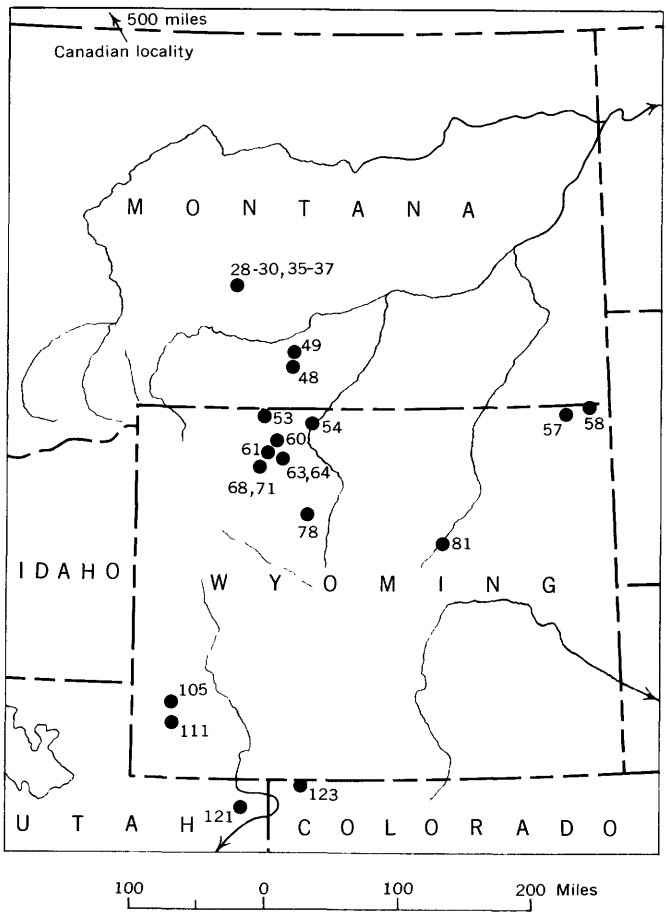

FIGURE 26.—Localities of *Neogastroplites americanus* (Reeside and Weymouth).

define the venter. At 90 mm diameter the venter is gently arched, the flanks slightly pinched, the widest part of the whorl about one-third the distance out from the umbilicus to the venter, and the cross section of the whorl approaches a high oval. At 130 mm diameter the flanks, though still faintly pinched, round into the venter, the widest point approaches the middle of the flank, and the cross section is a symmetrical high oval. At 200 mm the cross section is about the same, with the widest part at the middle of the flank. Cross section at larger diameters probably nearly the same, though not actually known because of the crushing of larger specimens. Measurements of 28 specimens from USGS loc. 23042 and one (127 mm) from loc. 17934 are given in the table below.

Whorls to about 5 mm diameter for shell smooth; then faint broad ribs appear on the flanks, and in half a whorl become well-defined costae that begin at the umbilical shoulder, pass obliquely forward to the middle of the flank and mostly divide there into two radially directed secondary ribs; these bend slightly forward at the margin of the venter and cross the venter with shallow forward convexity. The trend of the ribs is shallowly sigmoid. They are highest near the umbilicus and on the ventrolateral area and weakest on the median line of the venter. Umbilicus smooth. At 20 mm diameter the primary ribs have become moderately high, subangular, mostly dividing below the middle of the flank into two weaker secondary ribs that bend abruptly forward and become

Diameter of shell (mm)	Figure No. on—				Whorl						Width of umbilicus		Width of venter	
					Height		Width							
							Over nodes		Between nodes					
	pl. 46	pl. 47	pl. 48	pl. 49	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
11.5					6	52	5.5	48			2.5	22	4±	35
15					7	47	6.5	43	6	40	4	27	4.5	30
18.5					10	54	8	43	7.5	40	3.5	19	5.5	29
20	10–12				10	50	8.5	43	7.5	38	4.5	23	5	25
20					10.5	52	8	40	7.5	38	4	20	5	25
20					10	50	9	45	8	40	4	20	5	25
24					12.5	52	10	42	9.5	40	5	21	7	29
27					13	48	11.5	43	10.5	39	5.5	20	7	26
29					14.5	50	12	41	10.5	36	5.5	19	8	28
29					16	55	13	45	11	38	6.5	22	9	31
30	20–22				15	50	11.5	38	10.5	35	5	17	7.5	25
32					16.5	52	12.5	39	11.5	36	6	21	8.5	29
32	15, 16				17	53	14	44	13	41	6.5	20	9.5	30
32	23–25				16	50	14	44	13	41	5.5	19	9	31
33.5					17.5	52	14	42	13	39	6	18	9	27
35	17–19				21	60	13.5	39	12	34	6	17	9	26
40					20.5	51	15.5	39	15	37	8	20	11.5	26
40					20.5	51	17	43	15	37	8.5	21	10.5	26
41					23	56	15	37	14	34	7	18	9	22
43					24.5	57	16	37	13.5	31	7	16	9.5	22
47					26	55	18	38	16	34	8	17	11	23
47					27	57	17	36	15	32	8	17	10.5	22
48					26.5	55	18	38	16	33	9.5	20	9.5	20
49					28.5	58	20.5	41	18	37	10.5	21	9	18
56	26–28				32	57	20	36	19	34	12	21	10	18
78					44.5	56	24.5	31	24	31	11	14	13	17
91		1–3			54	59	30	33			11.5	13	14.5	16
127		4–6			75	51	42	33			12.5			
195			1	9	115	59	60	31			15			

higher at the ventrolateral margin, thus defining venter and flank. On the venter the ribs run nearly straight across, with a weaker part on the median line. At 30 mm diameter the sculpture is much the same but stronger and the ribs cross the venter with even strength and faint forward convexity. At 40 mm diameter the ribs are broader and lower and the ventrolateral bends are low nodes inclined forward. In the half whorl from 40 to 65 mm diameter the ribs weaken on the flanks until they are difficult to see, the outermost part of the flank becomes faintly concave, the ventrolateral nodes become rounded but still strong, and the ventral ribs become faint swellings. At 100 mm diameter the flanks are nearly smooth and have a faintly concave outer zone, there is an undulating ventrolateral shoulder, and the venter is well arched and faintly undulated by a remaining trace of the ventral ribs. At larger diameters the flanks are essentially smooth and merge into a well-rounded venter, and the umbilicus is small and smooth. Rib counts of specimens from USGS loc. 23042:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
11.5	14±	30±	35	18	30
15	16	32	40	17	33
18.5	18	38	40	15	29
20	17	35	41	16	30
20	16	32	43	16	29
20	17	32	47	15	30
24	16	31	48	16	32
27	16	34	49	16	33
29	16	33	56	13	25
29	16	32	86	13	26
30	14	27	91	12±	27±
32	17	34			
32	19	37	Average	16	31
33.5	16	35			

The suture is that of the genus (see text figs. 23*a*, *b*, *e*, *f*).

Remarks.—*Neogastroplites americanus* var. A is characterized by its strong, relatively fine sculpture in the younger stages (31 ventral ribs per whorl), lack of lateral nodes, the rapid loss of sculpture with increase in size, large smooth adults, and generally compressed form. It differs from var. B in its less stout whorls, loss of ribs on the flanks with increase in size, and lack of median ventral nodes. It resembles *N. maclearni* var. A, *N. muelleri* var. A, and *N. cornutus* var. A in the development of large smooth adults, but differs from all in the finer sculpture of the early stages and from the latter two in the more nearly tabulate venter. It differs from *N. haasi* var. A in its stronger, finer sculpture and its tabulate venter.

Neogastroplites americanus var. A in the younger stages suggests rather strongly some of the species of the considerably older genus *Gastroplites* McLearn, though it differs sharply from all of them. It has a smaller umbilicus and is more finely ribbed and more compressed at equal diameters than *G. canadensis* Whiteaves (McLearn, 1933, p. 15, pl. 1, figs. 1-5). It is much more finely ribbed and more weakly ribbed than *G. kingi* McLearn (1933, p. 19, pl. 3, figs. 4, 5). From other species of *Gastroplites* it differs in the size of the umbilicus, the degree of arching of the venter, the relative strength of the ventral ribs, or in other features.

Figured specimens.—GSC 13632, 13633; USNM 73775, 129528*a*, *b*, 129529–129553.

Neogastroplites americanus var. A-B, transitional variant

Plate 7, figures 7–9; plate 49, figures 1, 7; text figure 23*d*

Neogastroplites americanus var. A-B is represented by six specimens from one locality. They have rather stout whorls and strong primary ribs resembling those of var. B in the stages up to 50 mm diameter, but in the larger stages the ribs on the flanks fade out and the shell has the form of var. A. Measurements of four specimens from USGS loc. 23042 are as follows:

Measurements of four specimens

Diameter of shell (mm)	Figure No. on pl. 49	Whorl						Width of umbilicus		Width of venter	
		Height		Width							
				Over nodes		Between nodes					
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
25		12	48	11.5	46	10	40	5	20	8	32
35		17.5	50	14	40	12.5	36	7.5	21	9	26
40		21	53	17	43	14	34	8	20	10	25
51	1, 7	26.5	52	21.5	42	19	37	8.5	17	14	27

Rib counts

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
25	15	31
35	18	33
40	12	26
70±	11	21
Average	14	28

Figured specimens.—USNM 129528*c*, 129554–129556.

Neogastroplites americanus var. B

Plate 7, figures 10–12; plate 49, figures 3, 4; plate 50, figures 1–30; plate 51, figures 1–5, 9–12; text figures 23*c*, *g*, *h*

Neogastroplites americanus var. B is represented by 581 specimens from 11 localities. The largest individual is a fragment representing nearly half a whorl,

estimated to have had an original diameter of perhaps 80 mm. Other fragments too crushed to measure probably reached a diameter of 100 mm and one with the rostrum preserved may have been still larger. The large shells formed a thick disk.

Cross section of whorl to 6 mm diameter for shell depressed oval; subcircular at 7 mm diameter; subquadrate at 9 mm diameter, with umbilical and ventrolateral shoulders distinct and venter gently arched. In later stages the height of the whorl increases more proportionately than the width and a generally subtrapezoidal form of cross section is maintained; umbilical wall is steep and widest part of whorl is at about one-fourth the distance from the umbilicus to the ventrolateral shoulder; outer part of flank nearly flat; venter tabulate or only gently arched to 50 mm diameter and gently arched thereafter. Measurements of 29 specimens from USGS loc. 23042 are as follows:

Diameter of shell (mm)	Figure No. on pl. 50	Whorl						Width of umbilicus		Width of venter			
		Height		Width									
				Over nodes		Between nodes				Over nodes		Between nodes	
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
14	4–6	6.5	46	6	43	5.5	39	3.5	25	4.5	32	4	29
16	7–9	8	50	8	50	7.5	47	3.5	24	5	31	4	25
18		9	50	10	55	9	50	5	28	6.5	36	5.5	30
19		9	47	9	47	8	42	5.5	29	6.5	34	5	26
20	10–12	10.5	55	9	45	8	40	4	20	5.5	28	4.5	22
23.5		12	51	11	47	10	43	6.5	23	8	34	6.5	28
25		14	56	11.5	46	10	40	6	24	7.5	30	6	24
27	13, 14	14	52	12	45	11	41	6.5	24	9	33	7	26
28		15.5	56	14	50	13	47	6.5	23	8.5	30	7	25
33	23, 24	18	55	15	45	13	39	7	21	9	27	7.5	23
36		19	53	15.5	43	14	36	8	22	10.5	29	8.5	24
38		19	50	17.5	46	16	42	8	21	11.5	30	9.5	25
41		22.5	55	17	42	16.5	40	9	22	11.5	28	9	22
42	15, 25, 26	24	57	18	43	16.5	39	9.5	23	11.5	27	9	21
42	19–21	23	55	17.5	42	15	36	8.5	20	10	24	8	19
43	16–18	24	56	19	37	16	44	9	21	11.5	21	9.5	22
45		24	53	18	40	16	36	10	22	12	27	10	22
46		25	54	19	41	17.5	38	9	20	12.5	27	10.5	23
46		24	52	18	39	16.5	36	11	24	13.5	29	10	22
48.5		26	54	20.5	42	19	39	12	25	13.5	28	11	23
52		28	54	22.5	43	21	40	11	21	16	31	12.5	23
53		29	55	22	42	20	38	12.5	24	14.5	27	11.5	22
53		30	57	22	42	20	38	12.5	24	14.5	27	11	21
55	22, 27, 28	31	56	23	42	20	37	13	24	15	27	12	22
55		30	55	24	44	22.5	41	11.5	21	16.5	30	13	24
57		31	54	27	47	23	40	13	23	17	30	13	23
61		34	56	25	41	23	38	14	23	17	28	13	21
64		35	55	25	39	23.5	37	13.5	21	18.5	29	15	24
80±	29, 30	43	54	40±	50			15	19	25	31	19	24

Early whorls to about 5 mm diameter for shell smooth; then faint ribs appear on the flanks and in the half whorl to 7 mm diameter extend across the venter. The primary ribs mostly divide into two secondary ribs and a few secondary ribs are intercalated; the ribs are highest near the umbilicus and in the ventrolateral region and lowest on the median line of the venter. The umbilical margin and the ventrolateral shoulder are not defined. At 9 mm diameter the primary ribs are inclined forward and rise somewhat to the middle of the flank, where they divide; the secondaries pass radially to the ventrolateral region, where they bend forward and rise into a subdued node, and then cross the venter with a shallow forward convexity; the flanks and venter are clearly defined, though the ribs are still weak on the median ventral line. At 30 mm diameter the primary ribs are high, the ventrolateral nodes are strong, and the ventral ribs are strong across the venter. With increase in size the lateral ribs become lower and broader, the ventrolateral nodes are even more distinct, and the ventral ribs thicken on the median line and weaken near the ventrolateral nodes. At about 50 mm diameter a rounded median ventral node appears on each rib and quickly becomes well marked. On the largest individuals available the primary ribs are still distinct, though the outermost part of the flank is nearly smooth, the ventrolateral nodes are elongated inward, and the ventral nodes strong and rounded. A large fragment with the rostrum shows a ventral node elongated parallel to the rib. It is probable that var. B did not reach the

large size attained by var. A. Rib counts of specimens from USGS loc. 23042:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
14	14	28	45	15	30
16	16	28	46	15	28
18	14	28	46	14	26
19	16	32	48.5	15	28
20	16	33	52	16	28
23.5	15	30	53	16	27
25	13	30	53	15	28
27	16	32	53	17	28
35	16	31	55	16	30
38	17	34	57	12	22±
38	16	32	61	15	26
38	16	32	61	16	27
42	14	26	70	15	25
42	12	24			
43	15	19	Average	15	28

The suture is that of the genus (see text figs. 23*c*, *g*, *h*).

Remarks.—*Neogastroplites americanus* var. B is characterized by its only moderately compressed whorls, fine ribs, the persistence of strong primary ribs on the flanks of the whorl, and the presence in later stages of strong ventrolateral and median ventral nodes. It differs from var. A in its stouter whorl and stronger ornamentation, including the median ventral nodes, though it averages somewhat fewer ribs per whorl. It differs from var. C in its less stout shell, lack of nodes on the flanks, and later appearance of median ventral nodes. *N. americanus* var. B differs in the younger stages from all variants of *N. haasi* in the tabulate venter and finer sculpture and in the later stages in the presence of median ventral nodes. It bears considerable resemblance to *N. cornutus* var. D but differs in its stouter whorls, stronger ornamentation on the flanks though lacking lateral nodes, and later appearance of the median ventral tubercles. It resembles *N. muelleri* var. C somewhat but differs sharply in its much finer sculpture at all stages. It differs from *N. maclearni* var. B chiefly in its finer sculpture, having fewer ribs per whorl, and in its slightly more compressed whorls, though otherwise much like it.

Figured specimens.—USNM 129528*d*, 129557–129577.

Neogastroplites americanus var. B-C, transitional variant

Plate 7, figures 13–15; plate 51, figures 6–8; plate 52, figure 25; text figure 24*a*

Neogastroplites americanus var. B-C is represented by 48 specimens from six localities. It has the moderately compressed cross section and somewhat weaker sculpture of var. B, but shows the beginnings of the lateral nodes and the early appearance of the median ventral nodes more characteristic of var. C. The largest specimens available are about 50 mm in diameter and are somewhat crushed. Measurements of four specimens from USGS loc. 23042 (27, 32.5, 33, and 37 mm) and five from loc. 24568 (28, 29, 33.5, 41.5, and 44 mm) are as follows:

Diameter of shell (mm)	Whorl						Width of umbilicus		Width of venter			
	Height		Width									
			Over nodes		Between nodes				Over nodes		Between nodes	
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
27	14.5	54	13.5	50	12.5	46	6	22	9	33	7.5	28
28	15	54	13	46	11.5	41	6	21	9	32	7	25
29	15	52	14	48	12	41	6.5	22	10.5	36	8	28
32.5	18	55	16	49	13	40	7	22	11	34	7	22
33	18	55	17	52	14	42	7	22	10.5	32	7.5	23
33.5	18	54	15	45	13	39	7.5	22	11±	33	8±	24
37 [1]	19.5	53	17.5	47	16	43	8	22	10.5	28	8	22
41.5	23	55	20	48	17.5	42	9	22	13	31	10	24
44	23	52	21	48	18	41	9	21	14	32	10	23

[1] Figures 6–8 on plate 51.

Rib counts of the same specimens are as follows:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
27	12	27	44	11	23
28	16	34	45±	13	24
29	12	27	50±	13	25
32.5	11	23			
33	12	26	Average	13	26
38±	15	27			

Figured specimens.—USNM 129528*e*, 129578–129582.

Neogastroplites americanus var. C

Plate 7, figures 16–21; plate 52, figures 1–24, 26; plate 53, figures 24, 25; text figure 24*h*

Neogastroplites americanus var. C is represented by 222 specimens from 12 localities. The largest uncrushed specimen is about 50 mm in diameter, but fragments suggest individuals that must have reached

at least 80 mm in diameter. The largest shells were apparently a stout disk.

Cross section of whorl to diameter of 4 mm for shell much depressed oval. At 10 mm diameter depressed oval between the ribs and biconvex-lenticular through the ribs; venter well defined and only very gently arched; umbilical shoulder not well defined. Cross section increasing in relative height until at 25 mm diameter it is subcircular between ribs and hexagonal through them; venter gently arched and umbilical shoulder fairly well defined. At largest uncrushed diameter available (50 mm) cross section is still hexagonal, but lateral angles have become more prominent and outer part of flank is concave; venter is arched and umbilicus smooth. Larger fragments suggest that form of cross section did not change materially at largest diameters. Measurements of 15 specimens from USGS loc. 23042 (11, 14, 16, 19, 20.5, 22, 23, 24, 25, 27, 28, 31, 33, and 38 mm), three from loc. 24555 (35.5, 43.5, and 48.5 mm), and 10 from loc. 24568 (16.5, 22, 24.5, 27.5, 28.5, 32.5, 34, 44, 47, and 51 mm) are as follows:

Diameter of shell (mm)	Figure No. on pl. 52	Whorl						Width of umbilicus		Width of venter			
		Height		Width						Over nodes		Between nodes	
				Over nodes		Between nodes							
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
11	4–6	5	45	7.5	68	6.5	59	4	36	5±	45		
14		6	43	9	64	8	57	4	29	6±	43		
16		8	50	10	63	9	56	4	25	7±	44		
16.5		8.5	52	8	48	7	43	4	24	5	30	4±	24
19		9	47	11.5	60	10	53	5	26	7±	37	6±	31
20.5		10	49	11	54	10	49	5.5	27	8	39	5.5	27
22		11	50	13	59	12	55	6	27	8.5	39	7±	32
22		11.5	52	11	50	9.5	42	5	23	8±	36	6±	27
23		12	52	13	57	11	48	6	26	8	35	6	26
24		13	54	12.5	52	11	46	5.5	23	9	42	7	29
24.5		12	49	11.5	47	10	41	6.5	27	8.5	35	6	24
25	7, 8, 12	13	51	14	56	12	48	6	24	10	40	7	28
27		14	52	15	56	13	48	7	26	8.5	32	7	26
27.5		15.5	56	13	47	10.5	38	6	22	9.5	35	7	25
28		15	54	18	64	15	54	8	27	11.5	41	8	29
28.5		15	53	14	49	12	42	6.5	23	9±	32	7±	25
31		17	55	18.5	60	15	48	7	23	11.5	37		
32.5		18	55	17.5	54	14	43	8	25	11	34	7	22
33	23, 24	18	55	18	55	15	45	8	24	12.5	38	9	27
34		18.5	55	20.5	60	16	47	7	21	12.5	42	9	26
34		19	56	15	44	12	35	7	21	10	29	7	21
35.5		19	54	16.5	47	14	40	8	23	11.5	32	8.5	24
38	13–15	20	53	18	47	16	42	8.5	22	11.5	30	8.5	22
43.5		23	53	19.5	45	18	41	10	23	14	32	10	23
44		23	52	23.5	53	19	43	9.5	22	16	36	11	25
47		26	55	26	55	20	43	10	21	17	34	11.5	25
48.5		25.5	53	23	47	20	40	12	25	16.5	34	12	25
51		28.5	56	24	47	19.5	39	9	18	18	35	12	24

Early whorls to about 4 mm diameter for shell smooth; then weak primary ribs appear on the flanks. About one-fourth whorl farther, at 5 mm diameter, the ribs extend across the venter, low, weakest at the median ventral line and strongest at the ventrolateral margin. At 7 mm diameter the primary ribs show clearly division into two secondary ribs each; umbilicus smooth. At about 10 mm diameter the primary ribs are high, sharp and inclined forward, each dividing at an incipient node into two secondary ribs that pass straight across the venter, highest at the ventrolateral margin and weakest on the median ventral line; there are a few intercalated secondary ribs. At about 20 mm diameter the primary ribs rise into a sharp node at the middle of the flank; the secondary ribs bear a distinct node inclined forward at the ventrolateral margin; and the ventral ribs are convex forward and of equal strength across the venter. At about 30 mm diameter the ventral ribs have thickened on the median part, and at about 40 mm diameter median tubercles, mostly rounded but a few elongated parallel to the rib, have appeared. The sculpture in larger specimens of strong primary ribs bearing a node at the point of division at the middle of the flank, weaker ribs on the outer part of the flank, strong ventrolateral tubercles, and median ventral tubercles persists to the end of the largest specimens available. The ventrolateral and ventral nodes on some specimens are truncated anteriorly. Rib counts on the specimens noted above:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
11	14	28	28.5	15	30
14	14	29	31	12	24
16	15	32	32.5	13	25
16.5	15	32	33	12	25
19	13	27	34	15	30
20.5	13	28	35.5	15	29
22	15	30	38	11	25
22	16	32	43.5	18	30
23	12	27	44	13	24
24	15	29	47	12	23
24.5	14	30	51	11	22
25	15	30	75±	14	22
27	12	28			
27.5	14	27	Average	14	28
28	12	27			

The suture is that of the genus (see text fig. 24*h*).

Remarks.—*Neogastroplites americanus* var. C is characterized by its stout whorls at all stages, development of high, sharp primary nodes on the flanks at relatively early stages (20 mm diameter), and the presence of strong ventrolateral and median ventral nodes at fairly early stages (30 mm diameter). It differs from var. B in its stouter shell, the lateral nodes, and the earlier development of the median ventral nodes. It differs from var. D in its less stout, less depressed whorls, weaker ornament of nodes rather than spines on the flanks of the later stages. It differs from all variants of *N. haasi* in the presence of median ventral nodes. It resembles *N. cornutus* var. E but differs in its more numerous and stronger ribs and its weaker median ventral nodes. It differs from *N. muelleri* var. D in its stouter shell, more numerous ribs, and stronger sculpture in general, and from *N. maclearni* var. C chiefly in the much finer sculpture. The presence of nodes separates it from all species of *Gastroplites*.

Figured specimens.—GSC 13634; USNM 129528*f*, *g*, 129583–129596.

Neogastroplites americanus var. C-D, transitional variant

Plate 7, figures 22–24; plate 53, figure 1–5; text figure 24*d*

Neogastroplites americanus var. C-D is represented by 13 specimens from four localities. It has the relatively less stout form of var. C, especially in the younger whorls, and the ornamentation of var. D in the later stages. The largest specimen available is a half whorl at about 50 mm diameter and somewhat distorted. Others at about 40 mm are uncrushed. Measurements of five specimens from USGS loc. 23042 and one from loc. 24608 (40 mm) are as follows:

Measurements of six specimens

Diameter of shell (mm)	Figure No. on pl. 53	Whorl						Width of umbilicus		Width of venter			
		Height		Width									
				Over nodes		Between nodes				Over nodes		Between nodes	
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
18		8	44	10.5	58	9	50	5	28	7.5	42	6±	33
24		11	44	14	56	11.5	46	6	25	10.5	42	7±	29
25		13	52	14	56	12.5	50	6	24	10	40	7	28
27.5		14.5	53	15	55	13	47	6.5	25	10.5	43	8	29
34	3–5	18	53	22	65	18.5	54	8	24	14	41	9.5	28
43	1, 2	23	54	21	50	19	45	9	23	13	30	10	25

Rib counts

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
18	12	27
24	11	25
25	15	27
27.5	15	29
34	10	20
Average	12	25

Figured specimens.—USNM 129528*h*, 129597–129599.

Neogastroplites americanus var. D

Plate 7, figures 25–27; plate 53, figures 6–23, 26–28; plate 54, figures 1–5; text figures 24*c*, *f*

Neogastroplites americanus var. D is represented by 87 specimens from 10 localities. The largest uncrushed specimen is about 40 mm in diameter. A fragment of an outer whorl, probably including the rostrum and attached to inner whorls 28 mm in diameter, represents a shell about 50 mm in diameter. The largest shells formed a very stout disk.

Cross section of whorl to about 5 mm diameter for shell a much depressed oval; at 12 mm diameter the cross section is a depressed oval between nodes and a thick biconvex-lenticular figure through the nodes; at 15 mm diameter it is depressed hexagonal, with venter flat and well-defined facets on outer and inner parts of the flank; umbilicus smooth. Largest uncrushed specimens show much the same form of whorl except that the venter shows the median node and the outer and inner parts of the flank are concave. The largest fragments are relatively lower, with the cross section a much depressed hexagon. Measurements of 17 specimens from USGS loc. 23042 and three from loc. 24568 (21, 25, 40 mm) are as follows:

Diameter of shell (mm)	Figure No. on—		Whorl						Width of umbilicus		Width of venter			
			Height		Width						Over nodes		Between nodes	
					Over nodes		Between nodes							
	pl. 53	pl. 54	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
10	10–12		4	40	7	70	6	60	4	40	4.5	45		
15			6	40	10	62	9	60	4	27	6.5	43	6	40
17			8	47	12.5	74	10	59	5	29	7	41	6	35
17			8	47	11	65	10	59	5	29	8	47	6	35
17.5			8	46	12	69	10	57	5	29	8	46	6	34
18	14–16		7.5	42	12	67	10	56	4.5	25	8	44	6	33
18.5	26–28		8.5	46	13	70	12	65	5	27	8	43	6.5	35
20	6, 13		10	50	14	70	11.5	58	5.5	28	8.5	43	6.5	33
21			11	53	14	67	10.5	50	5.5	29	10	48	7	33
22			11.5	52	15.5	71	13	59	5	23	10	46	7	32
24	19–21		11.5	48	16.5	69	13	54	7	29	10	42	7.5	31
25			12.5	50	14.5	58	11.5	46	6	24	11	44	7	28
27			14	52	16.5	61	14	52	6	22	11.5	43	8.5	32
27			13	48	19	71	16	59	8	29	12	44	9	33
28		1–3	15	54	18	64	15	54	7	25	12	43	8.5	30
32			17	53	24	75	17.5	55	8	25	14	44	9.5	30
38	17, 18, 22		21	55	28	74	20	53	7	18	17	45	11.5	30
39			19.5	50	28	72	19	49	8.5	22	15	38	11.5	30
39			19	49	32	81	22	56	8	21	20	51	14	36
40			20	50	26±	65	19.5	49	9.5	24	17	43	12	30

Early whorls to about 3 mm diameter for shell smooth; then weak primary ribs appear on the flanks and at 5 mm diameter have increased in strength and extend across the venter with a faint forward convexity and a low point on the median ventral line. At 7 mm diameter the primary ribs have become sharp and divide each into two secondary ribs that show an incipient node on the ventrolateral area; umbilicus smooth. At about 12 mm diameter the secondary ribs cross the venter with equal strength across and a faint forward convexity, and the primary ribs bear sharp nodes at the point of division. At 25 to 30 mm diameter the ribs on the venter thicken on the median line of the shell, and at about 30 mm diameter a node appears, the ventrolateral nodes are elongated diagonally forward, and the primary nodes have become spines and have moved out on the flanks. At 40 mm diameter the median ventral nodes are elongated parallel to the rib and appear to lie behind the growth lines connecting the ventrolateral nodes; the lateral and ventrolateral nodes are truncated anteriorly. In the largest fragment the last ventrolateral and ventral nodes are weak and suggest strongly that the fragment is close to the aperture and probably in the final stage of the shell. Rib counts on the specimens noted above:

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
15	14	27
17	12	26
17	14	28
17.5	13	28
20	13	30
22	13	28
24	12	27
25	14	27
27	14	26

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
27	13±	25±
28	13	28
38	11	25
39	11	23
39	11	23
39	9	21
40	12	23
Average	12	26

The suture is that of the genus (see text figs. 24*c*, *f*).

Remarks.—*Neogastroplites americanus* var. D is characterized by the relatively depressed whorls at all stages and hence very stout, almost subglobose form; by its strong sculpture, including high sharp lateral nodes in early stages and lateral spines in later stages; and its relatively wide venter on the later stages. It differs from var. C in its stouter, more depressed whorls and spinose ornamentation. It differs from var. E chiefly in its less stout shell at all stages and later development of spinose ornamentation. *N. americanus* var. D differs from all variants of *N. haasi* in the presence of the median ventral nodes, from *N. cornutus* var. F in its much finer and weaker sculpture at similar diameters, from *N. muelleri* var. E in its stouter shell and more numerous and stronger ribs, and from *N. maclearni* var. D in its more numerous ribs and later appearance of the median ventral nodes. The presence of nodes separates it from all species of *Gastroplites*.

Figured specimens.—GSC 13635; USNM 129528*i*, 129600–129611.

Neogastroplites americanus var. D-E, transitional variant

Plate 7, figures 28–33; plate 54, figures 7–9; text figure 24*g*

Neogastroplites americanus var. D-E is represented by nine specimens from three localities. It has stouter whorls than var. D, but is not as stout at any stage as var. E. The largest uncrushed specimen is 33 mm in diameter, but a single specimen preserving much of a crushed living chamber may have been 45 mm in diameter. Measurements and rib counts of five specimens from USGS loc. 23042 are as follows:

Measurements of five specimens

Diameter of shell (mm)	pl. 54	Whorl						Width of umbilicus		Width of venter			
		Height		Width									
				Over nodes		Between nodes				Over nodes		Between nodes	
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
14		6	43	9	64	8	57	4.5	32	5	36		
23		12	52	16.5	72	13	57	5.5	24	9	39	7	30
30	7–9	15.5	52	22±	73	17	57	8	27	14	47	10	33
30.5		14	46	21±	69	15.5	51	8	26	11	41	8	26
33.5		17	51	25	75	19	57	7	21	14	42	10	30

Rib count

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
20	11	25
23	12	27
30	12	24
30.5	12	25
33.5	13	28
Average	12	26

Figured specimens.— USNM 129528*j*, *k*, 169612, 169613.

Neogastroplites americanus var. E

Plate 7, figures 34–42; plate 54, figures 6, 10–28; plate 55, figures 1–10; text figures 24*b*, *e*

Neogastroplites americanus var. E is represented by 52 specimens from eight localities. The largest individual is about 62 mm in diameter, with apparently the last half whorl unseptate. The largest shells are subglobose.

Cross section of whorl to about 5 mm diameter for shell much depressed oval. At 7 mm diameter it is still depressed oval between the ribs, but is biconvex-lenticular through the ribs. At 10 mm diameter venter is flattened but poorly defined. At 15 mm diameter cross section of whorl between nodes is depressed oval and through the nodes is depressed hexagonal, with venter well defined. This general form persists into the largest individuals available. The lateral angles are high and prominent, the inner and outer flanks are concave, and the venter is broad and only gently arched. Measurements of 15 specimens from USGS loc. 23042 and of one (24 mm) from loc. 24502 are as follows:

Diameter of shell (mm)	Figure No. on—		Whorl						Width of umbilicus		Width of venter			
			Height		Width									
					Over nodes		Between nodes				Over nodes		Between nodes	
	pl. 54	pl. 55	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
15.5	15–17		6	39	12	78	10	65	4	26	6.5	42	5	32
18	6, 13, 14		8	44	15	83	11.5	64	6	33	8	44	6	33
20	18, 23		10	50	16.5	83	12	60	6	30	9.5	48	6.5	33
21			9	43	17	81	13	62	5	23	10	48	7.5	36
24	24–26		11	46	21	83	15.5	65	6	25	11	46	8	33
24		1–3	10.5	43	24	100	14	58	7	27	11	46	8	33
25			12	48	21	84	16	64	8	32	11.5	46	8.5	34
26			13	50	19±	74	15	58	6.5	25	12	46	9	35
26.5			12.5	47	23±	87	17	64	6	23	14.5	55	10	38
28			12.5	45	22	79	18	64	6	21	13.5	48	10	36
30			13	43	28±	93	21.5	72	7	23	15	50	11	37
32			15	46	27.5	83	20	61	8	25	15	46	11	34
32	19–21		15	46	28±	85	21	64	7.5	23	15.5	47	12	37
35		4, 8, 10	18	52	30±	86	23	66	7	20	17	49	14	40
38.5	22, 27, 28		19	49	30±	78	22	57	7	18	16.5	43	12.5	33
41			21	51	32±	78	25	61	8	20	19	46	12	39
62		5–7	31	50	43	70	38	61	15	24	27	44	21	34

Early whorls to about 3 mm diameter for shell smooth. Then weak ribs appear on the flanks and at 5 mm diameter become sharp and extend across the venter, each primary rib dividing into two secondary ribs that are strongest on the margin of the venter and weakest on the median line of the venter. At 8 mm diameter a thickening of the secondary ribs on the margin on the venter appears and the ventral ribs are gently convex forward. At 12 mm diameter the ribs cross the venter with even strength and the primary ribs are high, sharp nodes; there are a few intercalated secondary ribs and the umbilicus is smooth. At 20 mm diameter a thickening appears on the ribs at the median ventral line and quickly becomes a node elongated parallel to the rib; the ventrolateral thickening has become a distinct low node, and the lateral nodes are rising into spines. At 30 mm diameter the lateral nodes are blunt spines, the ventrolateral nodes are sharp and elongated diagonally forward, and the ventral nodes are fairly prominent. On the latest

stages available much the same sculpture is present, with the lateral spines moved outward toward the venter, the ventrolateral nodes truncated on the forward side, and the ventral nodes apparently behind the growth lines connecting the ventrolateral nodes and much like a pinched-up rib, though in a few specimens they are more rounded. On several of the larger specimens the last two or three sets of nodes decrease abruptly and progressively in size and are thought to be virtually at the aperture. Rib counts on the specimens noted above:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
15.5	12	29	30	8	22
18	11	24	32	11	25
21	12	25	32	10	22
24	12	27	38.5	9	24
25±	10	26	41	8	20
25	10	24	62	8	18
26	10	26			
26.5	10	22	Average	10	24
28	13	23			

The suture is that of the genus (see text figs. 24*b*, *e*).

Remarks.—Neogastroplites americanus var. E is characterized by the much depressed whorls at all stages and very broad venter, and by its strong sculpture, with sharp high lateral nodes in early stages and lateral spines in later stages; the flanks remain distinct from the venter, which tends to remain flat. It differs from var. D chiefly in its stouter shell and earlier development of strong sculpture. It differs from the stout variants of *N. haasi* in the presence of the ventral nodes, though otherwise similar to them; from *N. cornutus* vars. F and G in its stouter shell and much more numerous ribs, elongated rather than round ventral nodes, and the placement of the lateral spines below the level of the venter in even large specimens; from *N. maclearni* var. E chiefly in its consistently more numerous ribs at similar diameters. The presence of nodes and the subglobose form separate it from all species of *Gastroplites*.

Figured specimens.—USNM 129528*l–n*, 129614–129625.

Neogastroplites maclearni Reeside and Cobban, n. sp.

Plate 57, figures 13–15; text figures 27–29

As is true of other species of *Neogastroplites* here considered, the range in *N. maclearni* of form and ornamentation precludes any simple statement of characters. The most distinctive features are its relatively strong sculpture, with ribs only average in number per whorl for the genus, and tabular or only faintly arched venter; in the compressed variants the early ribs on the flanks are strong, but are rapidly lost and the shells become smooth; in moderately compressed variants a median ventral node appears; in stout variants the lateral and median ventral nodes become strong; and in subglobose variants the lateral nodes move out on the flanks and the outer part of the flank and the venter tend to form one arched surface.

The form of *N. maclearni* at all stages is much like that of *N. americanus*, but differs sharply in its smaller number of ribs per whorl. From *N. haasi* it differs in its somewhat finer sculpture, the presence in all but the most compressed forms of median ventral nodes, the tabulate venter, and in the subglobose variants in the position of the lateral nodes well out on the flanks. From *N. cornutus* it differs in its considerably finer and stronger sculpture and its tabulate venter. From *N. muelleri* it differs in its finer and stronger sculpture and its tabulate venter.

The writers have found it convenient to describe below five variants, to which the letters A to E are applied. It is notable that the compressed costate portion of the assemblage has been reduced numerically to about half the total (49 percent), the stout nodose portion is little changed (12 percent), but the subglobose portion has expanded to nearly two-fifths (39 percent), a strong contrast with the earlier assemblages except that of *N. haasi*, the earliest. One large lot is available and four smaller lots, but these are perhaps enough to serve as a check on the numerical distribution of variants. Table 10 shows the distribution of the variants.

TABLE 10.—*Distribution of specimens of* Neogastroplites maclearni *by locality, variant, and size*

USGS Mesozoic locality No.	Map No.	Diameter of shell (mm)	Number of specimens for indicated character group and variant					Total
			Compressed costate		Stout nodose	Subglobose spinose		
			A	B	C	D	E	
Alberta								
GSC 17300	2	<25	33	16	14	56	22	141
		25–50	12	5	4	5	0	26
		>50	4	3	3	0	0	10
Total, Alberta			49	24	21	61	22	177
Montana								
24609	24	<25	2	0	0	0	0	2
		25–50	1	2	5	1	1	10
		>50	0	1	0	0	0	1
Total			3	3	5	1	1	13
24610	25	<25	2	0	------	------	------	2
		25–50	3	1	------	------	------	4
		>50	3	1	------	------	------	4
Total			8	2	------	------	------	10
24611	26	<25	3	0	------	------	------	3
		25–50	3	4	------	------	------	7
		>50	4	0	------	------	------	4
Total			10	4	------	------	------	14
24612	27	<25	0	------	------	------	------	0
		25–50	3	------	------	------	------	3
		>50	1	------	------	------	------	1
Total			4	------	------	------	------	4
Total, Montana			25	9	5	1	1	41
Grand total			74	33	26	62	23	218

The suture line of the species is that of the genus. External sutures of variants A, B, and E are shown in figure 27.

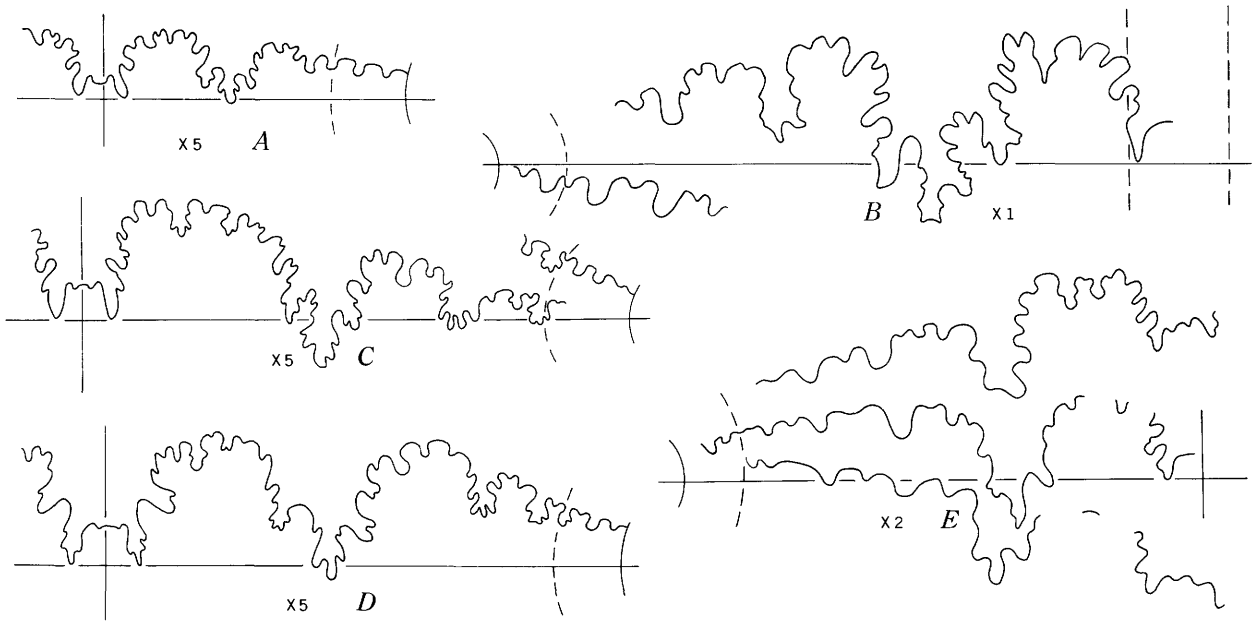

FIGURE 27.—Sutures of *Neogastroplites maclearni* Reeside and Cobban, n. sp. *a*. Var. E at about 11 mm diameter (× 5). *b*. Var. A at 130 mm diameter (× 1); suture much corroded; (see also pl. 56, figs. 19, 20). *c*. Var. A at about 21 mm diameter (× 5) (see also pl. 56, figs. 1–5). *d*. Var. B at 21 mm diameter (× 5) (see also pl. 57, figs. 19–21). *e*. Var. B at 53 mm diameter (× 2); suture much corroded; (see also pl. 57, figs. 13–15). Figures *a*, *b*, and *e* are from specimens from GSC loc. 17300, Grande Cache map area, Alberta; figure *c* is from a specimen from USGS loc. 24610, Wheatland County, Mont.; figure *d* is from a specimen from USGS loc. 24611, Wheatland County, Mont.

The overlap in proportions of the shell in the variants is brought out in figure 28.

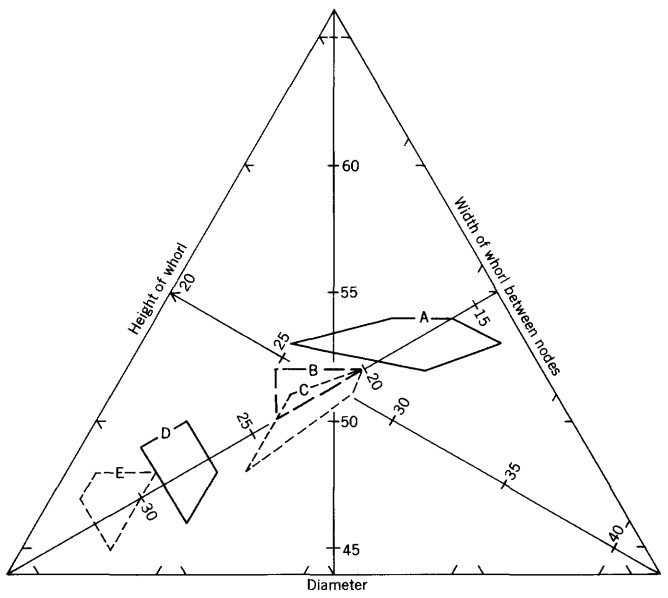

FIGURE 28.—*Neogastroplites maclearni* Reeside and Cobban, n. sp. Proportions of the shell in five variants as indicated by measurements of the diameter of the shell, the height of the whorl, and the width of the whorl between nodes. The point indicating the measurements falls within the enclosure lettered to correspond with the variant.

Occurrence.—As shown in table 10, *N. maclearni* is known at five localities in central western Alberta and in Wheatland County, Montana. Figure 29 shows the distribution of the localities in the United States.

Type specimen.—GSC 13645 (pl. 57, figs. 13–15).

Neogastroplites maclearni var. A

Plate 55, figures 11–14; plate 56, figures 1–20; plate 57, figures 1–3; text figures 27*b*, *c*

Neogastroplites maclearni var. A is represented by 74 specimens from five localities. The largest individual available, somewhat crushed, is about 140 mm in diameter and forms a compressed disk.

Cross section of whorl to about 3 mm diameter for shell depressed oval; at about 5 mm diameter, subcircular; at about 10 mm diameter, high oval, with ventrolateral and umbilical shoulders vague, venter rounded. At 15 mm diameter flanks of whorl are flattened, umbilical and ventrolateral shoulders well defined, venter only gently arched, and cross section of whorl is subtrapezoidal. At about 20 mm diameter cross section of whorl is high trapezoidal, venter nearly flat; in the later stages to 70 mm diameter this form is maintained, with height of whorl increasing more rapidly than the width and with greatest width near

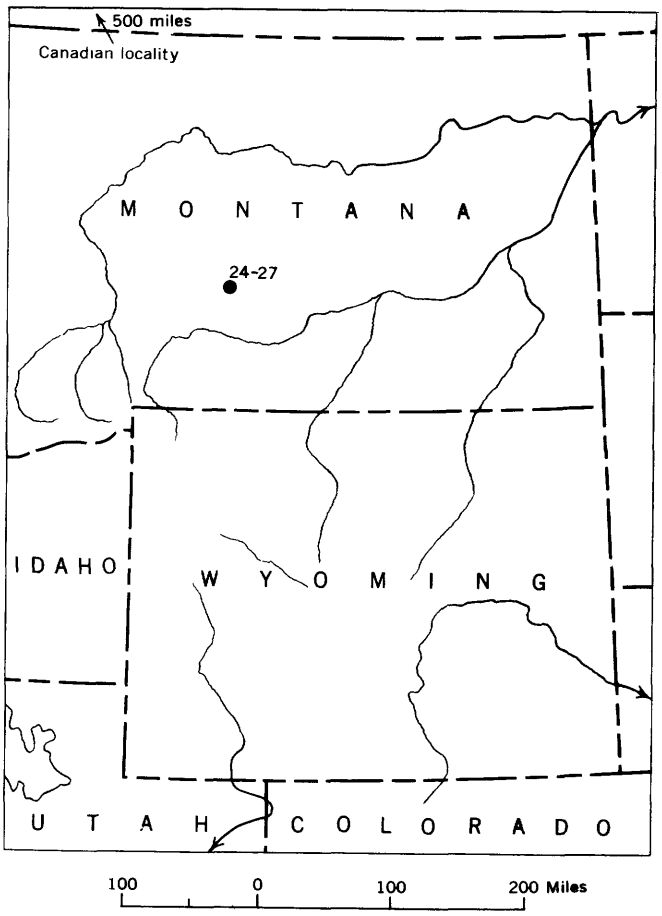

FIGURE 29.—Localities of *Neogastroplites maclearni* Reeside and Cobban, n. sp.

the umbilical shoulder. The largest individual available, about 140 mm in diameter, is somewhat flattened by crushing, but would perhaps approach a high oval in cross section of whorl. Measurements of 10 specimens from GSC loc. 17300, one from USGS loc. 24609 (43 mm), one from USGS loc. 24610 (68 mm), and one from USGS loc. 24611 (21 mm) are as follows:

Whorls to about 5 mm diameter for shell smooth; then faint swellings appear near the umbilicus and at about 10 mm diameter have become distinct costae that pass diagonally forward, mostly dividing on the flank and passing radially to the margin of the venter, where they bend faintly forward and cross the venter with shallow forward convexity; the costae are highest near the umbilicus and weakest on the venter; umbilicus smooth. At 16 to 20 mm diameter the primary ribs become sharp, moderately high, mostly dividing below the middle of the flank, and the secondary ribs bend forward and become strong on the ventrolateral shoulder, defining the flank and venter; on the venter the ribs cross nearly straight and are nearly of the same height clear across. At larger diameters up to perhaps 40 mm the sculpture is much the same, then the ribs of the flanks weaken and at about 60 mm diameter only the part of the primary ribs near the umbilicus remains, and the secondary ribs are represented by elongated nodes bordering the venter. At the largest diameters available only traces of the ribs remain and the whorls are essentially smooth. Rib counts of 17 specimens are as follows:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
19	14	25	39	16±	22±
20	15	29	43±	11	22±
20	11	23	43	11	24
21	11	24	46	13	27
22	11	26	64	11	20
24	14	26	68±	11	23
24	14	28	130	12	
24	11	25			
25	13	26	Average	12	25
39	12±	26±			

The suture is that of the genus (see text figs. 27*b*, *c*).

Remarks.—Neogastroplites maclearni var. A is characterized by its compressed form, relatively strong sculpture, with ribs medium in number for the genus (average, 25 ventral ribs per whorl) in the earlier

Diameter of shell (mm)	Figure No. on pl. 56	Whorl						Width of umbilicus		Width of venter			
		Height		Width						Over nodes		Between nodes	
				Over nodes		Between nodes							
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
9	7–9	4.5	50	4.5	50					3±	33		
13	10–12	7	54	6	46	4.5	35	3	23	4±	31	3.5±	27
16	7–9	8	50	8	50					6	38	5	31
16		8	50	7	44	6	37	4	25	5	31	4.5	28
21		12	57	8	38	7	33	3.5	17	5±	24	4±	19
21	13–15	10.5	50	10	48	8.5	40	4.5	21	7.5	36	6.5	31
25		13	52	10	40	8.5	34	4	16	7	28	6	24
39		22	56	14	36	12	31	7	18	9	23	7.5	19
43± [1]		26	60	15	35	12.5	29	5	12	9	21	8	19
46	16–18	24	52	17	37	16.5	36	9	20	10.5	23	9.5	21
64 [2]		35	55	23	36	22±	34	12	19	12.5±	20	10±	16
68±	1–5	36±	53	23±	34			7	10	13	19	11	16
130	19, 20	79	61	30	23			13±	10				

[1] Figures 12 and 13 on plate 55.
[2] Figures 1–3 on plate 57.

whorls, lack of lateral and ventral nodes, and rapid loss of sculpture with increase in size. It differs from var. B in its less stout whorls and lack of lateral and median ventral nodes at any stage. It resembles *N. americanus* var. A very closely in form and ornamentation but differs sharply in the number of ventral ribs (in *N. americanus* var. A, 31 per whorl). It differs from *N. haasi* var. A, *N. cornutus* var. A, and *N. muelleri* var. A in its stronger sculpture and more nearly tabulate venter. The younger stages of *N. maclearni* var. A suggest strongly some of the species of the older genus *Gastroplites* McLearn, though it differs sharply from all of them. It has a smaller umbilicus and more compressed whorls at equal diameters than *G. canadensis* (Whiteaves) (McLearn, 1933, p. 15, pl. 1, figs. 1-5), and the division of the primary ribs is farther out on the flank. It is not as strongly ribbed in the early stages at similar diameters as *G. kingi* McLearn (1933, p. 19, pl. 3, figs. 4, 5), and loses the ribs with increase in size, in contrast with *kingi*, which retains them. From other species of *Gastroplites* it differs in the smaller size of the umbilicus, degree of arching of the venter, relative strength of the ventral ribs, and other features.

Figured specimens.—GSC 13636–13644; USNM 129305, 129306, 129626–129628.

Neogastroplites maclearni var. B

Plate 57, figures 4–23; text figures 27*d*, *e*

Neogastroplites maclearni var. B is represented by 33 specimens from four localities. The largest individual in good condition is about 60 mm in diameter, but fragments suggest specimens up to 75 mm diameter. Undistorted specimens form a moderately stout disk.

Cross section to about 7 mm diameter for shell depressed oval; at about 9 mm diameter subcircular; subtrapezoidal at about 11 mm diameter, with umbilical and ventrolateral shoulders defined, flanks flattened, and venter very gently arched. This subtrapezoidal cross section is maintained to about 50 mm diameter, where the development of high points on the primary ribs at the middle of the flanks gives it a hexagonal form. At 50 mm the venter is arched and umbilicus smooth. Measurements of five specimens from GSC loc. 17300 and one each from USGS locs. 24609 (51 mm) and 24611 (24 mm) are as follows:

Diameter of shell (mm)	Figure No. on pl. 57	Whorl						Width of umbilicus		Width of venter			
		Height		Width									
				Over nodes		Between nodes				Over nodes		Between nodes	
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
17		8	47	8	47	7.5	44	3.5	21	6	35	5	29
17		9	53	8.5	50	8	47	3	18	6	35	5.5	32
23		12	52	10	44	9.5	41	5	22	8	35	7	30
24	19–21	13	54	11	46	9.5	40	6	25	8	33	6.5	27
50	13–15	27	54	23	46	20	40	10	20	17.5	35	14.5	29
51	9, 10	27	53	22±	43	20±	39	9	18	18±	35	13±	26
60	17, 22, 23	33	55	28	47	24	40	11	18	20	33	15	25

Whorls to about 5 mm diameter for shell smooth. Then faint ribs appear near the umbilicus and at 7 mm diameter extend across the whorl, though weak on the venter, the primary ribs mostly divide into two secondary ribs and the ribs are highest near the umbilicus and in the ventrolateral region; umbilical and ventrolateral margins not well defined. At about 10 mm diameter the primary ribs begin to rise at the point of division and the secondary ribs begin to incline gently forward at the margin of the venter, defining flank and venter. At about 20 mm diameter the primary ribs rise into a distinct sharp point at the point of division and the secondary ribs bear a distinct inclined node at the ventrolateral margin. In the larger stages the primary elevation becomes higher and moves to the middle of the flank and the ventrolateral nodes become prominent. At about 35 mm diameter a node appears on the secondary rib at the middle of the venter and is present to the end of the largest individuals available. The largest fragments (about 75 mm diameter) suggest that the ribs on the flanks are still distinct at that stage. Rib counts are:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
17	11	25	40	11±	24±
18	12	23	50	12	23
20	11	23	51	13±	24±
24	13	25	54	13	22
25	11	21	60	11	21±
31	11±	22±			
34±	11	22	Average	12	23

The suture is that of the genus (see text figs. 27*d* *e*).

Remarks.—*Neogastroplites maclearni* var. B is

characterized by its moderately stout whorls, strong sculpture, with ribs moderate in number for the genus (average 23 per whorl), development of high lateral ribs and in the later stages of median ventral nodes, and the persistence of the lateral ribs. It differs from var. A in its stouter whorls and the presence of lateral elevations and median ventral nodes, and from var. C in its less stout whorls and later appearance of lateral elevations and median ventral nodes. It differs from *N. americanus* var. B in its smaller number of secondary ribs (*N. americanus* var. B averages 28 per whorl), from all variants of *N. haasi* in its tabulate venter and the presence of median ventral nodes, from *N. cornutus* var. D. in its stouter shell and stronger ornamentation but weaker lateral nodes, and from *N. muelleri* var. D in its stouter form and stronger sculpture. It does not resemble any species of *Gastroplites*.

Figured specimens.—GSC 13645 (holotype), 13646–13651; USNM 129629–129631.

Neogastroplites maclearni var. C

Plate 58, figures 1–16

Neogastroplites maclearni var. C is represented by 26 specimens from two localities. The largest available specimen is 66 mm in diameter and forms a stout disk.

Cross section of whorl depressed oval to a diameter of 7 mm for shell; subcircular at about 8 mm diameter; subtrapezoidal at 10 mm diameter, with umbilical and ventrolateral shoulders defined, flanks flattened, venter gently arched. At about 18 mm diameter the cross section of the whorl is hexagonal, with venter gently arched. This form continues to the largest specimen available, with the change that the ventral tubercle causes the venter to appear somewhat more highly arched. Measurements of five specimens from GSC loc. 17300 and one from USGS loc. 24609 (44 mm) are as follows:

Diameter of shell (mm)	Figure No. on pl. 58	Whorl						Width of umbilicus		Width of venter			
		Height		Width									
				Over nodes		Between nodes				Over nodes		Between nodes	
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
13	1–3	7	54	8	61	7	54	3	23	5	38	4.5	35
17		9	53	8.5	50	7.5	44	3.5	21	7	41	5.5	32
24		13	54	12	50	10	42	5	21	9	37	7	29
32±	4, 5, 7, 11	17	53	15	47	12	37	7	22	10	31	8.5	27
44	12–14	22	50	23	52	20	45	9	20	16	36	12	27
66	15, 16	36	55	33	50	28	40	12	18	24	37	17	26

Whorls to about 4 mm diameter for shell smooth. Then faint ribs appear near the umbilicus and in the half whorl to about 6 mm diameter become stronger and extend until they cross the venter, though they are weak there. In another half whorl to about 9 mm diameter the ventral ribs are distinct though still weak on the median line; the primary ribs mostly divide into two secondary ribs that bend slightly forward in the ventrolateral region and cross the venter with shallow forward convexity. The point of division of the primary rib with increase in size becomes a sharp node and the forward-bending part of the secondary rib becomes a distinct node inclined forward. At about 18 mm diameter the primary ribs bear a high sharp node, the flank and venter are separated by well-marked ventrolateral nodes, and the ventral ribs are of even strength across the venter. At 25 to 30 mm diameter a weak node appears on the secondary rib at the median line of the venter and the sculpture of strong ribs with primary nodes at the middle of the flank, ventrolateral nodes, and median ventral nodes persists into the largest individuals available.

Rib counts on six specimens are:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
24	12	23	45±	11	22±
32	12±	24±	66	12	19
40±	11	22			
44	11	21	Average	12	22

Remarks.—*Neogastroplites maclearni* var. C is characterized by its stout whorls at all stages, strong sculpture, with ribs medium in number for the genus (average 22 per whorl), sharp lateral nodes at a fairly early stage (18 mm diameter) and median ventral nodes at a somewhat later stage (25 to 30 mm diameter). It differs from var. B in its stouter whorls and earlier appearance of lateral elevations and median ventral nodes, and from var. D in the less stout whorls and the later development of the lateral and ventral nodes. It resembles *N. americanus* var. C very much, but differs in the smaller number of secondary ribs (*N. americanus* var. C averages 28 per whorl). It differs from all variants of *N. haasi* in the presence of the

median ventral nodes; from *N. cornutus* var. E in its stronger, more numerous ribs and weaker median ventral nodes; from *N. muelleri* var. E in its more slender whorls and stronger ornamentation.

Figured specimens.—GSC 13652–13657; USNM 129632, 129633.

Neogastroplites maclearni var. D

Plate 58, figures 17–29

Neogastroplites maclearni var. D is represented by 62 specimens from two localities. The available specimens are all small, the largest being a mold of a fragment at about 32 mm diameter. The uncrushed or unbroken specimens range up to 28 mm in diameter, most being from 20 to 25 mm. They are very stout, almost subglobose shells.

Cross section of whorls a depressed oval to about 10 mm diameter for shell, then a somewhat depressed trapezoid to about 15 mm diameter, then a depressed hexagon to the largest diameter available. The venter is very gently arched in the later stages and the umbilicus is smooth. Measurements of seven specimens from GSC loc. 17300 are as follows:

Diameter of shell (mm)	Figure No. on pl. 58	Whorl						Width of umbilicus		Width of venter			
		Height		Width									
				Over nodes		Between nodes				Over nodes		Between nodes	
		Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
19	17–19	9	47	14±	74	10.5	55	4.5	24	9	47	7±	37
23.5		12	51	17.5	72	12.5	53	5	21	11.5	47	9	32
24	26–28	12	50	19±	79	15	63	5	21	12.5	52	9	38
24		12	50	19±	79	14.5	60	5	21	12	50	9	38
25		12	48	20	80	15.5	61	6	24	12	48	10	40
25		11	44	20±	80	15	60	5	19	13	50	10	40
28	20–22	15	54	23.5	84	18	64	5	18	13	46	10	36

Whorls to about 3 mm diameter for shell smooth; then weak nodes appear near the umbilicus and by about 5 mm diameter have become stronger and extend across the venter as faint broad ribs. At 8 or 9 mm diameter the primary ribs on the flanks incline forward, mostly divide into two secondary ribs that near the venter bend gently forward and cross the venter as distinct ribs, though weak at the middle of the venter. The point of division of the primary rib begins then to rise and at a diameter of 15 mm has become a sharp node. At about this diameter the forward bend of the secondary rib begins to thicken and at 18 mm diameter is a distinct node separating the flank and the venter; the ventral ribs are of equal strength across the venter. At about 20 mm diameter the lateral nodes have moved out on the flank and a weak node appears on each secondary rib on the median line of the venter. This sculpture of high, sharp lateral nodes, approaching blunt spines, ventrolateral nodes bordering a broad, gently arched venter and separating flank and venter, and weak median ventral nodes continues to the end of the largest specimens available. Rib counts of the specimens noted above:

At diameter (mm) of—	Number of ribs		At diameter (mm) of—	Number of ribs	
	Primary	Secondary		Primary	Secondary
19	12	26	26	9	21
23.5	10	23	28	10	21
24	10	23			
24	10	21	Average	10	23
25	11	22			

Remarks.—*Neogastroplites maclearni* var. D is characterized by its depressed whorls at all stages; its stout, almost subglobose, whorls, with venter and flank distinct; strong sculpture, with ribs medium in number for the genus (average 23 secondary ribs per whorl), strong lateral nodes and ventral nodes from an early stage (20 mm diameter). It differs from var. C in its stouter whorls and earlier development of the lateral and ventral nodes, and from var. E in the less stout whorls, somewhat narrower venter, preservation of distinction between flank and venter, and somewhat weaker sculpture. It resembles *N. americanus* var. D, but differs at similar diameters in its less numerous ribs (*N. americanus* var. D averages 26 secondary ribs per whorl) and earlier appearance of the median ventral nodes. It differs from all variants of *N. haasi* in the median ventral nodes and somewhat finer ribs, from *N. cornutus* vars. F and G at similar diameters in its stouter shell and more numerous ribs, from *N. muelleri* var. G at similar diameters in its stouter shell and finer ornamentation. No other Canadian species resembles it.

Figured specimens.—GSC 13658–13665; USNM 129634.

Neogastroplites maclearni var. E

Plate 33, figures 2–12; text figure 27*a*

Neogastroplites maclearni var. E is represented by 23 specimens from two localities. The specimens are

all small, the largest a distorted fragment at perhaps 30 mm diameter. The uncrushed specimens range up to 25 mm in diameter, but most are smaller. They are subglobose shells.

Cross section of whorl to about 7 mm diameter for shell is depressed oval; at 10 mm diameter it is still depressed oval between the nodes but depressed hexagonal through the nodes, with the ventral facet gently arched. At 15 mm diameter cross section of whorl is much depressed hexagonal, with ventral facet wide, well defined, and nearly flat. At the largest stages available the cross section is wide and biconvex lenticular, with the lateral angles acute. Measurements of four specimens from GSC loc. 17300 are as follows:

Diameter of shell (mm)	Whorl						Width of umbilicus		Width of venter			
	Height		Width									
			Over nodes		Between nodes				Over nodes		Between nodes	
	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter	Millimeters	Percent of diameter
21 [1]	9.5	45	18	86	14	67	4.5	21	11	52	10	48
23	11	48	19	81	13.5	59	4.5	20	11.5	50	9±	39
24±	12	50	21±	87	17	71	4.5	19	13	54	11	46
26 [2]	11.5	44	26	100	17	65	5	19	14.5	56	12	46

[1] Figures 10–12 on plate 33.
[2] Figures 5–7 on plate 33.

Whorls to about 3 mm diameter for shell smooth; then weak ribs appear on flanks near umbilicus and by 5 mm diameter both flank and ventral ribs are distinct, but the ribs are still weak at the middle of the venter; the primary ribs incline forward and mostly divide into two radial secondary ribs that near the venter bend gently forward and cross the venter with shallow forward convexity. At about 10 mm diameter the point of division of the primary ribs begin to rise. At 12 to 15 mm diameter it has become a high sharp node; the forward bend of the secondary ribs has become a weak node that separates flank and venter, and the ventral ribs are of even strength across the venter. In later stages the primary nodes become blunt spines and move out radially until the outer part of the flank and the venter form one gently curved surface, the ventrolateral nodes become more distinct, and a weak median ventral node appears on the secondary ribs. The general aspect of the shell is subglobose spinose. Rib counts on the specimens noted above:

At diameter (mm) of—	Number of ribs	
	Primary	Secondary
21	10	22
23	10	22
24±	10	20
26	8	19
Average	10	21

The suture is that of the genus (see text fig. 27*a*).

Remarks.—*Neogastroplites maclearni* var. E is characterized by its much depressed whorls at all stages; its subglobose form, with venter and flank almost confluent and very broad; and its strong sculpture, with medium number of ribs for the genus (average 21 per whorl), lateral spines and weak ventral nodes. It differs from var. D in its stouter shell, broad ventral aspect, and stronger sculpture. It resembles at similar diameters *N. americanus* var. E but differs chiefly in its consistently less numerous ribs (*N. americanus* var. E has 24 secondary ribs per whorl). It differs in the presence of median ventral nodes from all forms of *N. haasi* and particularly from *N. haasi* var. F at similar diameters by the confluent flank and venter. It resembles *N. muelleri* var. G very much, but differs in its stouter whorls. No previously recorded Canadian form resembles it.

Figured specimens.—GSC 13666–13671; USNM 129635.

Neogastroplites sp.

At 17 localities specimens of *Neogastroplites* have been found that are poorly preserved or do not otherwise lend themselves readily to specific determination. To complete the record they are listed here by the USGS locality number. Figure 30 shows the distribution of the localities.

Occurrence.—Montana: Cascade County, 26065, 26066; Judith Basin County, 3954, 23412, 24613; Fergus County, 24600, 24918, 24920; Wheatland County, 24604, 24606, 24607; Park County, 23023; and Big Horn County 20933, 23245. Wyoming: Johnson County, 4941; Fremont County, 8979. Colorado: Jackson County, 7100.

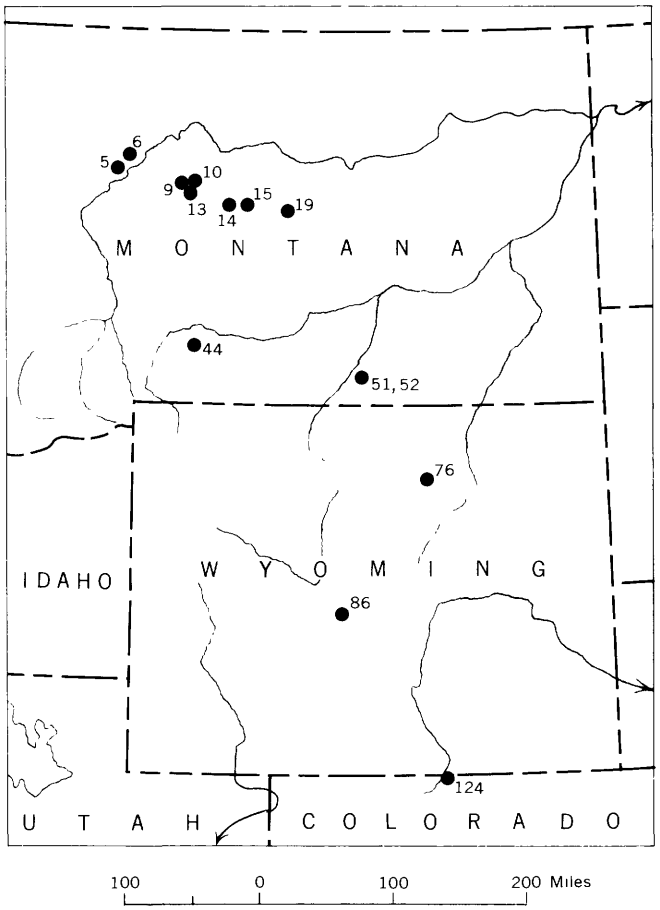

FIGURE 30.—Localities of *Neogastroplites* sp.

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[Italic numbers indicate descriptions]

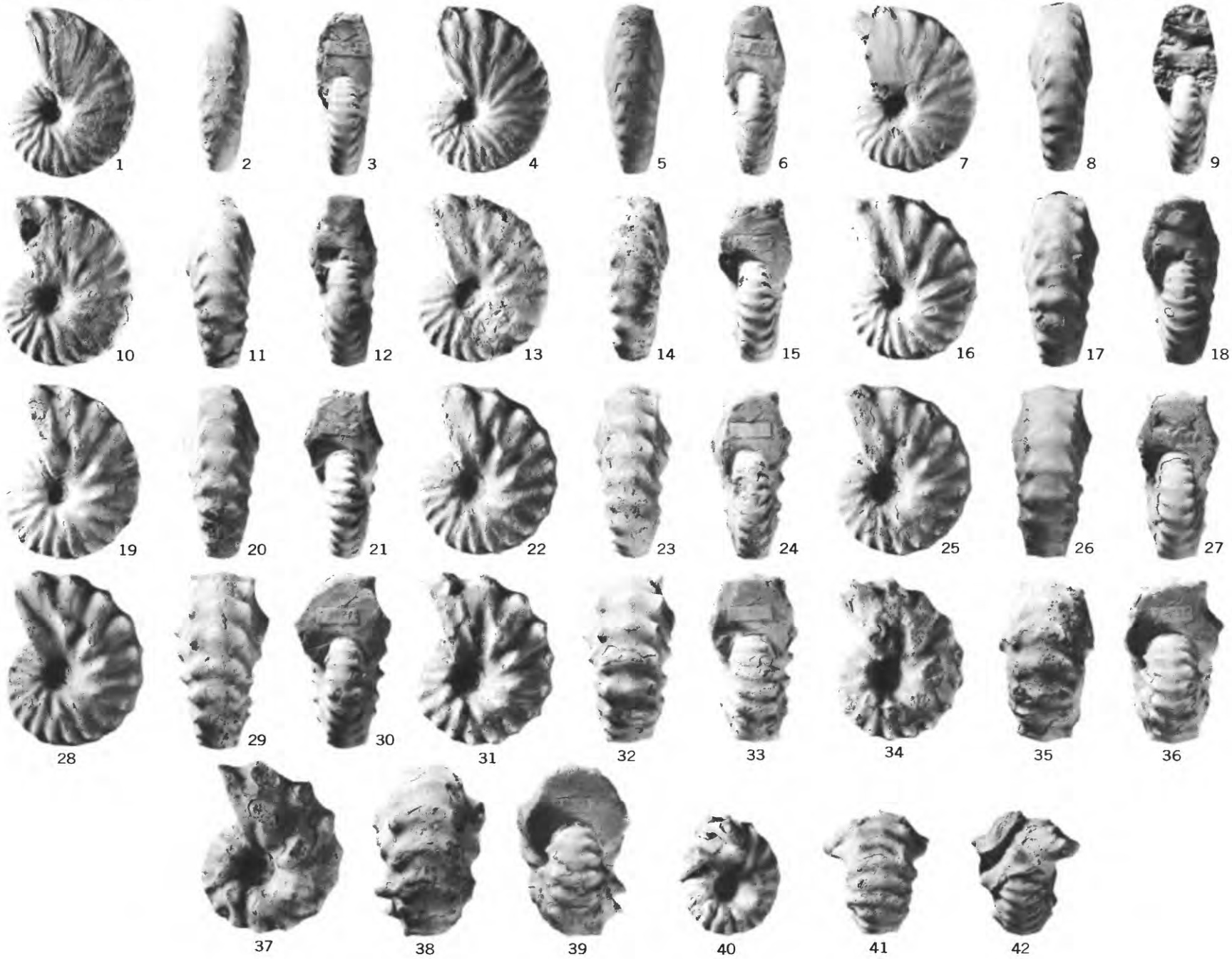
PLATES 5–58

PLATE 5

FIGURES 1–42. *Neogastroplites cornutus* (Whiteaves) (p. 67).

Side, rear, and front views (× 1) of 14 specimens from a single concretion in the basal part of the Mowry shale at USGS loc. 23021, Park County, Wyo., to show the range of variation.

1–3. Var. A. USNM 129320a.
4–6. Var. B. USNM 129320b.
7–9. Var. B–C. USNM 129320c.
10–12. Var. C. USNM 129320d.
13–15. Var. C–D. USNM 129320e.
16–18. Var. D. USNM 129320f.
19–21. Var. D–E. USNM 129320g.
22–27. Var. E. USNM 129320h, i.
28–33. Var. E–F. USNM129320j, k.
34–39. Var. F. USNM 129320l, m.
40–42. Var. G. USNM 129320n.



NEOGASTROPLITES CORNUTUS (WHITEAVES)

PLATE 6

FIGURES 1–51. *Neogastroplites muelleri* Reeside and Cobban, n. sp. (p. 81).

Side, rear, and front views (× 1) of 17 specimens from a single concretion at a horizon just below the middle of the Mowry shale member of the Colorado shale at USGS loc. 24065, Petroleum County, Mont., to show the range of variation.

1–6. Var. A. USNM 129416a, b.
7–9. Var. A–B. USNM 129416c.
10–12. Var. B. USNM 129416d.
13–18. Var. B–C. USNM 129416e, f.
19–21. Var. C. USNM 129416g.
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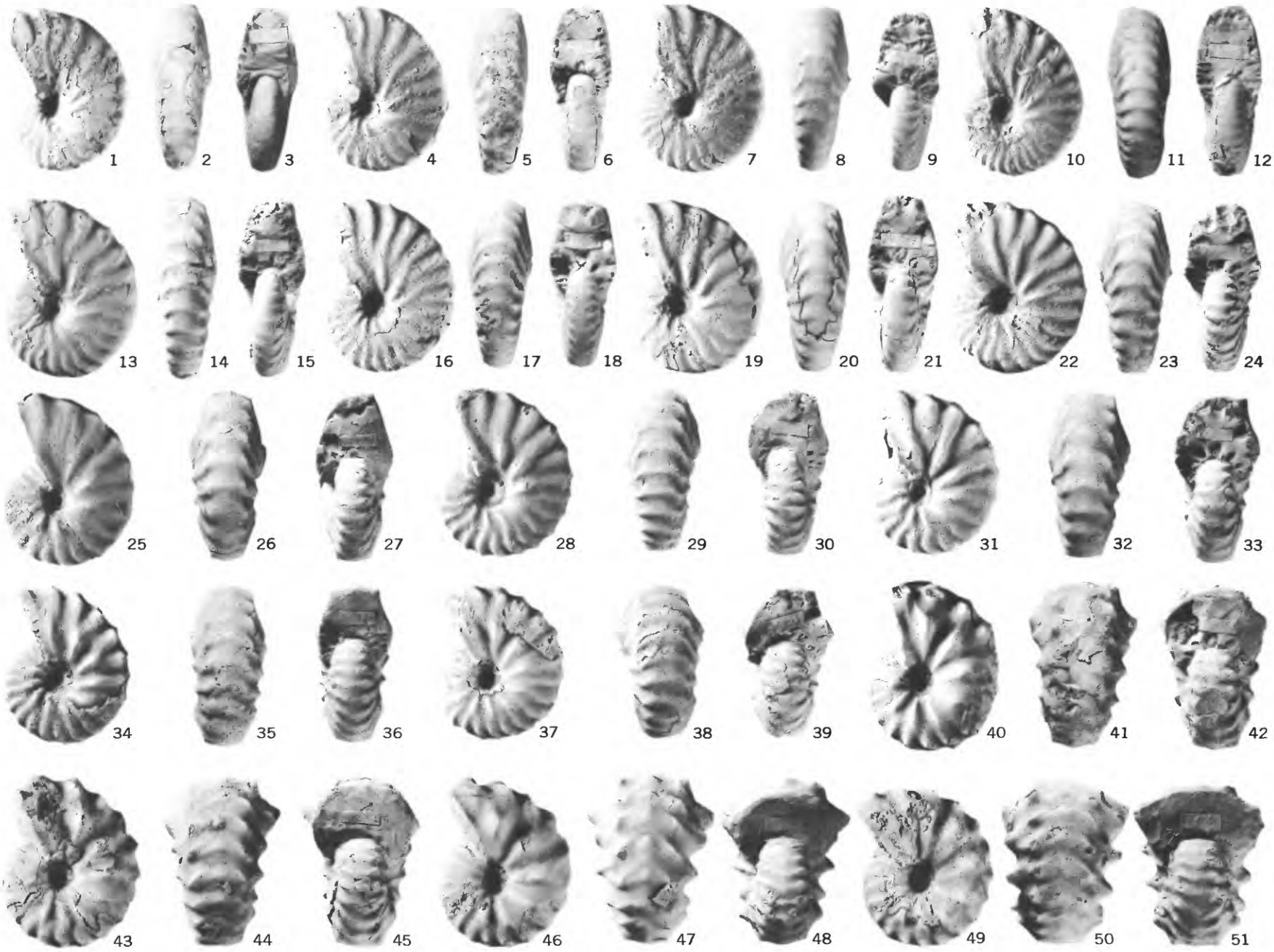
28–30. Var. D–E. USNM 129416j.
31–36. Var. E. USNM 129416 k, l.
37–39. Var. E–F. USNM 129416m.
40–45. Var. F. USNM 129416 n, o.
46–48. Var. F–G. USNM 129416p.
49–51. Var. G. USNM 129416q.



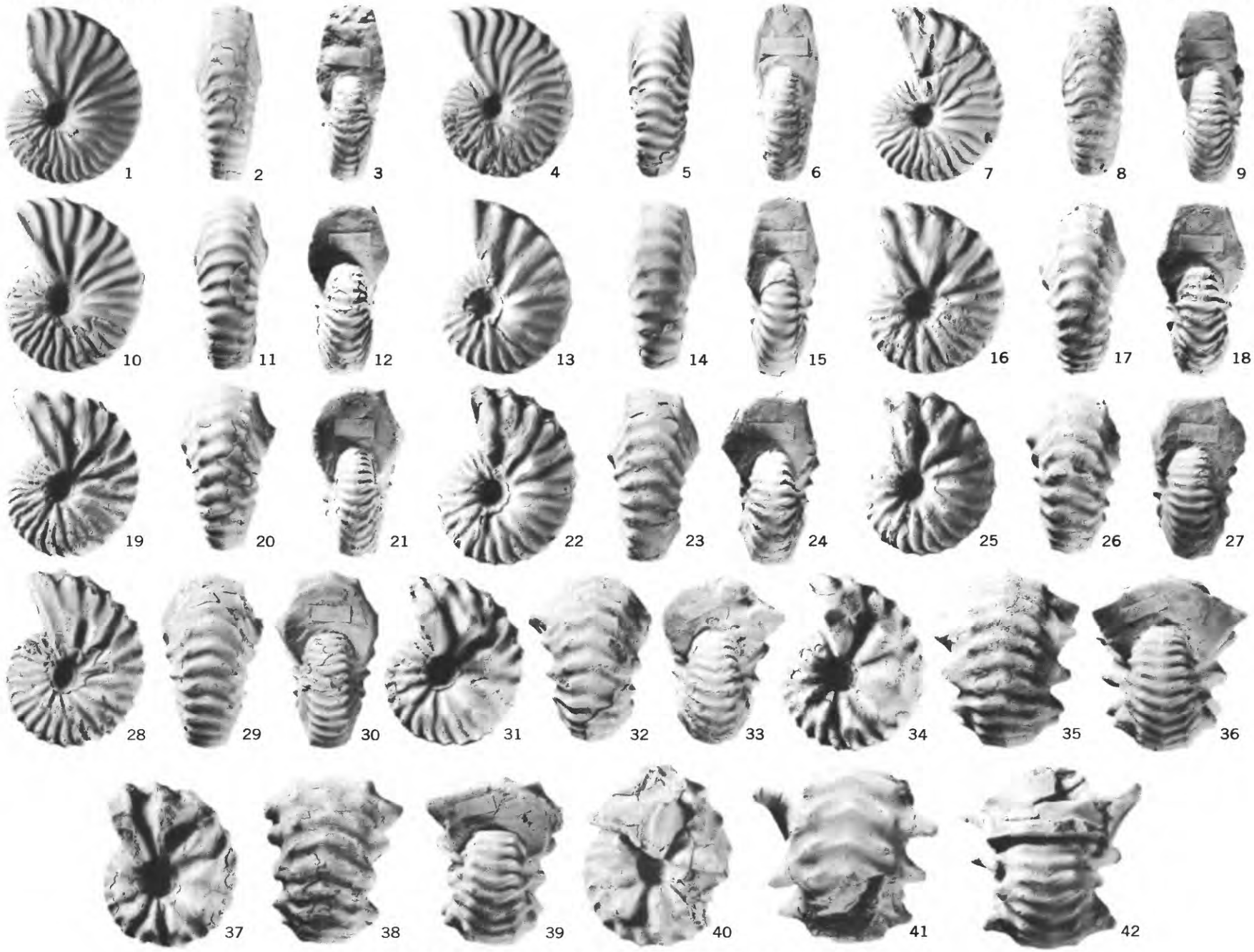
NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N. SP.

PLATE 7

FIGURES 1–42. *Neogastroplites americanus* (Reeside and Weymouth) (p. 98).

Side, rear, and front views (× 1) of 14 specimens from a single concretion 115 feet below the base of the Big Elk sandstone member of the Colorado shale at USGS loc. 23042, Wheatland County, Mont., to show the range of variation.

1–6. Var. A. USNM 129528 a, b.
7–9. Var. A–B. USNM 129528c.
10–12. Var. B. USNM 129528d.
13–15. Var. B–C. USNM 129528e.
16–21. Var. C. USNM 129528 f, g.
22–24. Var. C–D. USNM 129528h.
25–27. Var. D. USNM 129528i.
28–33. Var. D–E. USNM 129528 j, k.
34–42. Var. E. USNM 129528 l, m, n.



NEOGASTROPLITES AMERICANUS (REESIDE AND WEYMOUTH)

PLATE 8

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13, 14. Side and front views (× 1) of specimen from same locality as figure 5. GSC 13680.

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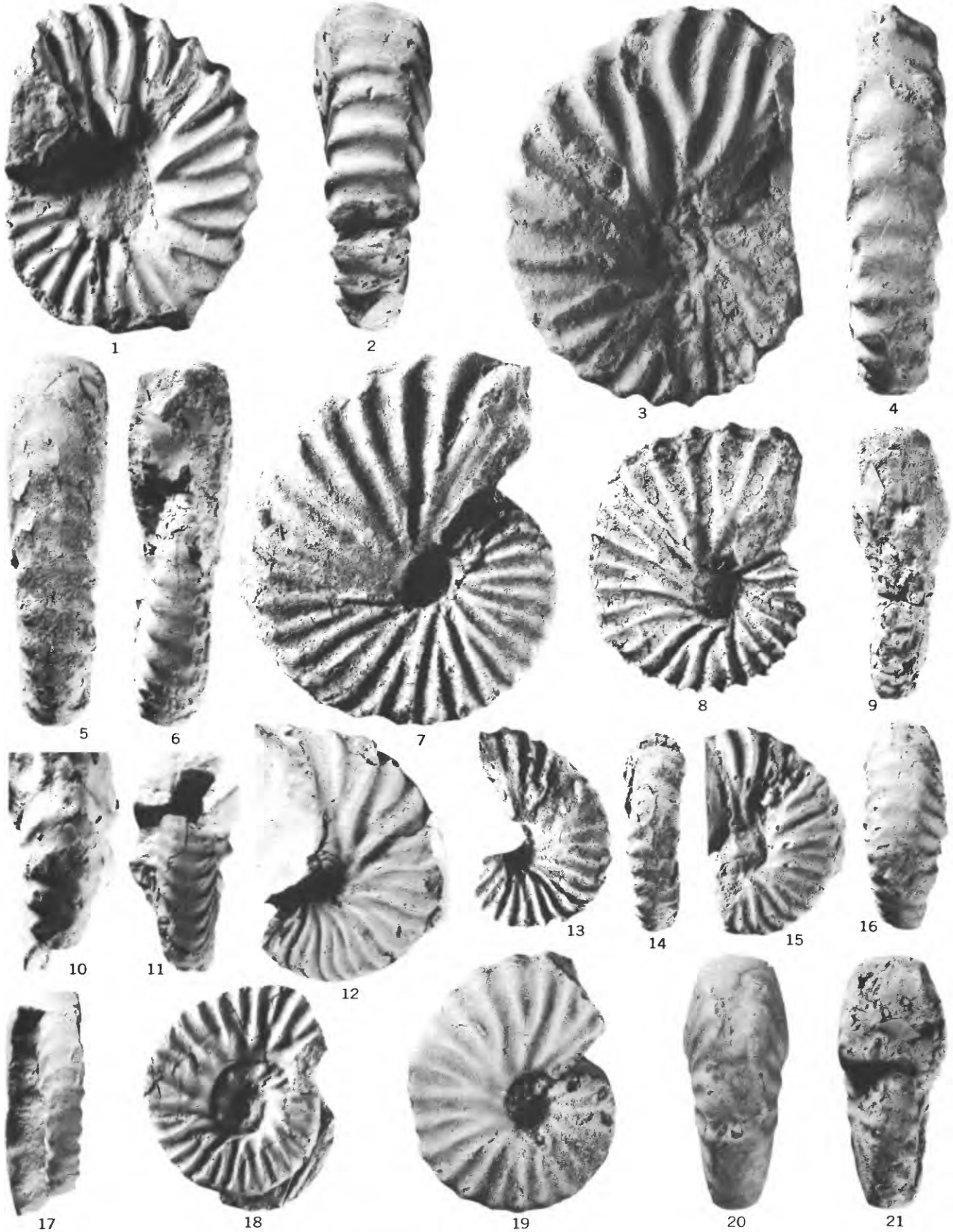

SPECIES OF *GASTROPLITES*

PLATE 9

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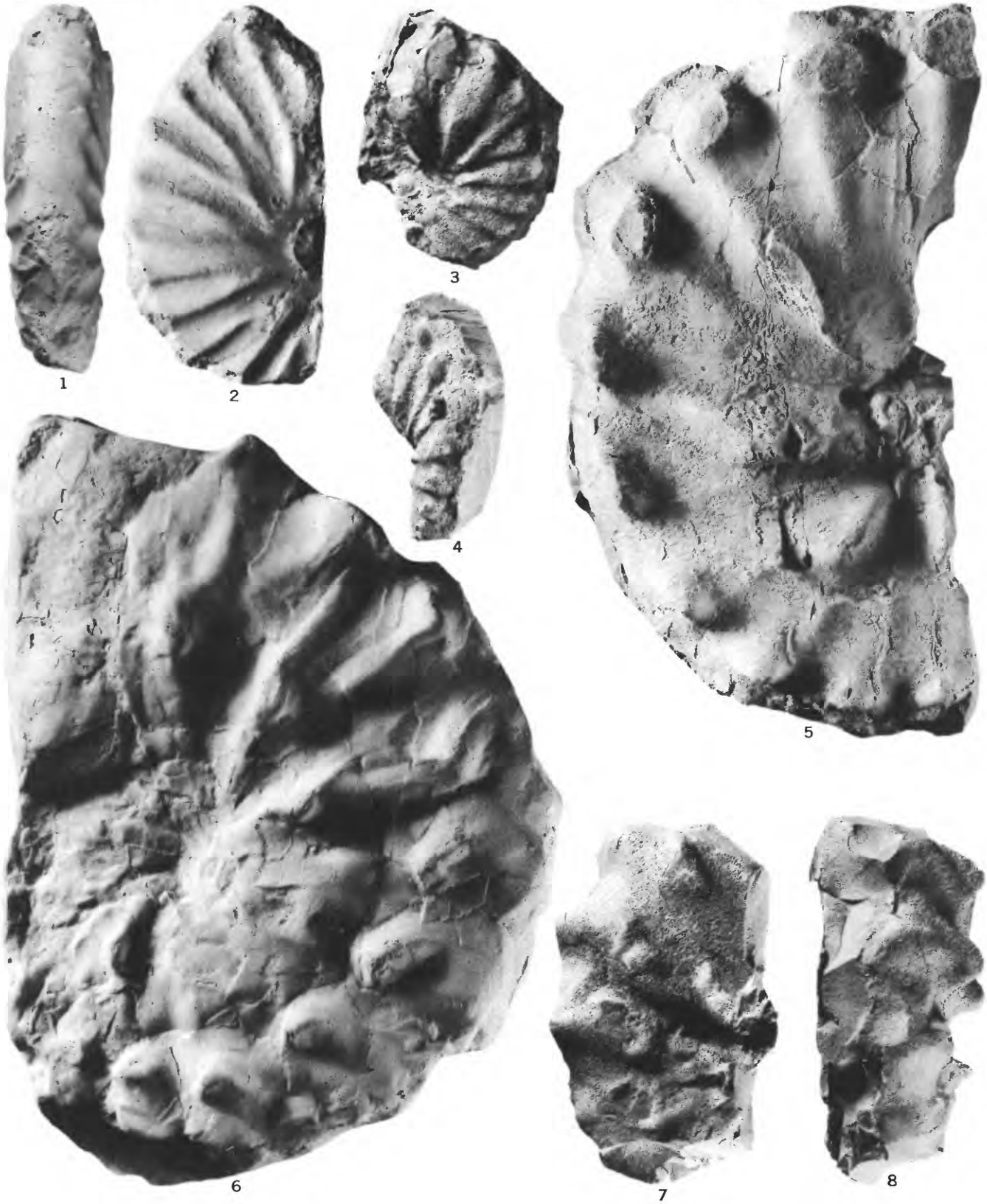

GASTROPLITES SPIEKERI MCLEARN AND *NEOGASTROPLITES CORNUTUS* (WHITEAVES)

PLATE 10

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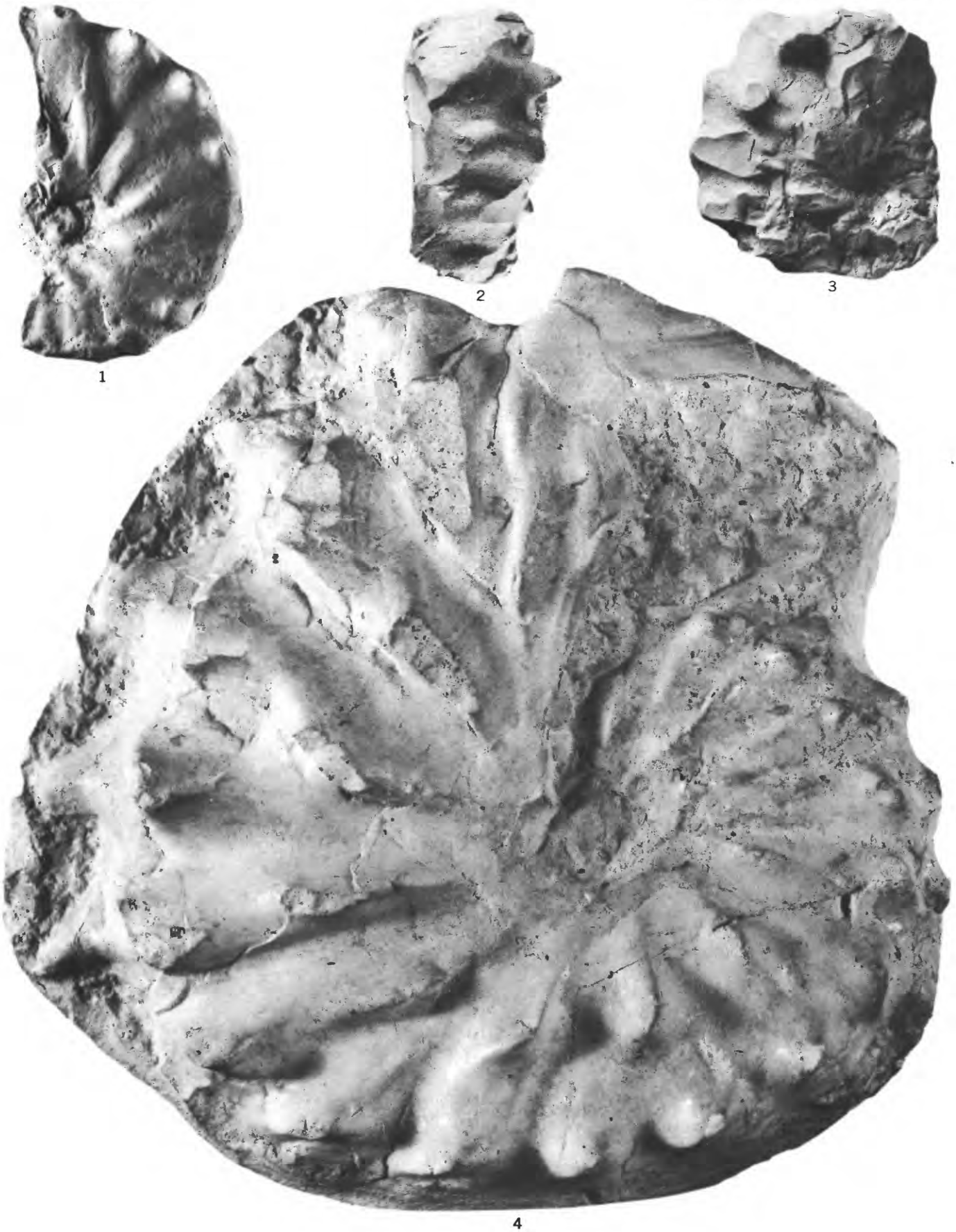
4. Cast of plesiotype (× 1), attributed here to var. E, from upper part of Fort St. John group, north bank of Peace River, 4 miles east of the mouth of Cache Creek, British Columbia. GSC 8007.



NEOGASTROPLITES CORNUTUS (WHITEAVES)

PLATE 11

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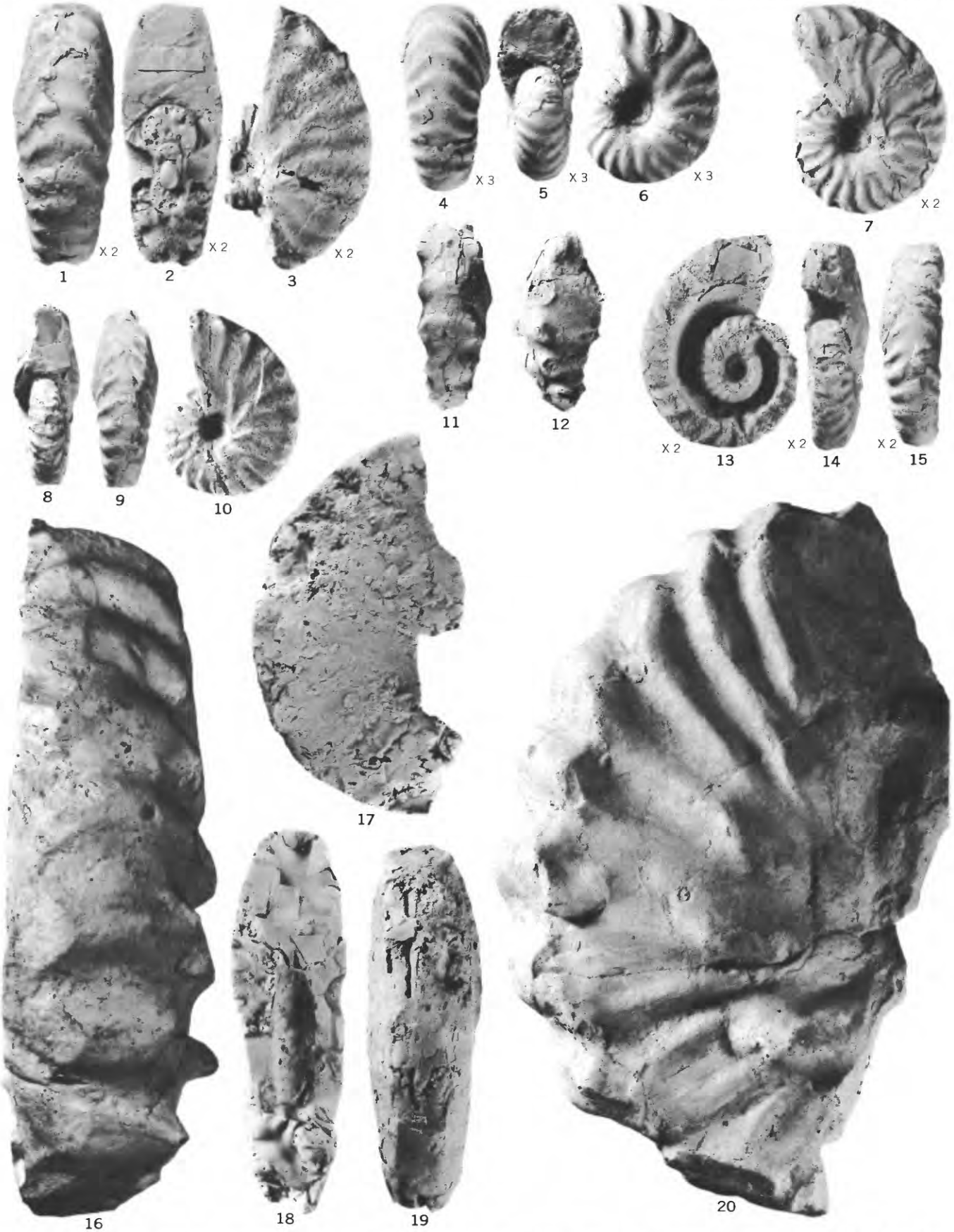
16, 20. *Neogastroplites selwyni* McLearn (p. 58).

Two views (× 1) of cast of holotype, from upper part of Fort St. John group, Peace River, near Fort St. John, British Columbia. GSC 8008.



NEOGASTROPLITES HAASI REESIDE AND COBBAN, N. SP., *AND NEOGASTROPLITES SELWYNI* MCLEARN

508901 O—60——7

PLATE 12

FIGURES 1–16. *Neogastroplites haasi* Reeside and Cobban, n. sp., var. B (p. 62).

1–3. Rear, front, and side views (× 3) of a specimen from dark shale just beneath Mowry shale member of Colorado shale at USGS loc. 24566, Stillwater County, Mont. AMNH 28098:7.

4, 5. Front and side views (× 1) of a specimen from same horizon and locality as figure 1. USNM 129641.

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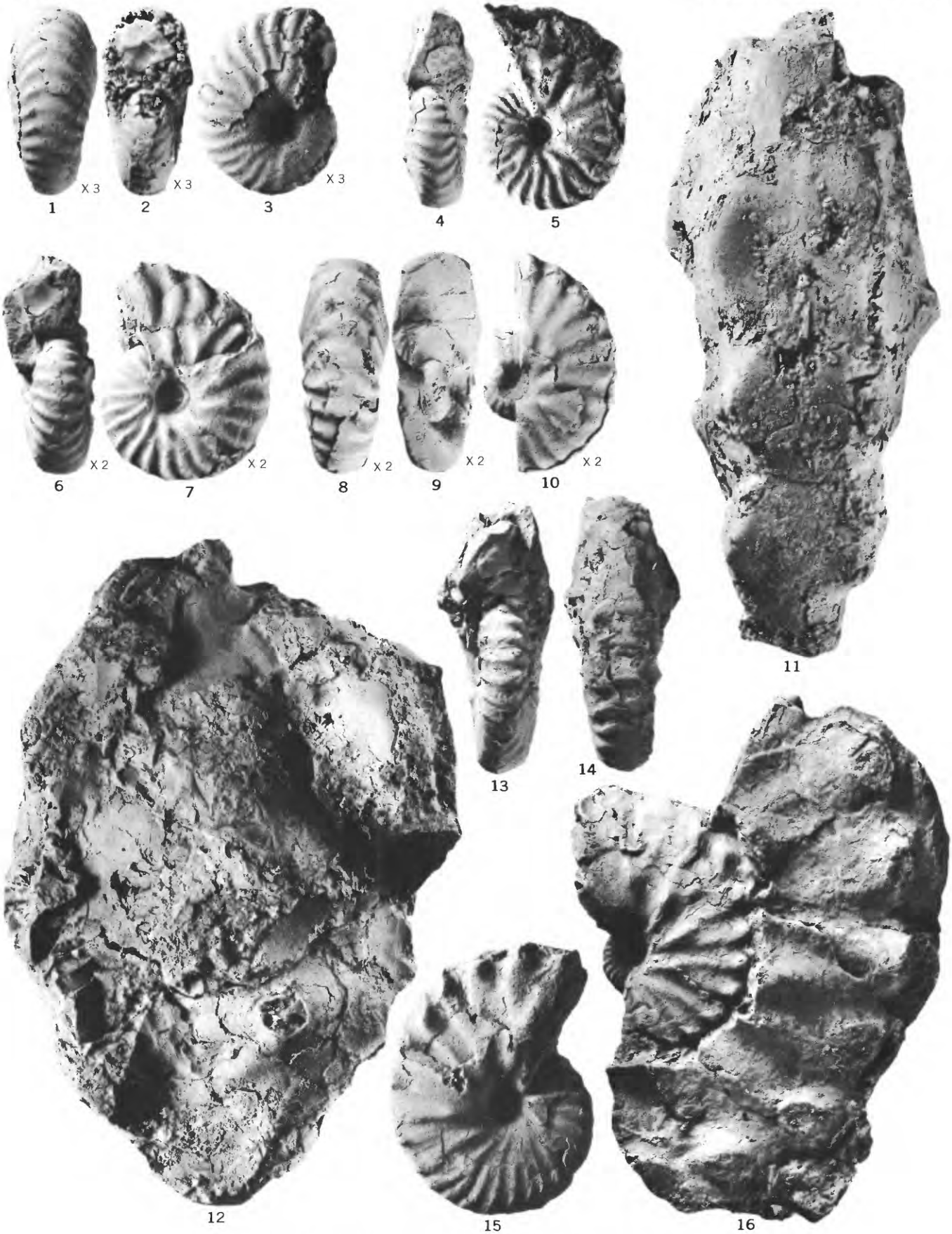
16. Side view of larger fragment from same horizon and locality as figure 1. AMNH 28098:4.

11, 12. Side and rear views (× 1) of a fragment from the upper part of the Thermopolis shale at USGS loc. 26414, Big Horn County, Wyo. YPM 20388.



NEOGASTROPLITES HAASI REESIDE AND COBBAN, N. SP., VAR. B

PLATE 13

[All specimens shown on this plate are from dark shale just beneath Mowry shale member of Colorado shale at USGS loc. 24566, Stillwater County, Mont.]

FIGURE 1. *Neogastroplites haasi* Reeside and Cobban, n. sp., var. B (p. 62). Side view (× 1) of fragment. AMNH 28098:5.

2–4. *Neogastroplites haasi* Reeside and Cobban, n. sp., var. B-C (p. 63). Side, rear, and front views (× 1). AMNH 28098:9.

5–24. *Neogastroplites haasi* Reeside and Cobban, n. sp., var. C (p. 63).

5, 6, 12. Side, rear, and front views (× 3), showing natural cross section of shell. AMNH 28098:12.

7–9. Rear, front, and side views (× 3). AMNH 28098:13.

10, 11, 18. Side, rear, and front views (× 1). USNM 129312.

13–15. Front, rear, and side views (× 2). AMNH 28098:11.

16, 17, 22, 23. Front, two side, and rear views (× 1). AMNH 28098:10.

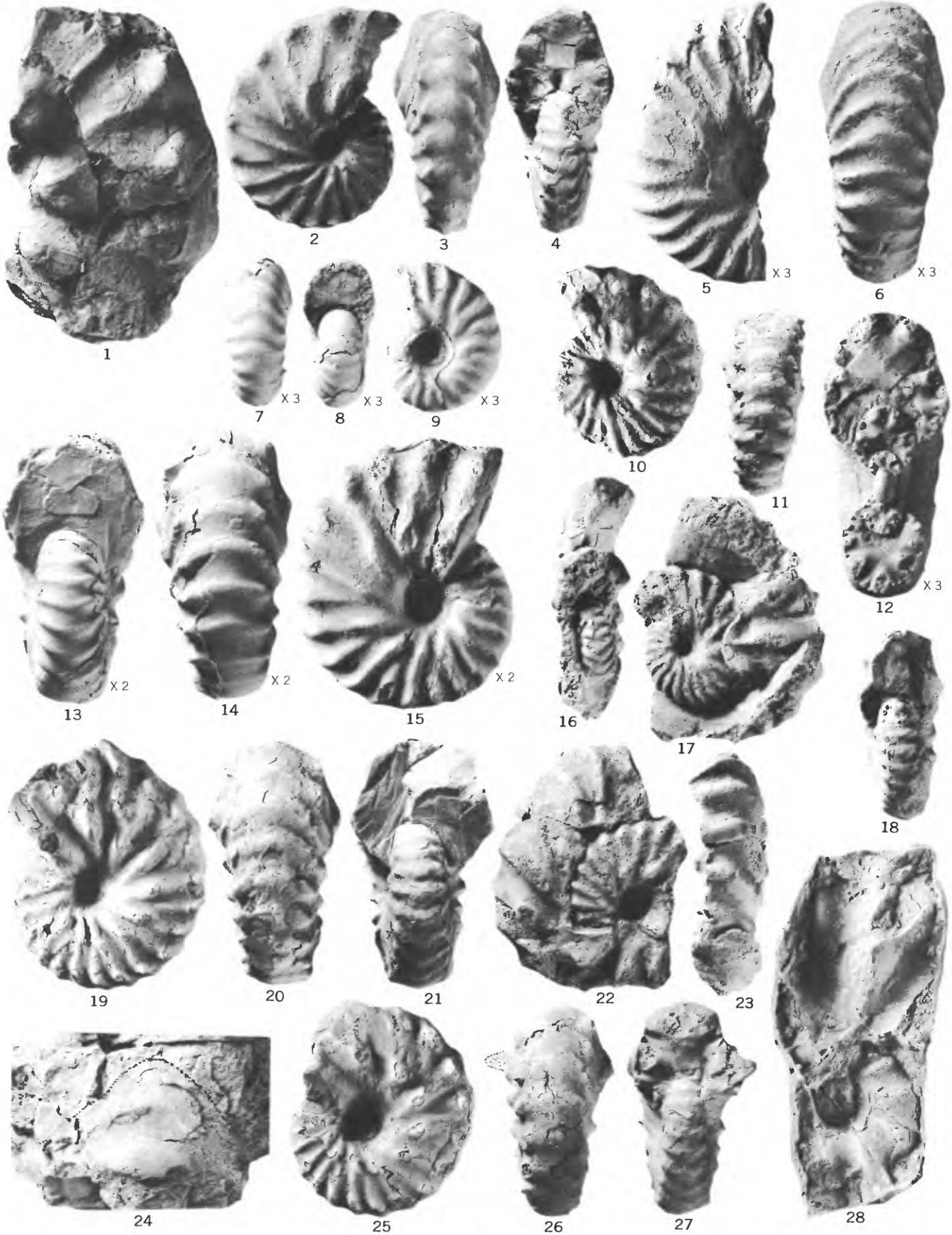
19–21. Side, rear, and front views of holotype (× 1). USNM 129314.

24. Rostrum attributed to var. C (× 1). AMNH 28098:14.

25–28. *Neogastroplites haasi* Reeside and Cobban, n. sp., var. C-D. (p. 64).

25–27. Side, rear, and front views (× 1). AMNH 28098:18.

28. View (× 1) of rubber cast from natural mold of a fragment. AMNH 28098:17.



VARIETIES OF *NEOGASTROPLITES HAASI* REESIDE AND COBBAN, N. SP.

PLATE 14

FIGURES 1–19. *Neogastroplites haasi* Reeside and Cobban, n. sp., var. D (p. 64).

1–3. Rear, front, and side views (× 3) of a specimen from dark shale just below Mowry shale member of Colorado shale at USGS loc. 24566, Stillwater County, Mont. AMNH 28098:22.

4–6. Side, rear, and front views (× 2) of a specimen from same horizon and locality as figure 1. USNM 129316.

7–9. Side, rear, and front views (× 1) of a specimen from same horizon and locality as figure 1. AMNH 28098:20.

10–12. Side, front, and rear views (× 1) of a specimen from same horizon and locality as figure 1. AMNH 28098:21.

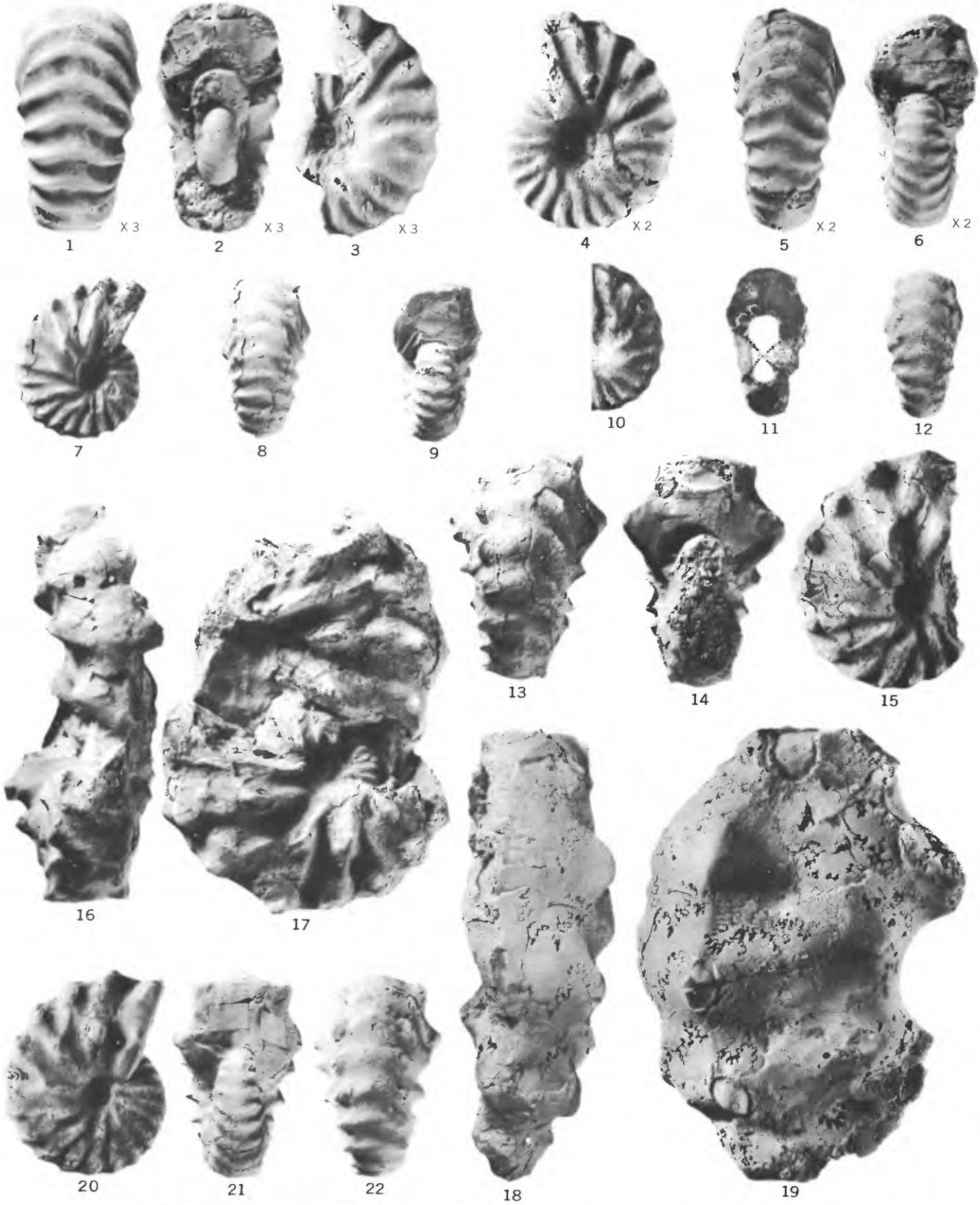
13–15. Rear, front, and side views (× 1) of a specimen from same horizon and locality as figure 1. USNM 129315.

16, 17. Front and side views (× 1) of two specimens from same horizon and locality as figure 1. USNM 129639.

18, 19. Rear and side views (× 1) of a fragment from the upper part of the Thermopolis shale at USGS loc. 26414, Big Horn County, Wyo. YPM 20389.

20–22. *Neogastroplites haasi* Reeside and Cobban, n. sp., var. D–E (p. 65).

Side, front, and rear views (× 1) of specimen from same horizon and locality as figure 1. AMNH 28098:24.



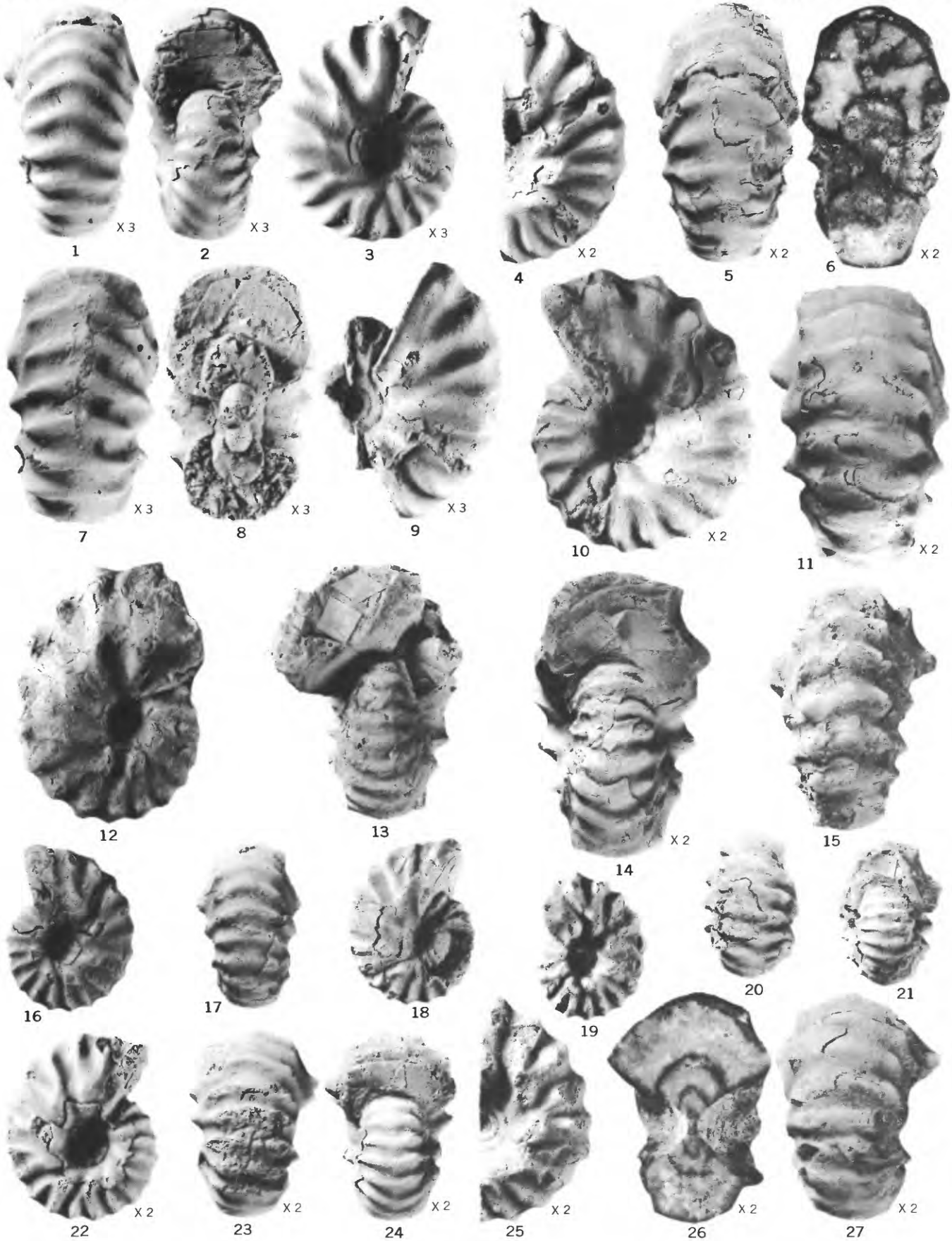
NEOGASTROPLITES HAASI REESIDE AND COBBAN, N. SP., VAR. D AND D–E

PLATE 15

[All specimens shown on this plate are from dark shale just beneath Mowry shale member of Colorado shale at USGS loc. 24566, Stillwater County, Mont.]

FIGURES 1–18. *Neogastroplites haasi* Reeside and Cobban, n. sp., var. E (p. 65).
- 1–3. Rear, front, and side views (× 3). USNM 129318.
- 4–6. Side, rear, and front views (× 2). AMNH 28098:28.
- 7–9. Rear, front, and side views (× 3). AMNH 28098:29.
- 10, 11, 14. Side, rear, and front views (× 2). AMNH 28098:27.
- 12, 13, 15. Side, front, and rear views (× 1). AMNH 28098:25.
- 16–18. Two side and rear views (× 1). AMNH 28098:26.

19–27. *Neogastroplites haasi* Reeside and Cobban, n. sp., var. F (p. 66).
- 19–21. Side, rear, and front views (× 1). AMNH 28098:31.
- 22–24. Side, rear, and front views (× 2). AMNH 28098:32.
- 25–27. Side, front, and rear views (× 2), including cross section of early whorls. AMNH 28098:33.



NEOGASTROPLITES HAASI REESIDE AND COBBAN, N. SP., VAR. E AND F

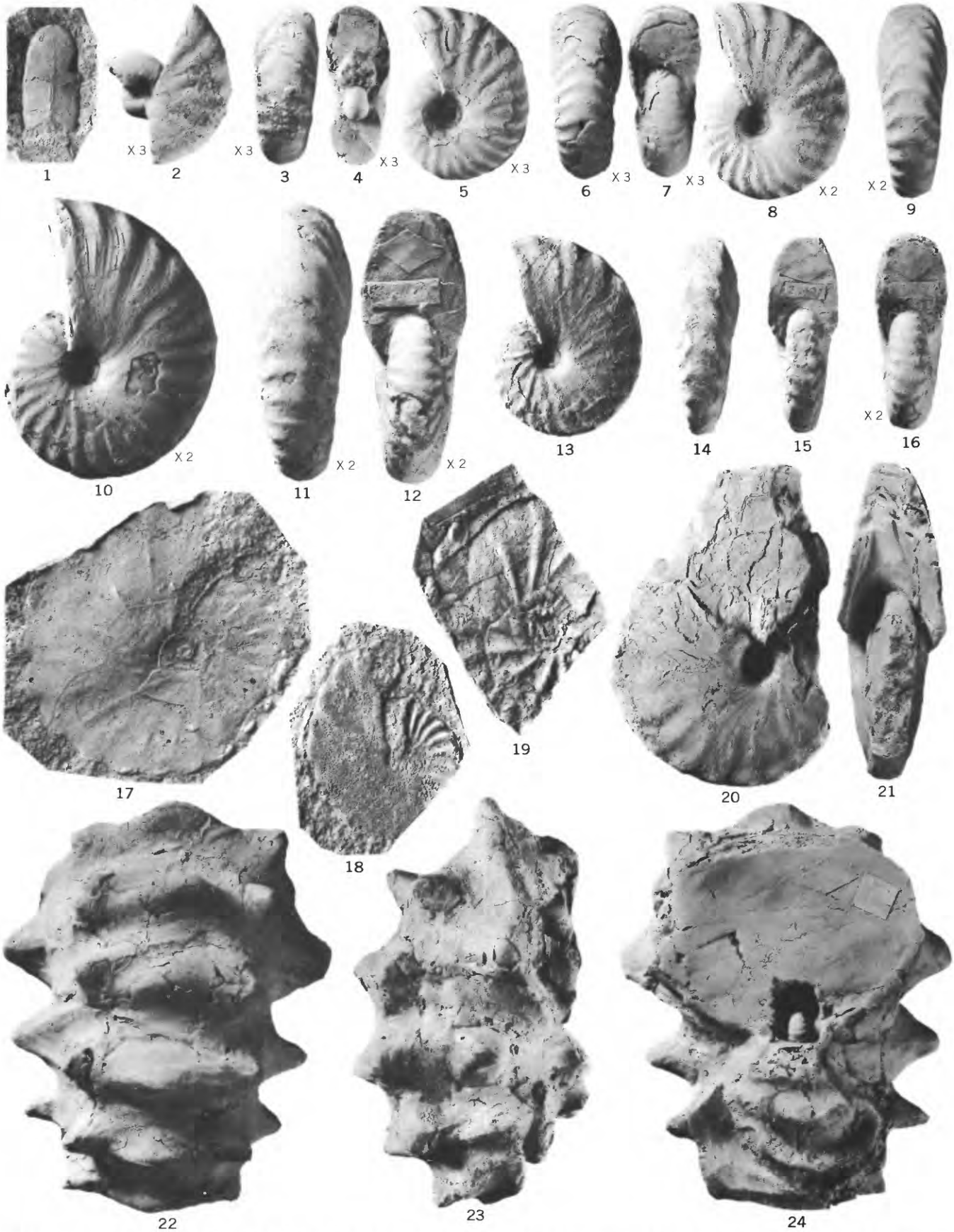
PLATE 16

FIGURE 1. *Neogastroplites cornutus* (Whiteaves) (p. 67).
Aptychus (× 1), not assigned to a variant, from the lower part of the Mowry shale at USGS loc. 24570, Natrona County, Wyo. USNM

2–16, 20, 21. *Neogastroplites cornutus* (Whiteaves) var. A (p. 69).
Basal part of Mowry shale at USGS loc. 23021, Park County, Wyo.
2–4. Side, rear, and front views (× 3). USNM 129326.
5–7. Side, rear, and front views (× 3). USNM 129325.
8, 9, 16. Side, rear, and front views (× 2). USNM 129324.
10–12. Side, rear, and front views (× 2). USNM 129323.
13–15. Side, rear, and front views (× 1). USNM 129322.
20–21. Side and front views (× 1). USNM 129321.

17–19. *Neogastroplites cornutus* (Whiteaves) var. B (p. 72).
Side views (× 1) of three rubber casts from natural molds from USGS loc. 24550, Uinta County, Wyo. USNM 129342–129344.

22–24. *Neogastroplites haasi* Reeside and Cobban, n. sp., var. F (p. 66).
Rear, side, and front views (× 1) of a specimen from USGS loc. 24566, Stillwater County, Mont. AMNH 28098:30.



VARIETIES OF *NEOGASTROPLITES CORNUTUS* (WHITEAVES) AND *N. HAASI* REESIDE AND COBBAN, N. SP.

PLATE 17

[All specimens on this plate are from the basal part of the Mowry shale at USGS loc. 23021, Park County, Wyo.]

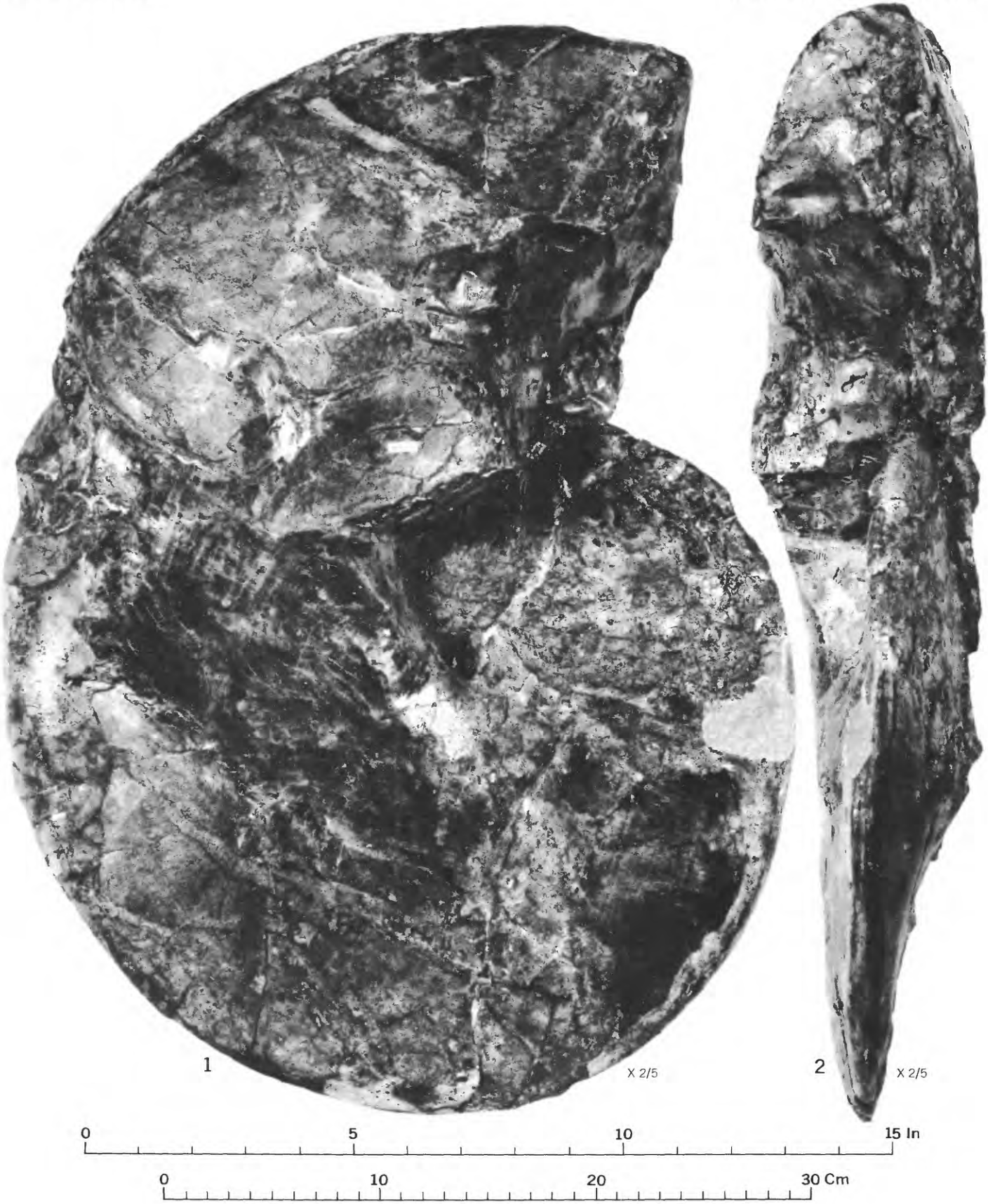
FIGURES 1–22. *Neogastroplites cornutus* (Whiteaves) var. B (p. 72).

1–3. Side, rear, and front views (× 3). USNM 129337.
4–6. Side, rear, and front views (× 3). USNM 129336.
7–9. Side, rear, and front views (× 3). USNM 129335.
10–12. Side, rear, and front views (× 1). USNM 129332.
13, 14. Side and front views (× 2), including cross section of early whorls. USNM 129334.
15, 16. Side and rear views (× 1) of stouter form with fewer ribs. USNM 129339.
17, 22. Side and front views (× 1) of crushed specimen. USNM 129330.
18. Side view (× 1) of crushed specimen. USNM 129331.
19–21. Side, rear, and front views (× 1). USNM 129333.

NEOGASTROPLITES CORNUTUS (WHITEAVES) VAR. B

PLATE 18

FIGURES 1, 2. *Neogastroplites cornutus* (Whiteaves) var. B (p. 72).
Side and front views (× 2/5) of a large crushed specimen from the basal part of the Mowry shale at USGS loc. 23021, Park County, Wyo. USNM 129340.



NEOGASTROPLITES CORNUTUS (WHITEAVES) VAR. B

PLATE 19

Neogastroplites cornutus (Whiteaves) var. B (p. 72).

Side view (× 1) of a specimen from the basal part of the Mowry shale at USGS loc. 23021, Park County, Wyo. USNM 129329.

See also plate 20, figure 1.

1

NEOGASTROPLITES CORNUTUS (WHITEAVES) VAR. B

PLATE 20

[All specimens shown on this plate are from the basal part of the Mowry shale at USGS loc. 23021, Park County, Wyo.]

FIGURES 1–4. *Neogastroplites cornutus* (Whiteaves) var. B (p. 72).

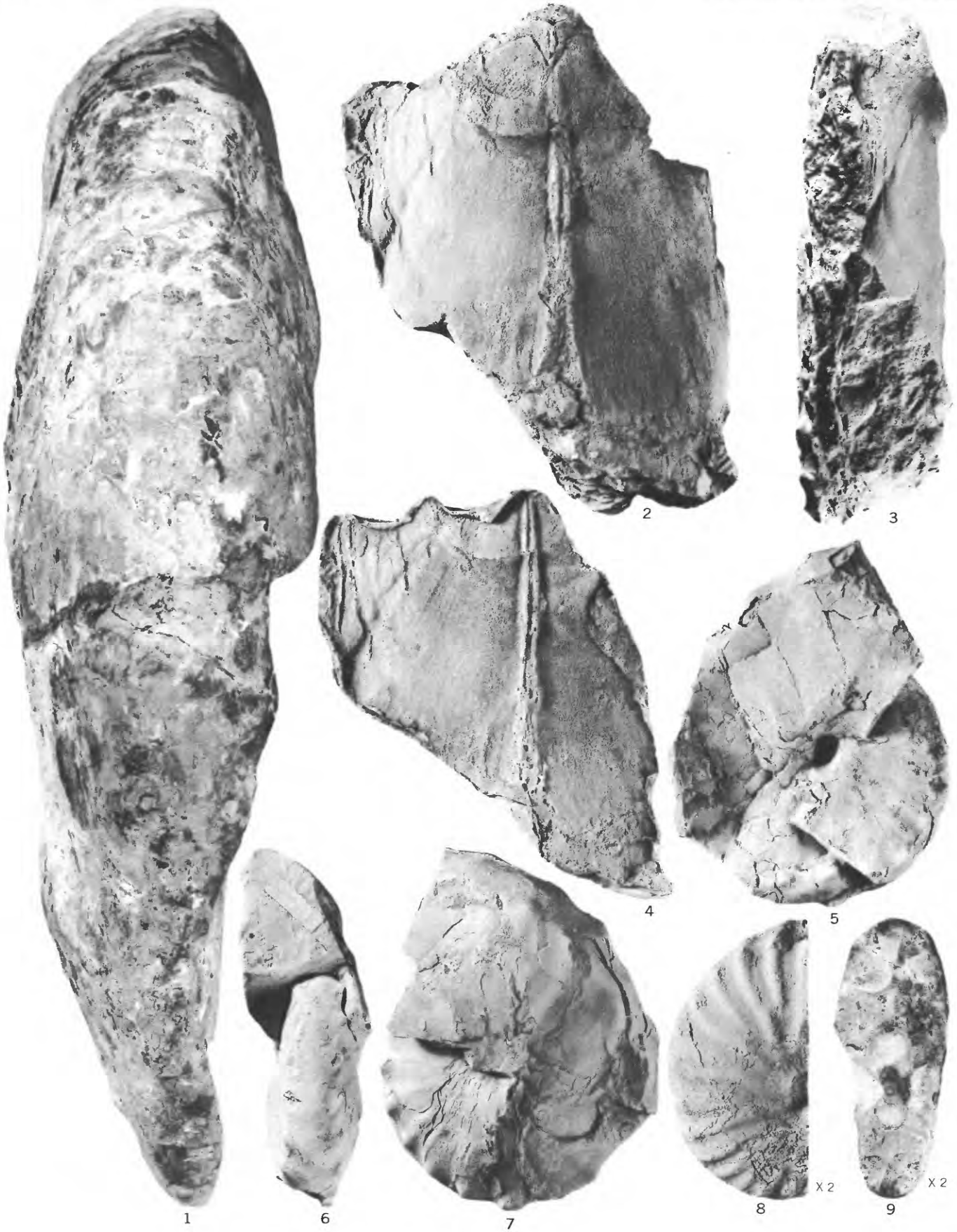
1. Rear view (× 1) of a large specimen. USNM 129329. See also plate 19.

2–4. Top and side views (× 1) of large aptychus assigned to var. B, and view (× 1) of a rubber cast of the natural mold of the same specimen to show more detail. USNM 129328.

5–9. *Neogastroplites cornutus* (Whiteaves) var. B–C (p. 73).

5–7. Two side and front views (× 1) of partly crushed specimen. USNM 129345.

8, 9. Side and front views (× 2), including cross section of early whorls. USNM 129346.



NEOGASTROPLITES CORNUTUS (WHITEAVES) VAR. B AND B–C

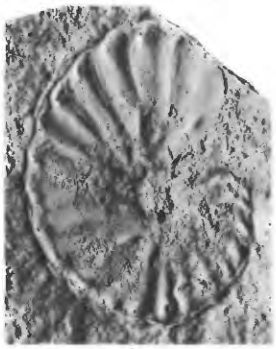
PLATE 21

FIGURE 1. *Neogastroplites cornutus* (Whiteaves) var. B (p. 72).

Natural mold of a specimen about 630 mm in maximum diameter in basal part of Mowry shale at USGS loc. 26233, Daggett County, Utah. Unrolled part of tape is 24 inches (610 mm) long. Photo by W. R. Hansen.

2–4. *Neogastroplites cornutus* (Whiteaves) var. C (p. 74).

Two rubber casts from natural molds (figs. 2, 4) and a specimen (fig. 3), all × 1, from the Aspen shale, 500 feet below the top, at USGS loc. 14719, Uinta County, Wyo. Figure 2, USNM 129356; figure 3, USNM 129357; figure 4, USNM 73778.



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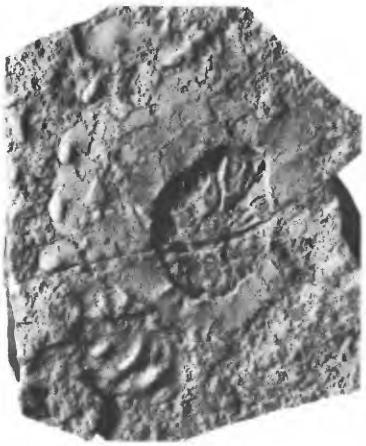


3

4

1

NEOGASTROPLITES CORNUTUS (WHITEAVES) VAR. B AND C

PLATE 22

FIGURES 1–17. *Neogastroplites cornutus* (Whiteaves) var. C (p. 74).

Basal part of Mowry shale at USGS loc. 23021, Park County, Wyo.

1–3. Front and two side views (× 2) of a broken specimen showing the early whorls. USNM 129353.

4–6. Side, rear, and front views (× 2). USNM 129351.

7–9. Side, rear, and front views (× 1). USNM 129350.

10, 11. Side and front views (× 2), including cross section of early whorls. USNM 129352.

12–14. Side, rear, and front views (× 1). USNM 129349.

15–17. Side, rear, and front views (× 1). USNM 129348.

18–20. *Neogastroplites cornutus* (Whiteaves) var. C–D. (p. 75).

Side, front, and rear views (× 1) of specimen from basal part of Mowry shale at USGS loc. 23021, Park County, Wyo. USNM 129358.

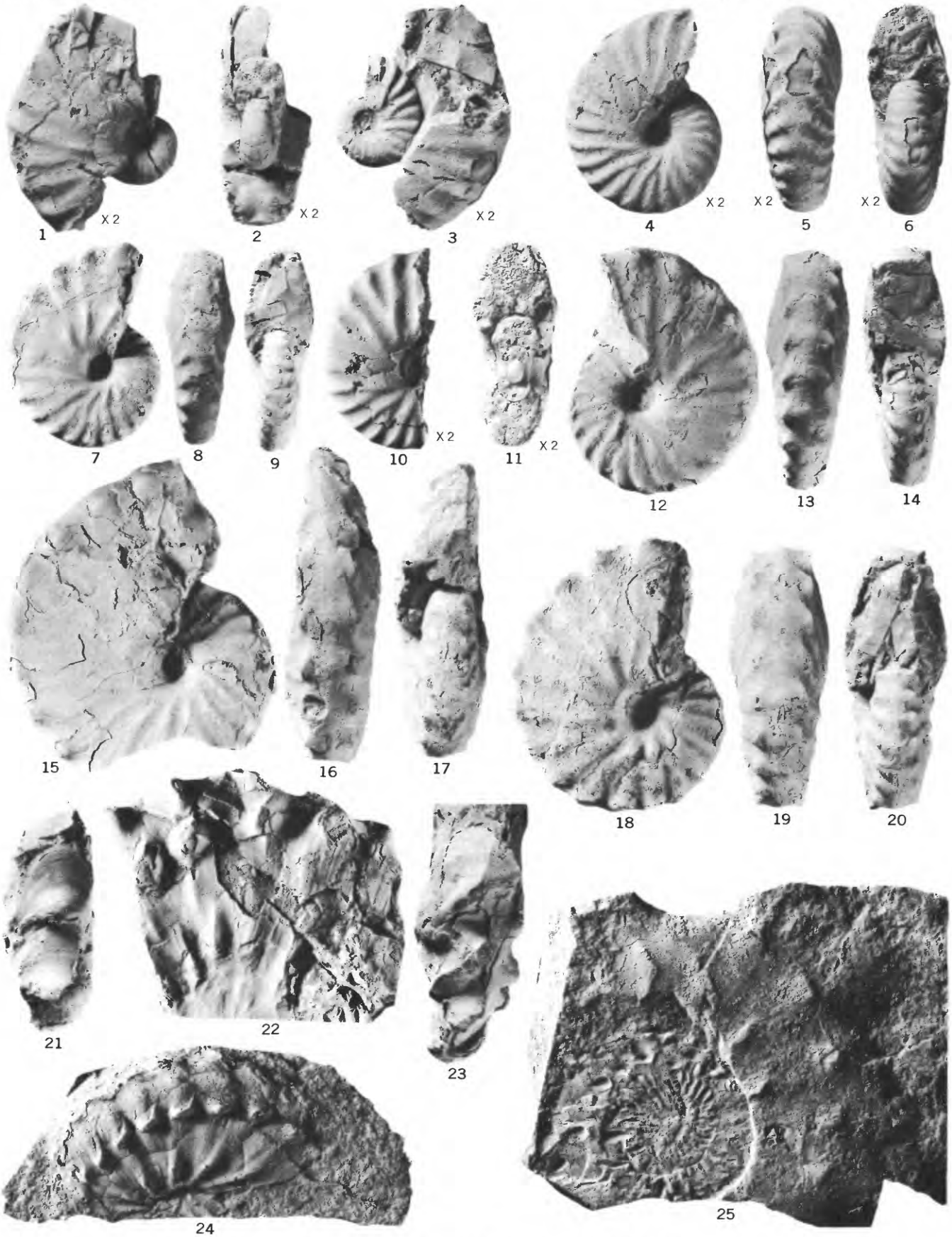
21–25. *Neogastroplites cornutus* (Whiteaves) var. D (p. 75).

21. Fragment (× 1) showing the rostrum, from the basal part of the Mowry shale at USGS loc. 23021, Park County, Wyo. USNM 129364.

22, 23. Side and rear views (× 1) of a fragment showing the rostrum, from same horizon and locality as figure 21. USNM 129363.

24. Rubber cast (× 1) from natural mold from Aspen shale, 500 feet below top, at USGS loc. 24550, Uinta County, Wyo. USNM 129379.

25. View (× 1) of specimen from same horizon and locality as figure 24. USNM 129378.



NEOGASTROPLITES CORNUTUS (WHITEAVES) VAR. C, C–D, AND D

PLATE 23

[All specimens shown on this plate are from the basal part of the Mowry shale at USGS loc. 23021, Park County, Wyo.]

FIGURES 1–19. *Neogastroplites cornutus* (Whiteaves) var. D (p. 75).

1, 3, 5. Two side and front views (× 3) of a broken specimen showing the early whorls. USNM 129370.

2, 6, 9. Rear, front, and side views (× 2). USNM 129376.

4, 7, 8. Rear, front, and side views (× 2). USNM 129368.

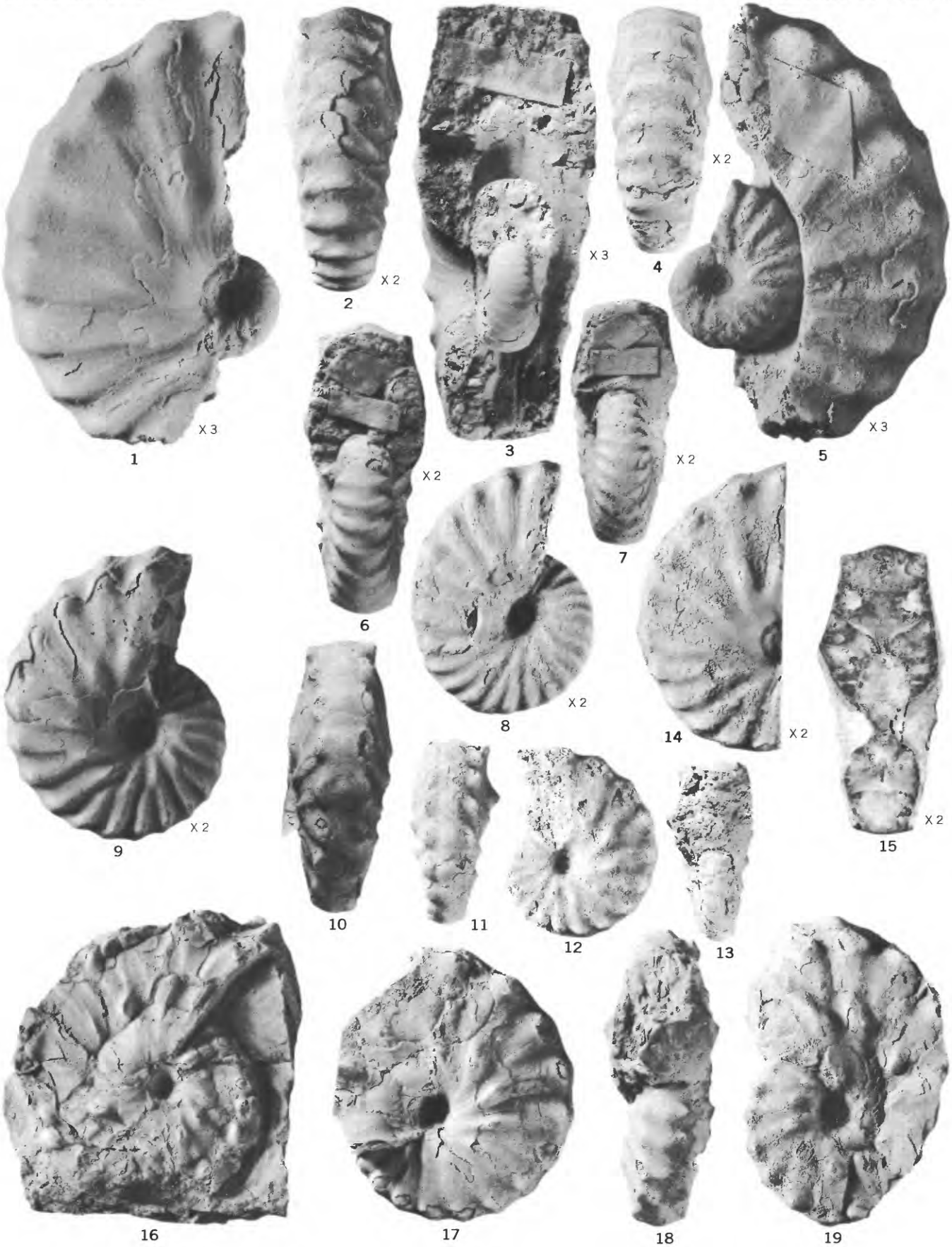
10, 17. Rear and side views (× 1). USNM 129365.

11–13. Rear, side, and front views (× 1). USNM 129366.

14, 15. Side and front views (× 2), including cross section of early whorls. USNM 129369.

16. Side view (× 1) of crushed specimen. USNM 129362.

18, 19. Front and side views (× 1) of partly crushed specimen. USNM 129361.



NEOGASTROPLITES CORNUTUS (WHITEAVES) VAR. D

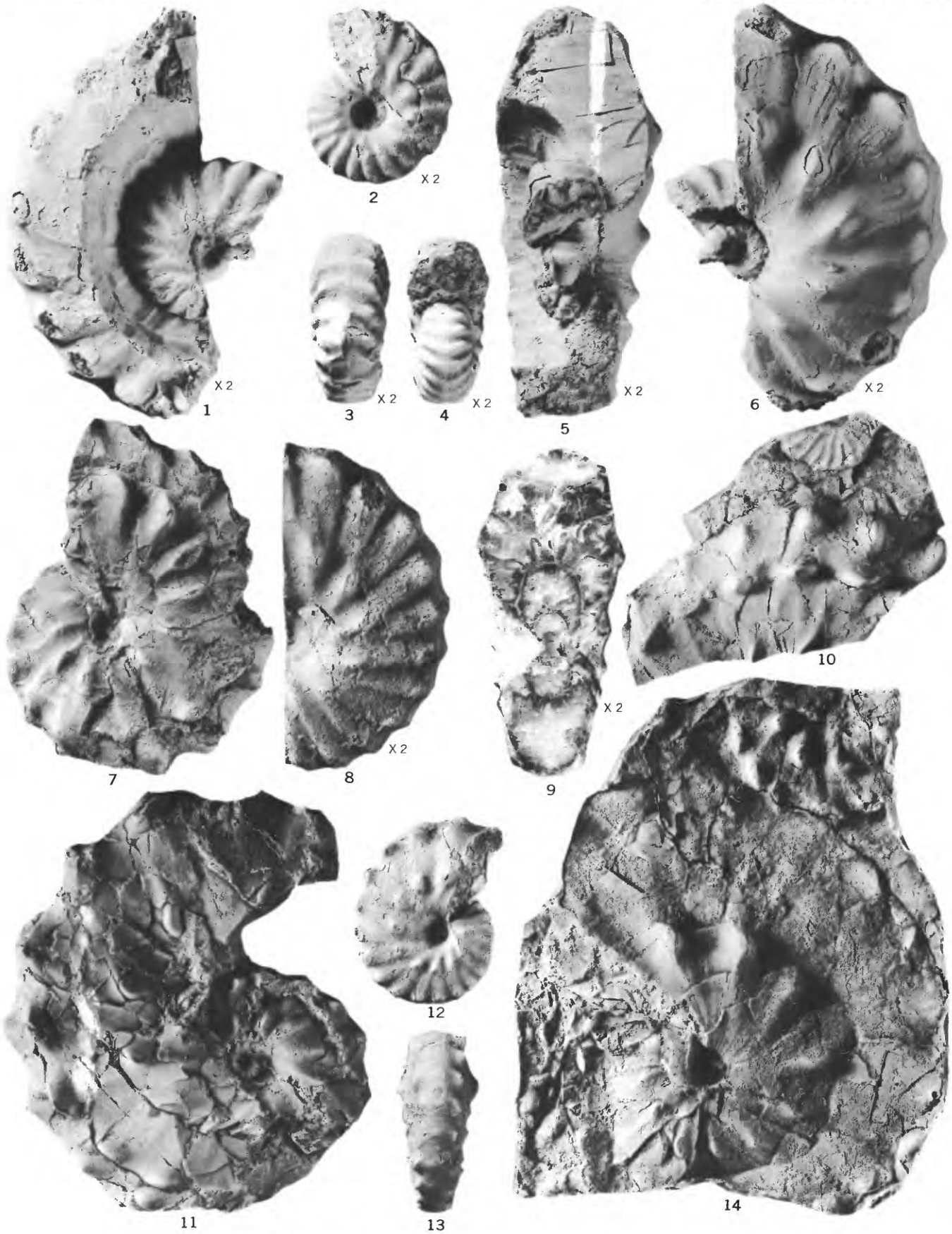
508901 O—60——8

PLATE 24

FIGURES 1–6, 8, 9. *Neogastroplites cornutus* (Whiteaves) var. E (p. 77).
Basal part of Mowry shale at USGS loc. 23021, Park County, Wyo.
1, 5, 6. Two side and front views (× 2). USNM 129390.
2–4. Side, rear, and front views (× 2). USNM 129392.
8, 9. Side and front views (× 2), including cross section of early whorls. USNM 129389.

7, 12, 13. *Neogastroplites cornutus* (Whiteaves) var. D–E (p. 76).
7. Crushed specimen (× 1) from same horizon and locality as figure 1. USNM 129381.
12, 13. Side and rear views (× 1) of specimen from same horizon and locality as figure 1. USNM 129380.

10, 11, 14. *Neogastroplites cornutus* (Whiteaves) var. D (p. 75).
10. Fragment (× 1) of large shell from same horizon and locality as figure 1. USNM 129360.
11. Crushed specimen (× 1) from same horizon and locality as figure 1. USNM 129371.
14. Rubber cast (× 1) from a natural mold from the basal part of the Mowry shale at USGS loc. 24569, Park County, Wyo. USNM 129377.



NEOGASTROPLITES CORNUTUS (WHITEAVES) VAR. E, D–E, AND D

PLATE 25

[All specimens shown on this plate are from the basal part of the Mowry shale at USGS loc. 23021, Park County, Wyo.]

FIGURES 1–16. *Neogastroplites cornutus* (Whiteaves) var. E (p. 77).

1–3. Side, rear, and front views (× 1). USNM 129391.

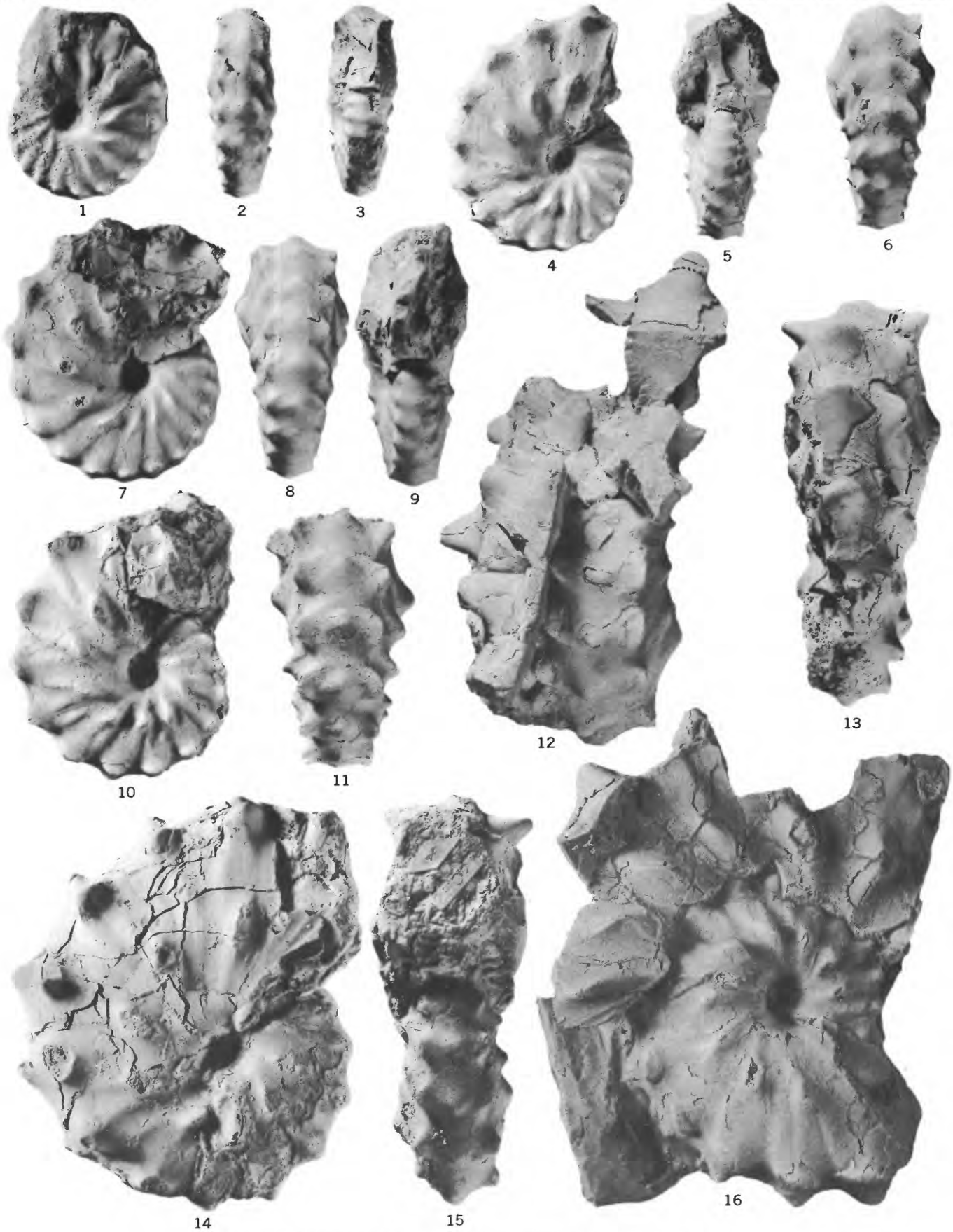
4–6. Side, front, and rear views (× 1). USNM 129388.

7–9. Side, rear, and front views (× 1) of a relatively coarse-ribbed specimen. USNM 129387.

10, 11. Side and rear views (× 1) of a specimen with lautiform ribbing. USNM 129386.

12, 16. Side and front views (× 1) of a specimen with outer whorl crushed. USNM 129384.

13–15. Rear, side, and front views (× 1) of a somewhat crushed specimen. USNM 129385.



NEOGASTROPLITES CORNUTUS (WHITEAVES) VAR. E

PLATE 26

FIGURES 1–4. *Neogastroplites cornutus* (Whiteaves) var. E (p. 77).

1, 4. Rubber casts (× 1) from natural molds from the Aspen shale, 500 feet below the top, at USGS loc. 14719, Uinta County, Wyo. Figure 1, USNM 129523. Figure 4, USNM 73773, is a view of the holotype of *Kanabiceras wyomingense* Reeside and Weymouth (1931, p. 12), called in error *K. aspenanum* in explanation of plate.

2, 3. Rear and side views (× 1) of a specimen from the Mowry shale member of the Colorado shale at USGS loc. 23410, Cascade County, Mont. USNM 129395.

5–12. *Neogastroplites cornutus* (Whiteaves) var. E–F (p. 78).

5–7. Two side and front views (× 1) of a specimen from the basal part of the Mowry shale at USGS loc. 23021, Park County, Wyo. USNM 129396.

8–10. Two side and front views (× 2) of a pathologic specimen from the same horizon and locality as figure 5. USNM 129397. The right flank of the specimen was damaged in life and did not produce the normal nodes shown on the left side.

11, 12. Side and rear views (× 1) of a specimen from the Mowry shale member of the Colorado shale at USGS loc. 23410, Cascade County, Mont. USNM 129400.

13–23. *Neogastroplites cornutus* (Whiteaves) var. F (p. 79).

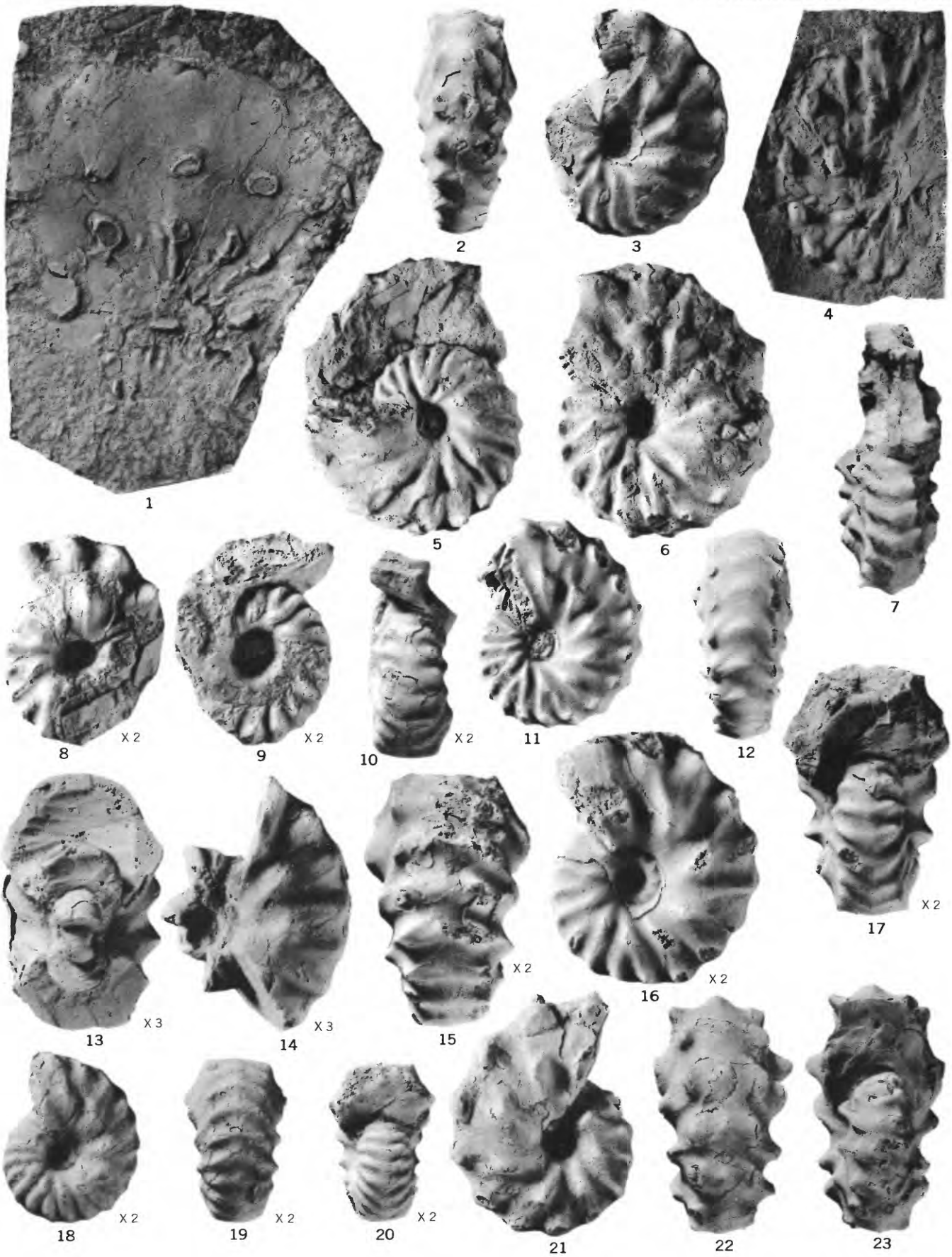
Basal part of Mowry shale at USGS loc. 23021, Park County, Wyo.

13, 14. Front and side views (× 3), showing cross section of early whorls. USNM 129406.

15–17. Rear, side, and front views (× 2). USNM 129404.

18–20. Side, rear, and front views (× 2). USNM 129405.

21–23. Side, rear, and front views (× 1). USNM 129403.



NEOGASTROPLITES CORNUTUS (WHITEAVES) VAR. E, E–F, AND F

PLATE 27

Neogastroplites cornutus (Whiteaves) var. F (p. 79).

Slab (× 1) showing several large specimens, one nearly complete, from basal part of Mowry shale at USGS loc. 23021, Park County, Wyo. USNM 129401.

1

NEOGASTROPLITES CORNUTUS (WHITEAVES) VAR. F

PLATE 28

FIGURES 1–4, 7. *Neogastroplites cornutus* (Whiteaves) var. F (p. 79).

1–3. Side, rear, and front views (× 1) of a specimen from the basal part of the Mowry shale at USGS loc. 23021, Park County, Wyo. USNM 129402.

4, 7. Rear and side views (× 1) of a specimen from the Mowry shale member of the Colorado shale at USGS loc. 23410, Cascade County, Mont. USNM 129409.

5, 6, 8–10. *Neogastroplites cornutus* (Whiteaves) var. G (p. 80).

Basal part of Mowry shale at USGS loc. 23021, Park County, Wyo.

5, 6, 8. Side, rear, and front views (× 2). USNM 129410.

9, 10. Side and front views (× 3), showing cross section of early whorls. USNM 129411.

11–23. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. A (p. 86).

Horizon just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont.

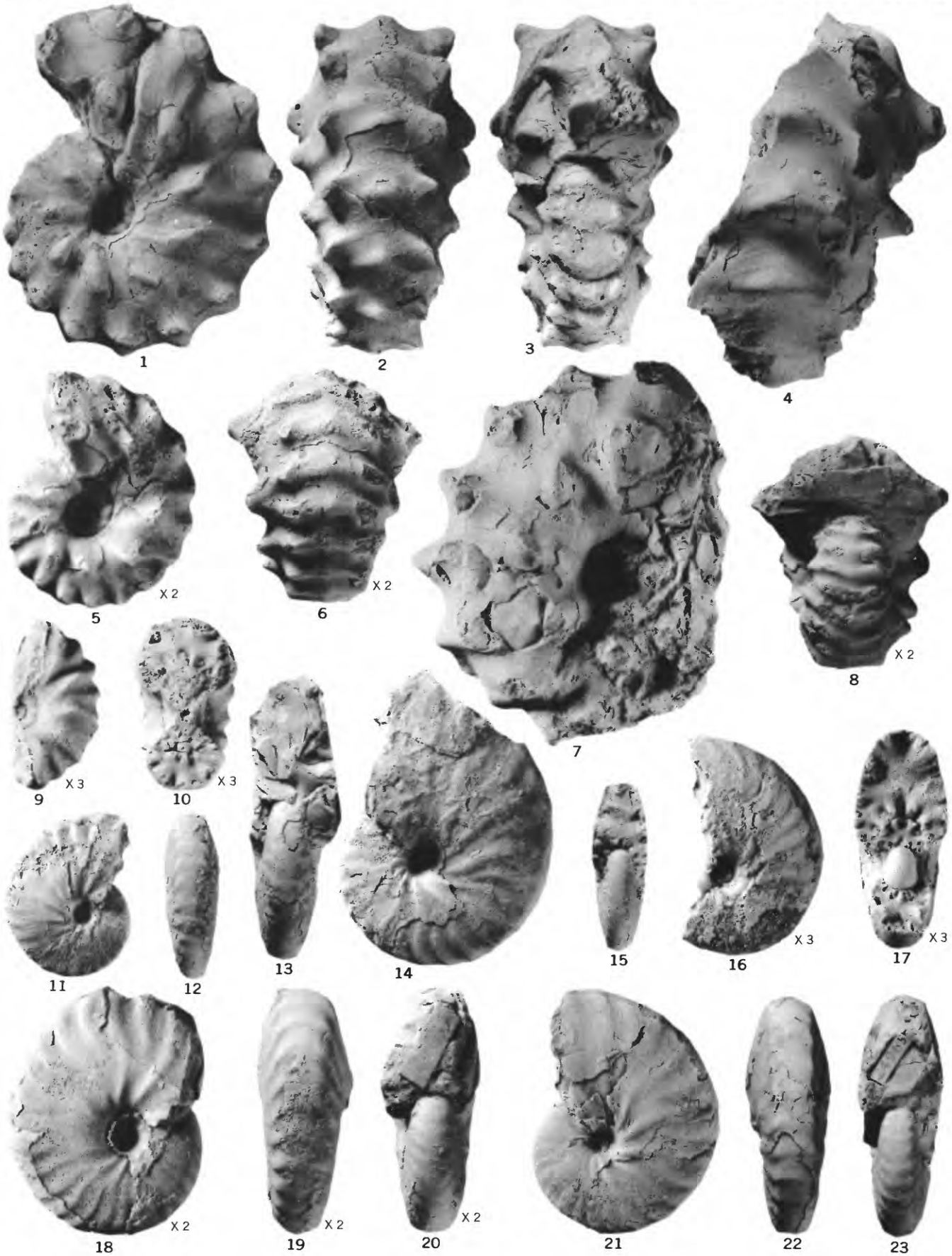
11, 12, 15. Side, rear, and front views (× 1). USNM 129419.

13, 14. Front and side views (× 1). USNM 129417.

16, 17. Side and front views (× 3), showing cross section of early whorls. USNM 129421.

18–20. Side, rear, and front views (× 2). USNM 129420.

21–23. Side, rear, and front views (× 1). USNM 129418.



NEOGASTROPLITES CORNUTUS (WHITEAVES) VAR. F AND G AND *N. MUELLERI* REESIDE AND COBBAN, N. SP., VAR. A

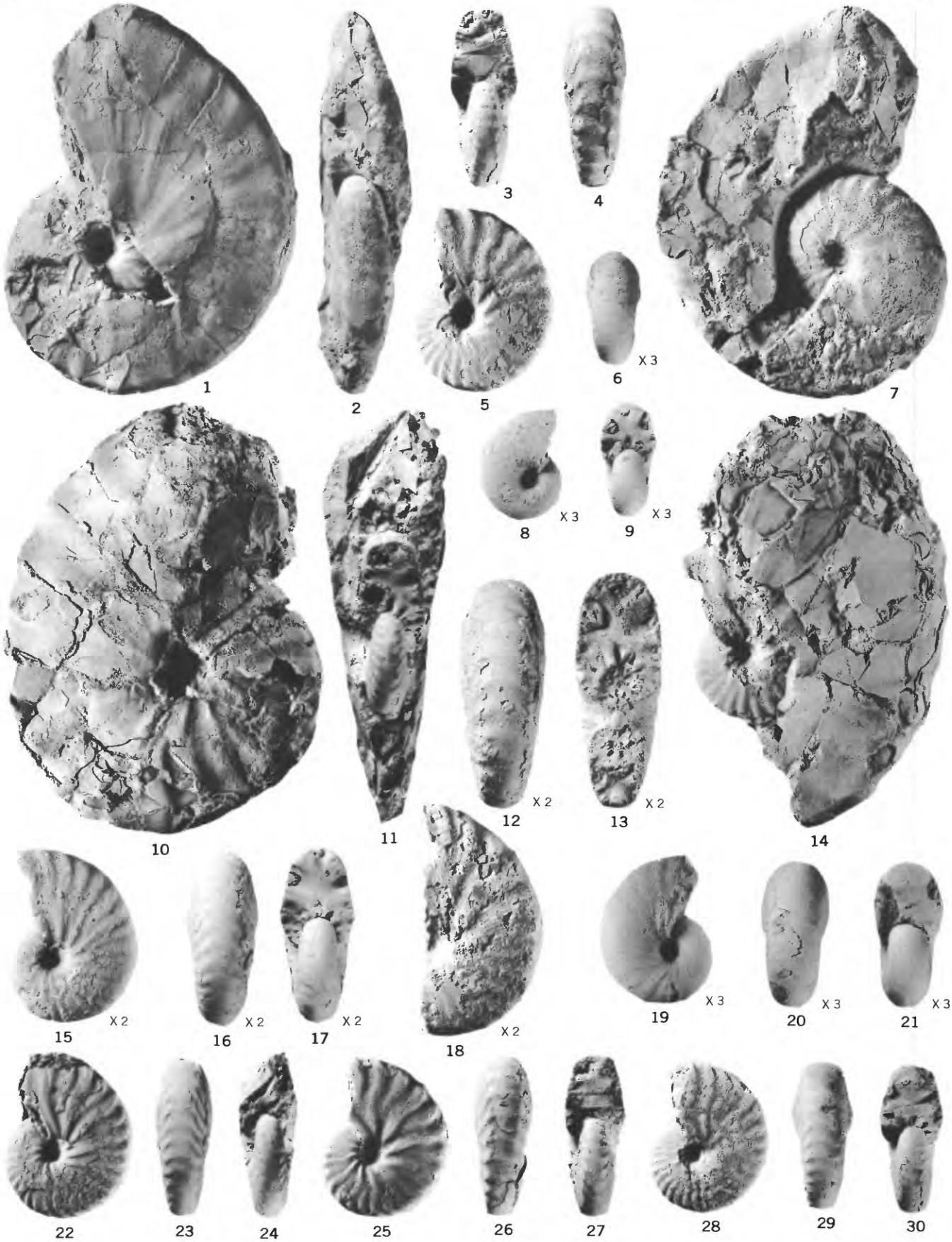
PLATE 29

[All specimens shown on this plate are from a horizon just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont.]

FIGURES 1, 2, 7. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. A (p. 86).
Two side and front views (× 1). USNM 129422.

3–5, 10, 11, 14. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. A–B (p. 87).
3–5. Front, rear, and side views (× 1). USNM 129426.
10, 11, 14. Two side and front views (× 1). USNM 129425.

6, 8, 9, 12, 13, 15–30. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. B (p. 87).
6, 8, 9. Rear, side, and front views (× 3). USNM 129442.
12, 13, 18. Rear, front, and side views (× 2), including cross section of early whorls. USNM 129439.
15–17. Side, rear, and front views (× 2). USNM 129440.
19–21. Side, rear, and front views (× 3) of a complete juvenile shell. USNM 129440.
22–24. Side, rear, and front views (× 1) of a specimen with 28 ventral ribs per whorl. USNM 129437.
25–27. Side, rear, and front views (× 1) of a specimen with 24 ventral ribs per whorl. USNM 129436.
28–30. Side, rear, and front views (× 1) of a specimen with 31 ventral ribs per whorl. USNM 129438.



NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N. SP., VAR. A, A–B, AND B

PLATE 30

[All specimens shown on this plate are from a bed just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont.]

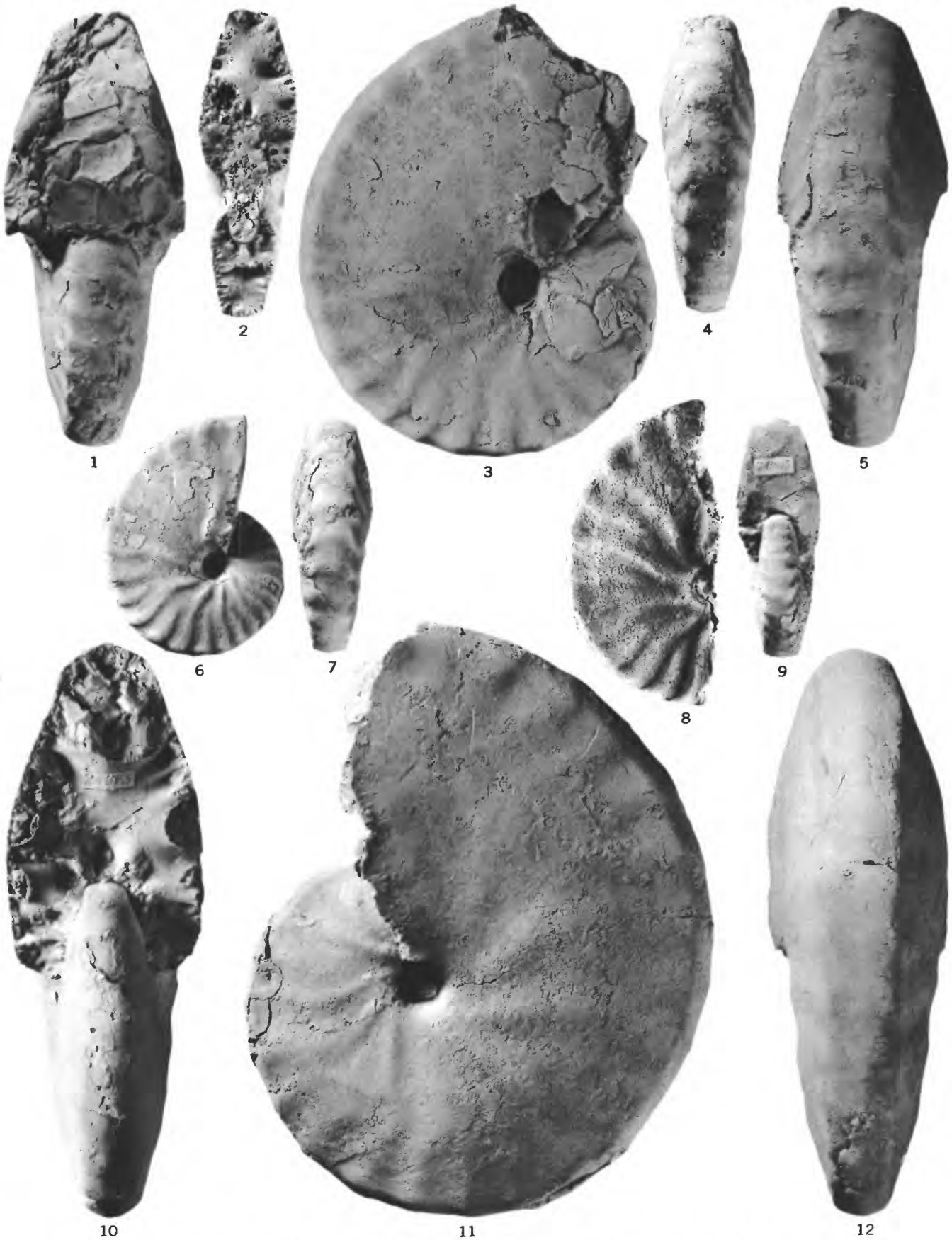
FIGURES 1–12. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. B (p. 87).

1, 3, 5. Front, side, and rear views (× 1). USNM 129431.

2, 4, 8. Front, rear, and side views (× 1), including cross section of early whorls. USNM 129434.

6, 7, 9. Side, rear, and front views (× 1). USNM 129435.

10–12. Front, side, and rear views (× 1) of the specimen selected as holotype. USNM 129432.



NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N. SP., VAR. B

PLATE 31

FIGURES 1–6. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. B (p. 87).

1–3. Front, side, and rear views (× 1) of specimen from horizon just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont. USNM 129430.

4–6. Side, rear, and front views (× 1) of specimen from same horizon and locality as figure 1. USNM 129433.

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NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N. SP., VAR. B

PLATE 32

Neogastroplites muelleri Reeside and Cobban, n. sp., var. B (p. 87).

Side view (× ⅔) of a large specimen from a horizon just below the middle of the Mowry shale member of the Colorado shale at USGS loc. 24065, Petroleum County, Mont. USNM 129429. See also plate 33, figure 1.

NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N.SP., VAR. B

PLATE 33

FIGURE 1. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. B (p. 87).

1. Front view (× 3/5) of a specimen from a horizon just below the middle of the Mowry shale member of the Colorado shale at USGS loc. 24065, Petroleum County, Mont. USNM 129429. See also plate 32.

2–12. *Neogastroplites maclearni* Reeside and Cobban, n. sp., var. E (p. 116).

2–4. Rear, side, and front views (× 3) of small, broken specimen showing the early whorls, from the Fort St. John group at GSC loc. 17300, Grande Cache map area, Alberta. GSC 13668.

5–7. Side, rear, and front views (× 1), from same horizon and locality as figure 2. GSC 13666.

8, 9. Side and rear views (× 1) of fragment from Colorado shale, 60 feet below Big Elk sandstone member, at USGS loc. 24609, Wheatland County, Mont. USNM 129635.

10–12. Side, front, and rear views (× 2) of specimen from same horizon and locality as figure 2. GSC 13667.

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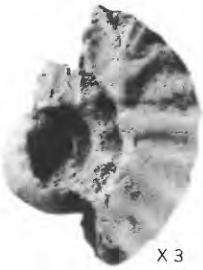

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NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N.SP., VAR. B, AND
N. MACLEARNI REESIDE AND COBBAN, N. SP., VAR. E

PLATE 34

Neogastroplites muelleri Reeside and Cobban, n. sp., var. B (p. 89).

Side view (× ⅔) of a specimen from a horizon just below the middle of the Mowry shale member of the Colorado shale at USGS loc. 24065, Petroleum County, Mont. USNM 129443.

NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N.SP., VAR. B

PLATE 35

[All specimens shown on this plate are from a horizon just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont.]

FIGURES 1, 2, 6, 7. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. B with relatively stout shell (p. 89).

1, 2, 6. Front, rear, and side views (× 1) of small specimen. USNM 129450.

7. Side view (× 1) of larger septate specimen. USNM 129449. See also plate 36, figures 9, 11.

3–5. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. B with relatively coarse sculpture (p. 89).

Two side and rear views (× 1) of broken specimen. USNM 129447.

NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N.SP., VAR. B

508901 O—60——9

PLATE 36

[All specimens shown on this plate are from a horizon just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont.]

FIGURES 1–5, 10. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. B–C (p. 89).

1, 5, 10. Rear, front, and side views (× 1) of a large specimen. USNM 129452.

2–4. Side, rear, and front views (× 1) of a small specimen. USNM 129453.

6–8. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. C (p. 90).

6. Rostrum (× 1) attributed to var. C. USNM 129463.

7, 8. Rear and side views (× 1) of a pathologic specimen. The latest part of the whorl shown was damaged and repaired during life. USNM 129464.

9, 11. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. B with relatively stout shell. (p. 89).

Front and rear views (× 1) of large specimen. USNM 129449. See also plate 35, figure 7.

NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N. SP., VAR. B–C, C, AND B

PLATE 37

[All specimens shown on this plate are from a horizon just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont.]

FIGURES 1–22. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. C (p. 90).

1–4. Rear, two side, and front views (× 3) of a broken specimen that shows the early whorls. USNM 129462.

5–7. Side, rear, and front views (× 2). USNM 129461.

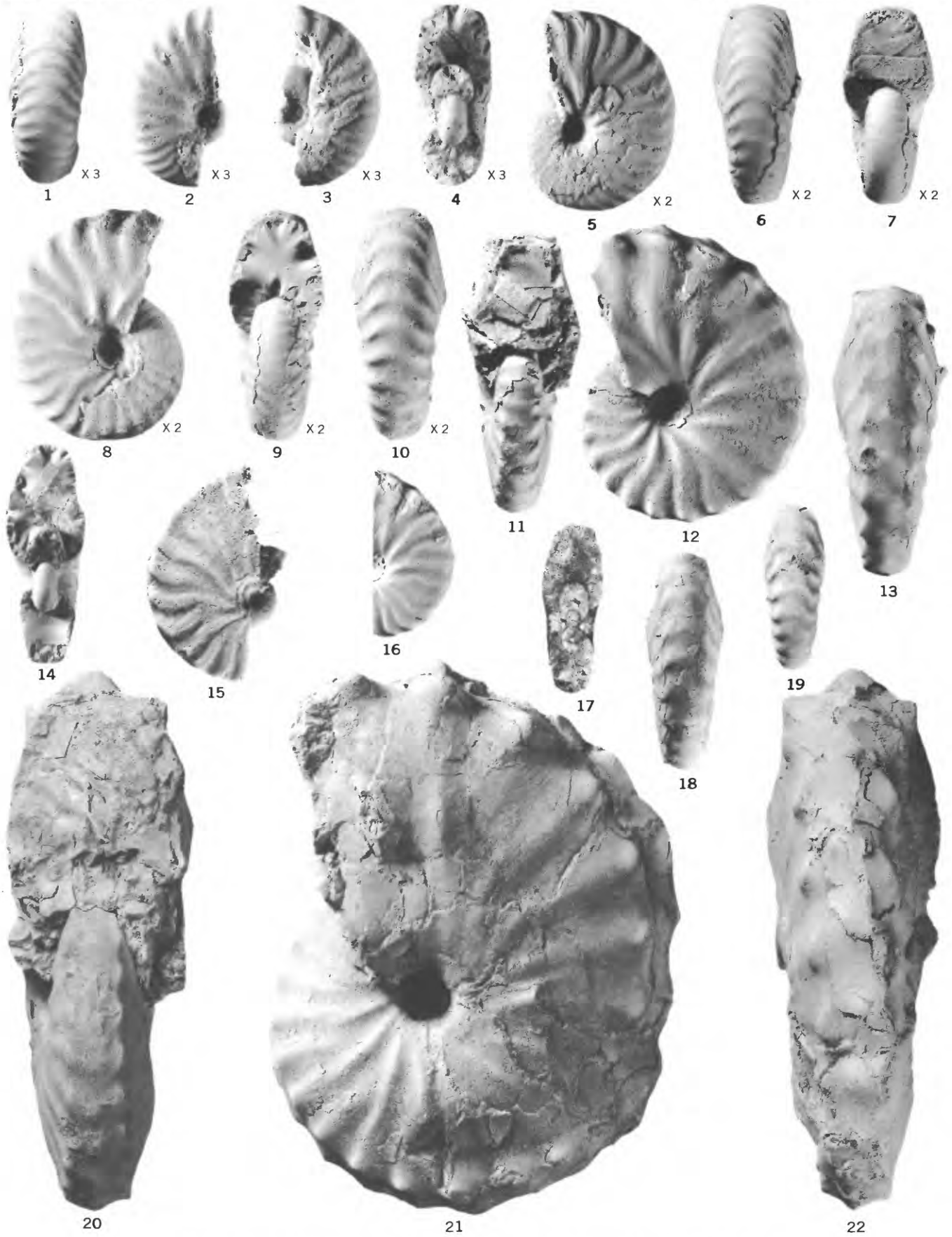
8–10. Side, front, and rear views (× 2). USNM 129460.

11–13. Front, side, and rear views (× 1). USNM 129457.

14, 15, 18. Front, side, and rear views (× 1) of a broken specimen that shows the early whorls. USNM 129458.

16, 17, 19. Side, front, and rear views (× 1), including a cross section of the early whorls. USNM 129459.

20–22. Front, side, and rear views (× 1) of a larger specimen. USNM 129455.



NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N.SP., VAR. C

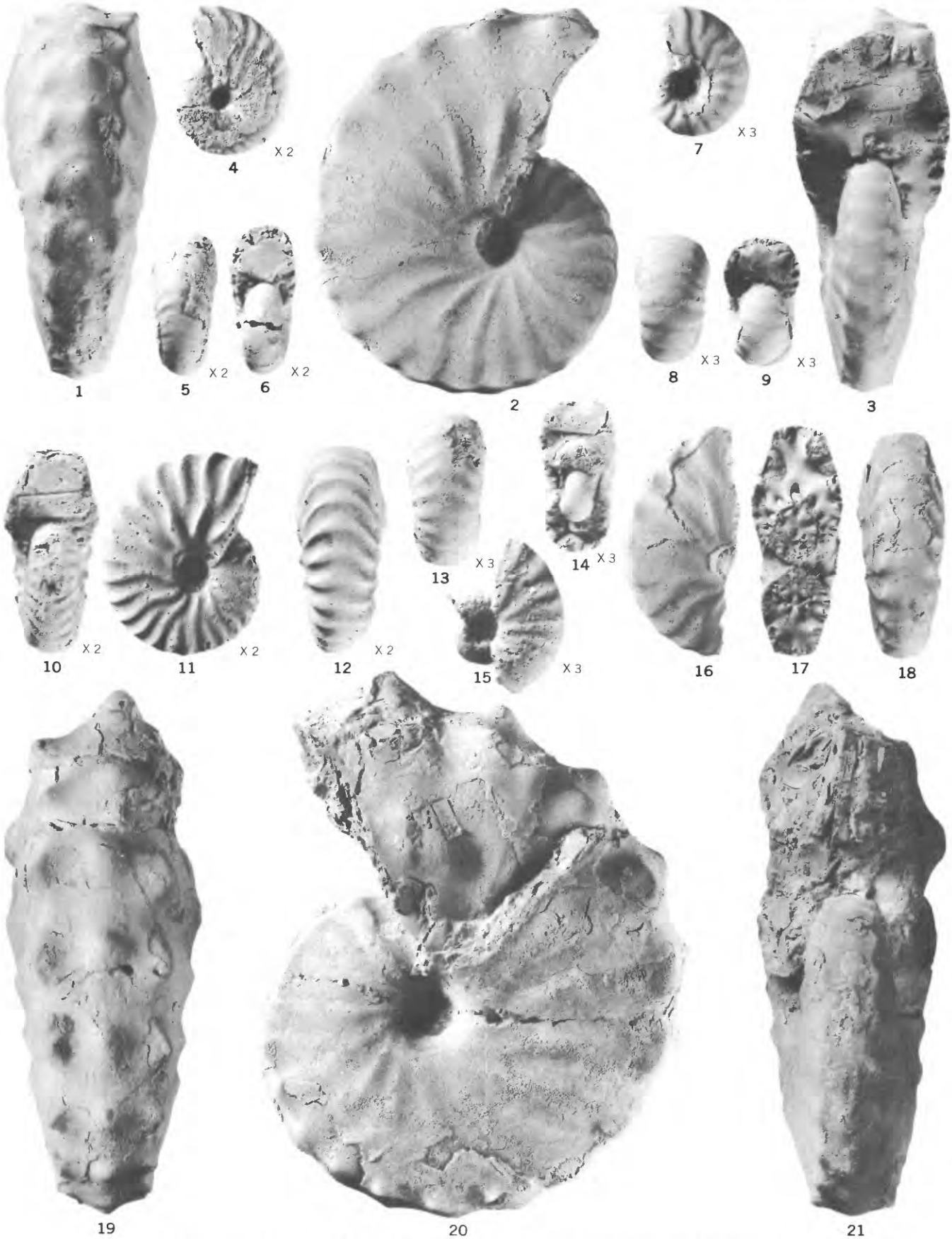
PLATE 38

[All specimens shown on this plate are from a horizon just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont.]

FIGURES 1–3. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. C (p. 90).
Rear, side, and front views (× 1). USNM 129456.

4–15. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. D (p. 91).
4–6. Side, rear, and front views (× 2) of inner whorls. USNM 129478.
7–9. Side, rear, and front views (× 3) of inner whorls. USNM 129479.
10–12. Front, side, and rear views (× 2). USNM 129477.
13–15. Rear, front, and side views (× 3) of broken specimen showing the inner whorls. USNM 129480.

16–21. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. C–D. (p. 91).
16–18. Side, front, and rear views (× 1), including cross section of early whorls. USNM 129468.
19–21. Rear, side, and front views (× 1) of a larger specimen. USNM 129467.



NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N. SP., VAR. C, D, AND C–D

PLATE 39

[All specimens shown on this plate are from a horizon just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont.]

FIGURES 1–19. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. D (p. 91).

1–3. Side, rear, and front views (× 1). USNM 129476.

4–6. Side, rear, and front views (× 1). USNM 129475.

7, 10, 11. Rear, side, and front views (× 1). USNM 129474.

8, 9, 12. Front, side, and rear views (× 1). USNM 129473.

13–15. Two side and end views (× 2) of a fragment of a pathologic shell. USNM 129481. The shell was injured and repaired in life, resulting in elimination of the ribs from one side.

16–19. Two side, front, and rear views (× 1) of a partly crushed larger shell. USNM 129472.

NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N. SP., VAR. D

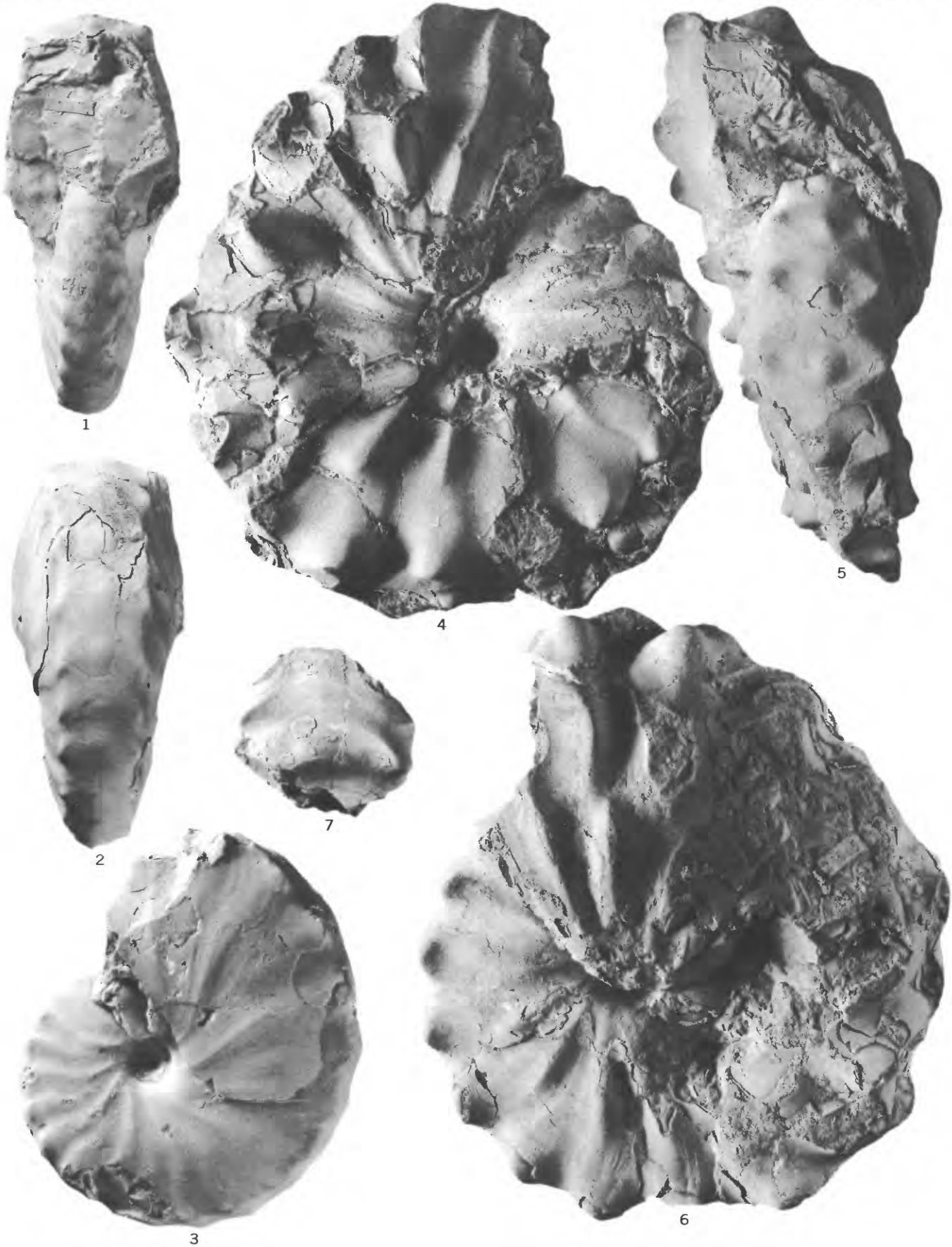
PLATE 40

[All specimens shown on this plate are from a horizon just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont.]

FIGURES 1–3. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. D with relatively weak sculpture (p. 93).
Front, rear, and side views (× 1). USNM 129483.

4–6. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. D (p. 91).
Two side and front views (× 1) of a nearly complete though crushed large specimen. USNM 129471.

7. *Neogastroplites muelleri* Reeside and Cobban, n. sp. (p. 81).
Rostrum (× 1) not assigned to a variant, but probably representing one of the nodose or spinose forms. USNM 129414.



NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N. SP., VAR. D AND AN UNASSIGNED VARIANT

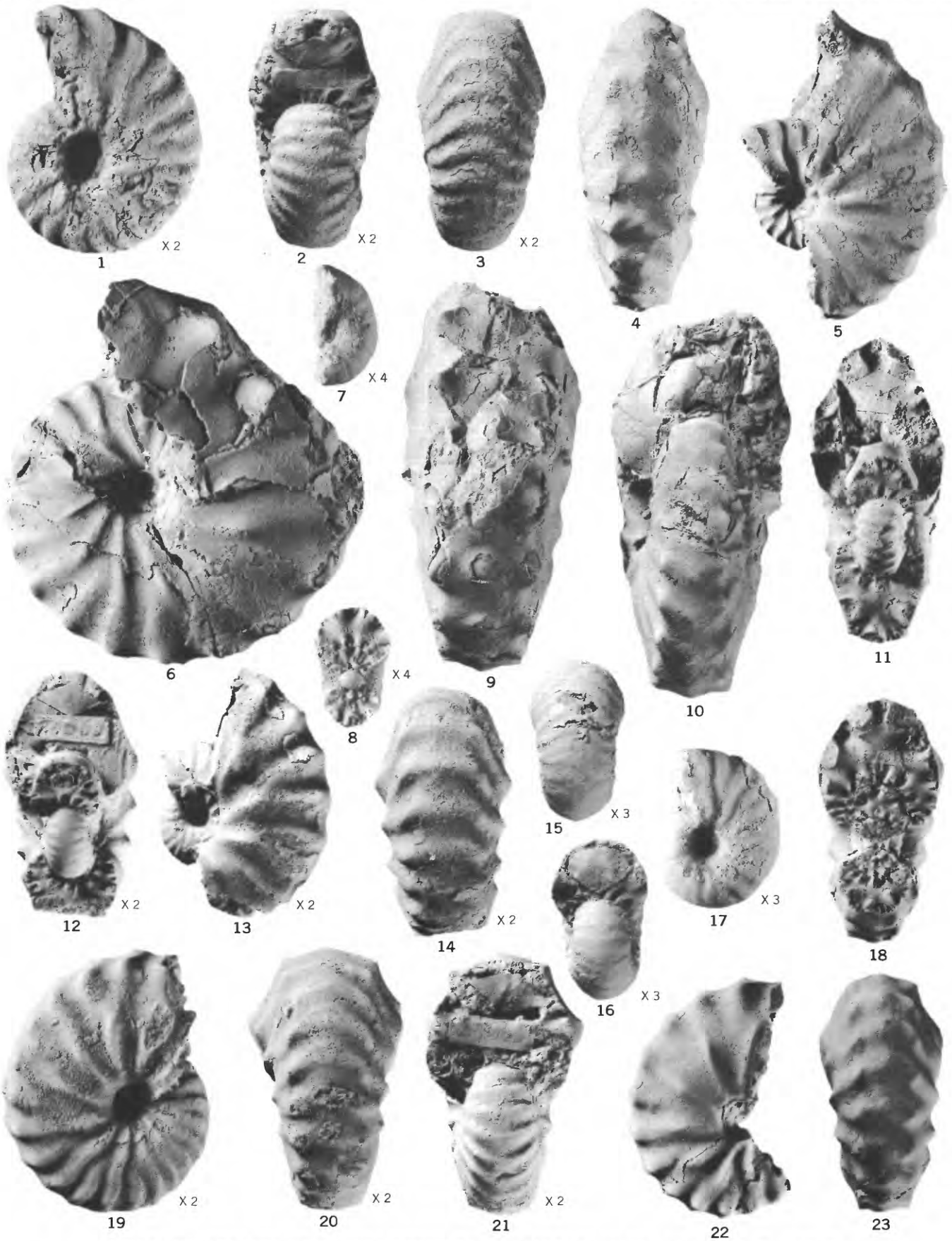
PLATE 41

[All specimens shown on this plate are from a horizon just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont.]

FIGURES 1–3. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. D with relatively stout shell (p. 93).
Side, front, and rear views (× 2). USNM 129485.

4–6, 9–11. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. D–E (p. 93).
4, 5, 11. Rear, side, and front views (× 1) of a broken specimen showing early whorls. USNM 129487.
6, 9, 10. Side, rear, and front views (× 1) of larger specimen. USNM 129486.

7, 8, 12–23. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. E (p. 94).
7, 8. Side and front views (× 4), including cross section of early whorls. USNM 129494.
12–14. Front, side, and rear views (× 2) of a broken specimen showing the early whorls. USNM 129492.
15–17. Rear, front, and side views (× 3) of early whorls. USNM 129493.
18, 22, 23. Front, side, and rear views (× 1), including cross section of early whorls. USNM 129490.
19–21. Side, rear, and front views (× 2) of small specimen. USNM 129491.



NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N. SP., VAR. D, D–E, AND E

PLATE 42

[All specimens shown on this plate are from a horizon just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont.]

FIGURES 1–5, 8. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. E–F (p. 95).

1, 2. Side and front views (× 1). USNM 129496.

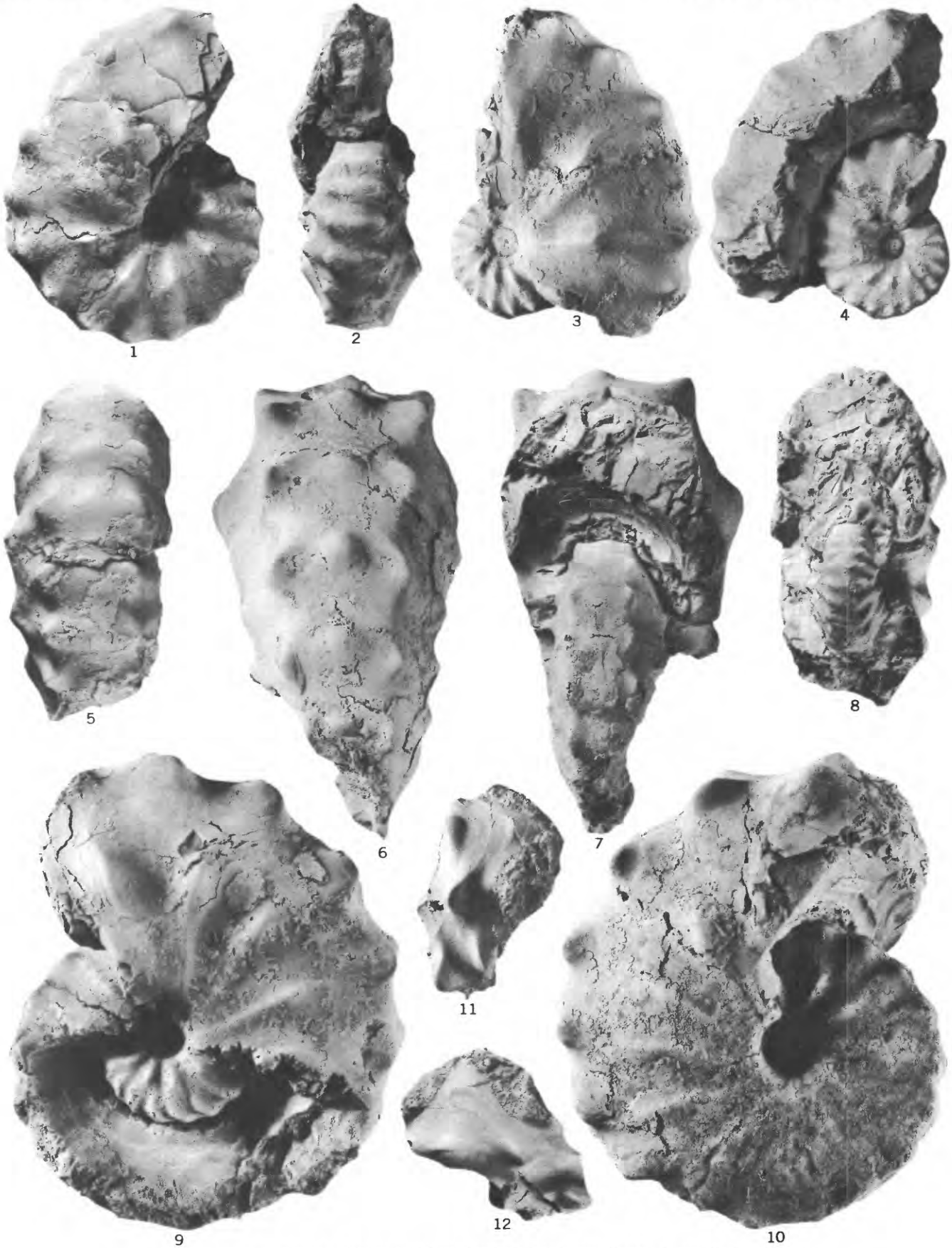
3–5, 8. Two side, rear, and front views (× 1) of a broken larger specimen showing the earlier whorls. USNM 129497.

6, 7, 9, 10. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. E (p. 94).

Rear, front, and two side views (× 1) of a broken large specimen. USNM 129487.

11, 12. *Neogastroplites muelleri* Reeside and Cobban, n. sp. (p. 81).

Rostrum (× 1) not assigned to a variant, but probably representing one of the nodose or spinose variants. Figure 11 is a side view with the specimen turned to the right to show the rostrum. USNM 129415.



NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N.SP., VAR. E–F, E, AND AN UNASSIGNED VARIANT

PLATE 43

[All specimens shown on this plate are from a horizon just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont.]

FIGURES 1–17, 19–24, 27, 28. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. F (p. 95).

1–3. Side, rear, and front views (× 3) of a small specimen. USNM 129506.

4–6. Side, rear, and front views (× 3) of a small specimen. USNM 129505.

7–9. Side, front, and rear views (× 2), including cross section of early whorls. USNM 129504.

10–12. Side, front, and rear views (× 2). USNM 129503.

13–15. Side, rear, and front views (× 1). USNM 129502.

16, 17, 19. Side, rear, and front views (× 1). USNM 129501.

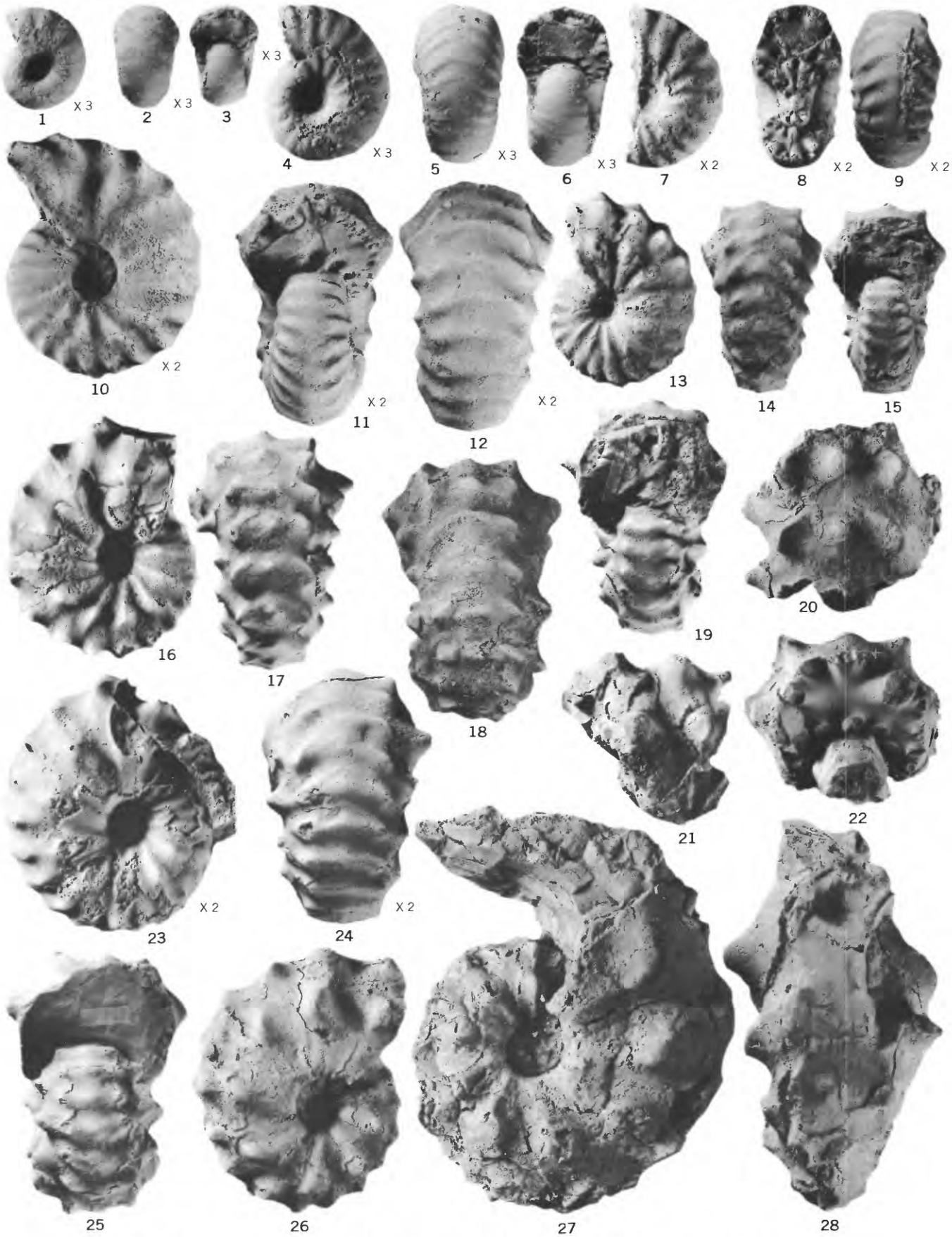
20–22. Rear, side, and front views (× 1) of a fragment of a large shell. USNM 129500.

23, 24. Side and rear views (× 2) of a pathologic specimen. USNM 129507. The shell was injured and repaired in life, resulting in elimination of the ventrolateral nodes near the end of the specimen.

27, 28. Side and rear views (× 1) of a crushed larger shell. USNM 129499.

18, 25, 26. *Neogastroplites muelleri* Reeside and Cobban, var. F–G (p. 96).

Rear, front, and side views (× 1). USNM 129510.



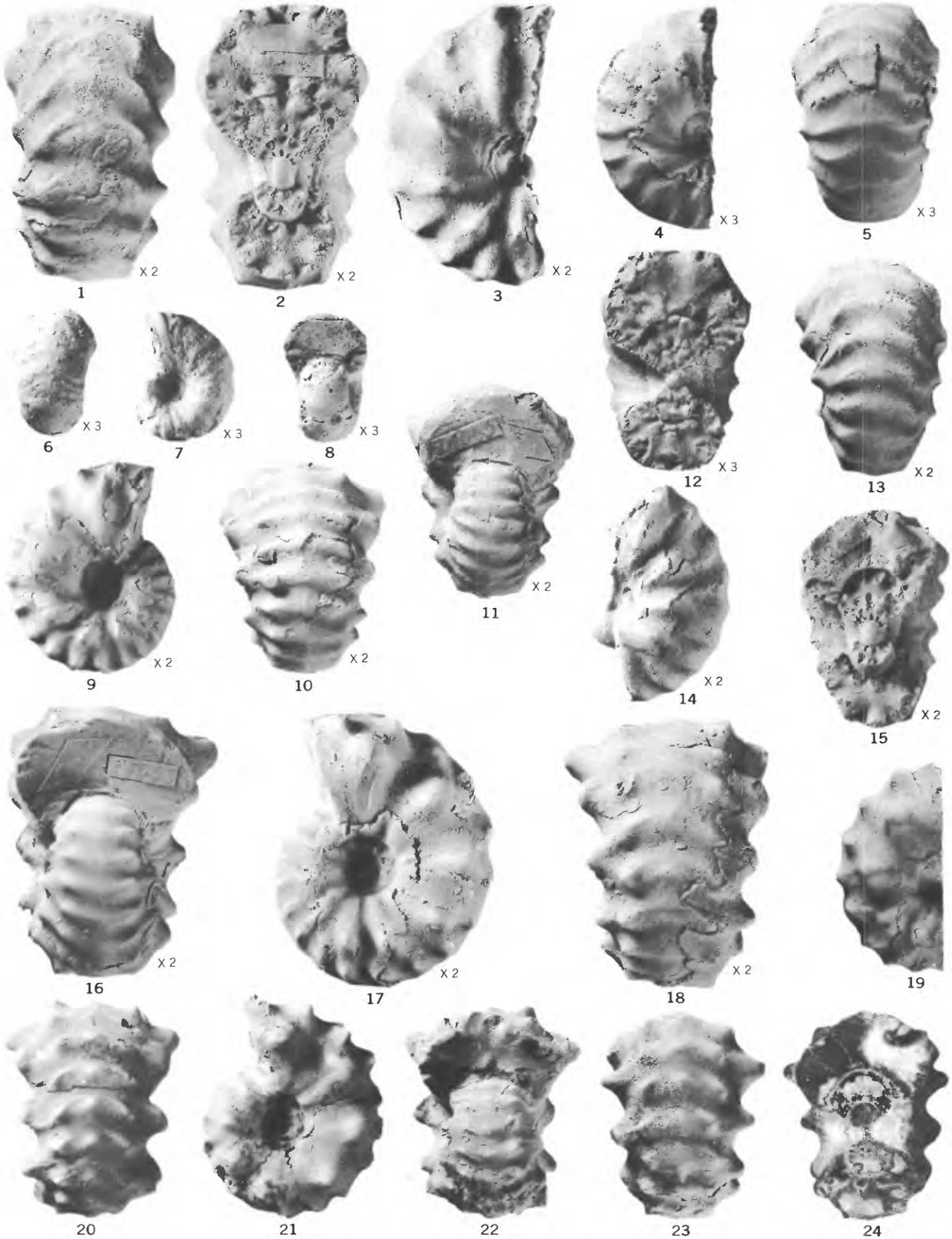
NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N. SP., VAR. F AND F–G

PLATE 44

[All specimens shown on this plate are from a horizon just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont.]

FIGURES 1–3. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. F–G (p. 96).
Rear, front, and side views (× 2) of a broken specimen showing the early whorls. USNM 129511.

4–24. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. G (p. 97).
4, 5, 12. Side, rear, and front views (× 3) of a broken specimen showing the early whorls. USNM 129525.
6–8. Rear, side, and front views (× 3) of a small specimen. USNM 129522.
9–11. Side, rear, and front views (× 2). USNM 129520.
13–15. Rear, side, and front views (× 2) of a broken specimen showing the early whorls. USNM 129521.
16–18. Front, side, and rear views (× 2). USNM 129519.
19, 23, 24. Side, rear, and front views (× 1), including a cross section of early whorls. USNM 129518.
20–22. Rear, side, and front views (× 1). USNM 129517.



NEOGASTROPLITES MUELLERI REESIDE AND COBBAN, N. SP., VAR. F–G AND G

PLATE 45

FIGURES 1–12. *Neogastroplites americanus* (Reeside and Weymouth) var. A (p. 101).

1, 2. Two views (× 2) of part of an aptychus attributed to var. A, from the Colorado shale, 115 feet below Big Elk sandstone member, at USGS loc. 23042, Wheatland County, Mont. USNM 129541.

3. Part of an aptychus (× 2) attributed to var. A, from same horizon and locality as figure 1. USNM 129542.

4, 5. Two views (× 1) of an aptychus attributed to var. A, folded on itself, from the Mowry shale at USGS loc. 17934, Park County, Wyo. USNM 129549.

6. View (× 1) of rubber cast from natural mold of part of an aptychus attributed to var. A, from same horizon and locality as figure 4. USNM 129547.

7. View (× 1) of rubber cast from natural mold of part of an aptychus attributed to var. A, from same horizon and locality as figure 4. USNM 129548.

8, 9. Two views (× 1) of an aptychus attributed to var. A, from same horizon and locality as figure 4. USNM 129546.

10–12. Two side and rear views (× 1) of the holotype of the species, a fragment of a crushed internal mold (*Acompsoceras* Reeside and Weymouth, 1931, pl. 3, figs. 1–4). From the Aspen shale, 70 to 100 feet below top, at USGS loc. 14718, Lincoln County, Wyo. USNM 73775.

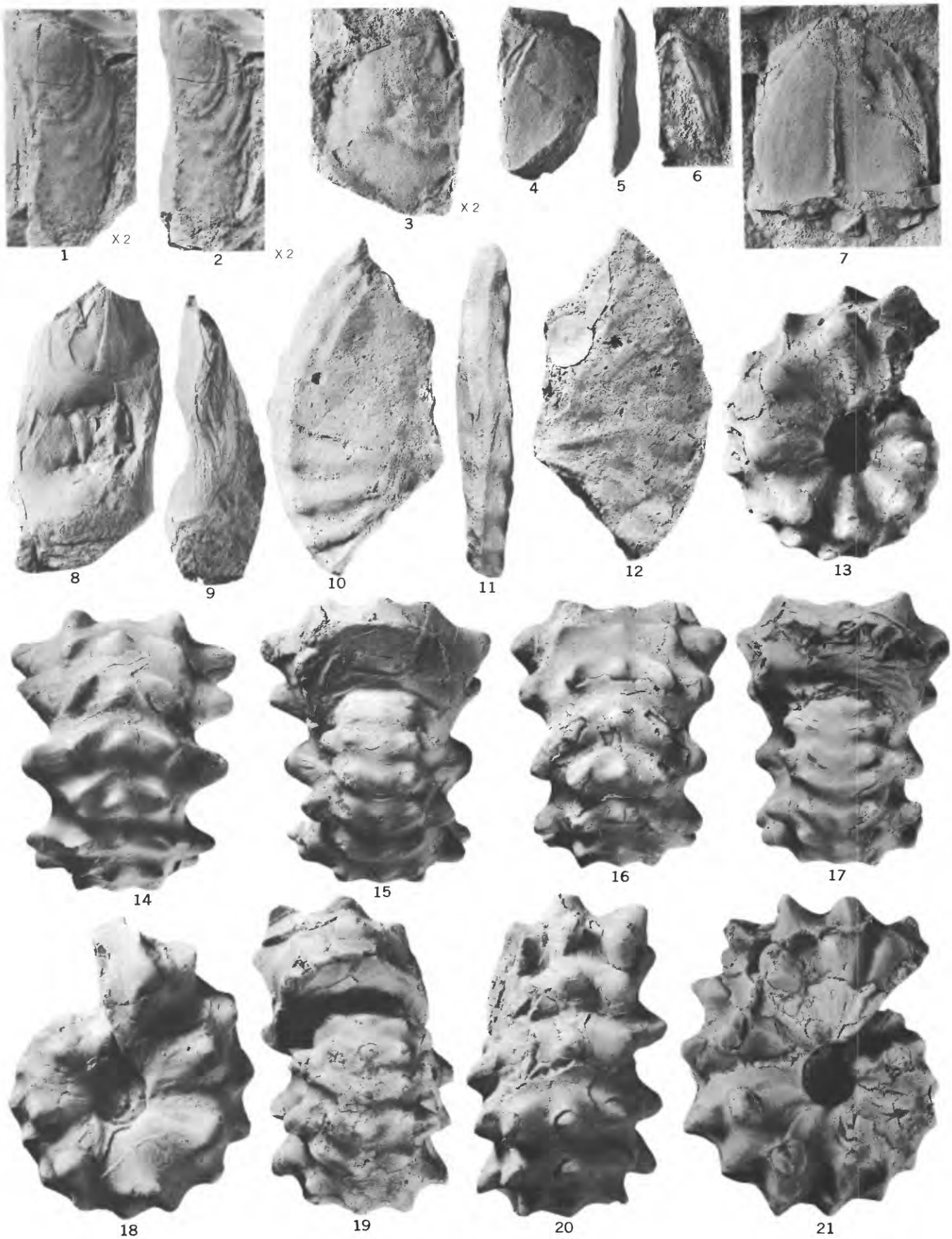
13–21. *Neogastroplites muelleri* Reeside and Cobban, n. sp., var. G (p. 97).

Just below middle of Mowry shale member of Colorado shale at USGS loc. 24065, Petroleum County, Mont.

13, 16, 17. Side, rear, and front views (× 1) of nearly complete large specimen. USNM 129514.

14, 15, 18. Rear, front, and side views (× 1) of nearly complete large specimen. USNM 129515.

19–21. Front, rear, and side views (× 1) of nearly complete large specimen. USNM 129516.



NEOGASTROPLITES AMERICANUS (REESIDE AND WEYMOUTH) VAR. A AND
N. MUELLERI REESIDE AND COBBAN, N. SP., VAR. G

PLATE 46

FIGURES 1–30. *Neogastroplites americanus* (Reeside and Weymouth) var. A (p. 101).

1–12, 15–28. Colorado shale, 115 feet below Big Elk sandstone member at USGS loc. 23042, Wheatland County, Mont.

1–3. Rear, side, and front views (× 3) of a broken specimen showing the early whorls. USNM 129540.

4–6. Side, rear, and front views (× 2) of small specimen. USNM 129538.

7–9. Side, rear, and front views (× 3) of small specimen. USNM 129539.

10–12. Side, rear, and front views (× 2) of small specimen. USNM 129537.

15, 16. Side and front views (× 2), including cross section of early whorls. USNM 129536.

17–19. Side, rear, and front views (× 1) of a specimen with 32 ventral ribs per whorl. USNM 129534.

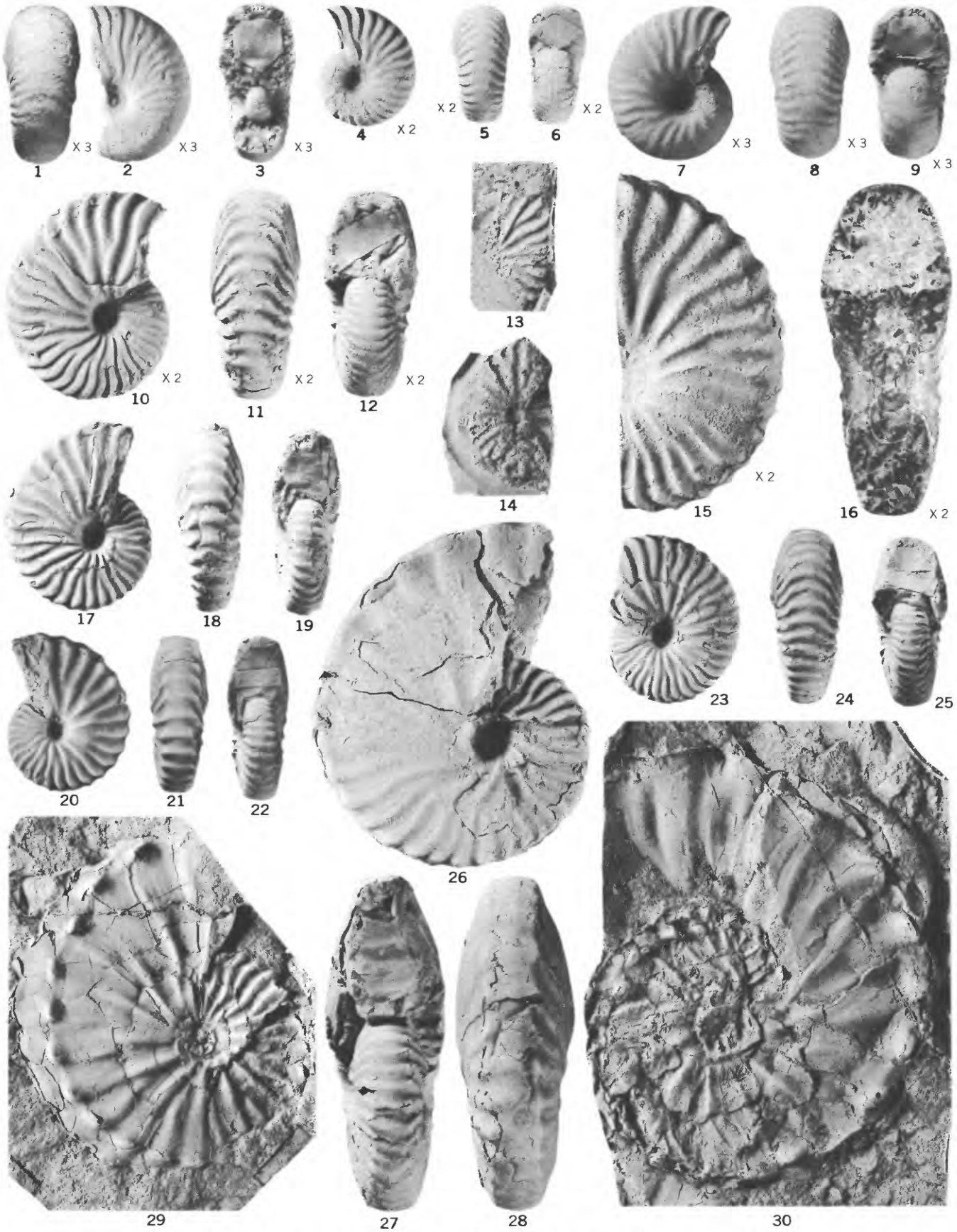
20–22. Side, rear, and front views (× 1) of a specimen with 27 ventral ribs per whorl. USNM 129535.

23–25. Side, rear, and front views (× 1) of a specimen with 38 ventral ribs per whorl. USNM 129533.

26–28. Side, front, and rear views (× 1). USNM 129532.

13, 14. Rubber cast (× 1) from a natural mold and a specimen (× 1) from the Aspen shale, 70 to 100 feet below top, at USGS loc. 14718, Lincoln County, Wyo. USNM 129522, 73776. (*Metoicoceras whitei* Hyatt of Reeside and Weymouth, 1931, pl. 3, fig. 8: pl. 4, fig. 2.)

29, 30. Two rubber casts (× 1) from natural molds of flattened specimens in Mowry shale, 60 feet below top, at USGS loc. 23465, Crook County, Wyo. USNM 129550, 129551.



NEOGASTROPLITES AMERICANUS (REESIDE AND WEYMOUTH) VAR. A

PLATE 47

FIGURES 1–6. *Neogastroplites americanus* (Reeside and Weymouth) var. A (p. 101).

1–3. Two side and rear views (× 1) of a specimen from the Colorado shale, 115 feet below the Big Elk sandstone member, at USGS loc. 23042, Wheatland County, Mont. USNM 129531.

4–6. Rear, side, and front views (× 1) of a specimen from the Mowry shale at USGS loc. 17934, Park County, Wyo. USNM 129545.

NEOGASTROPLITES AMERICANUS (REESIDE AND WEYMOUTH) VAR. A

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PLATE 48

Neogastroplites americanus (Reeside and Weymouth) var. A (p. 101).

Side view (× 1) of large specimen from the Colorado shale, 115 feet below the Big Elk sandstone member at USGS loc. 23042, Wheatland County, Mont. USNM 129529. See also plate 49, figure 9.

1

NEOGASTROPLITES AMERICANUS (REESIDE AND WEYMOUTH) VAR. A

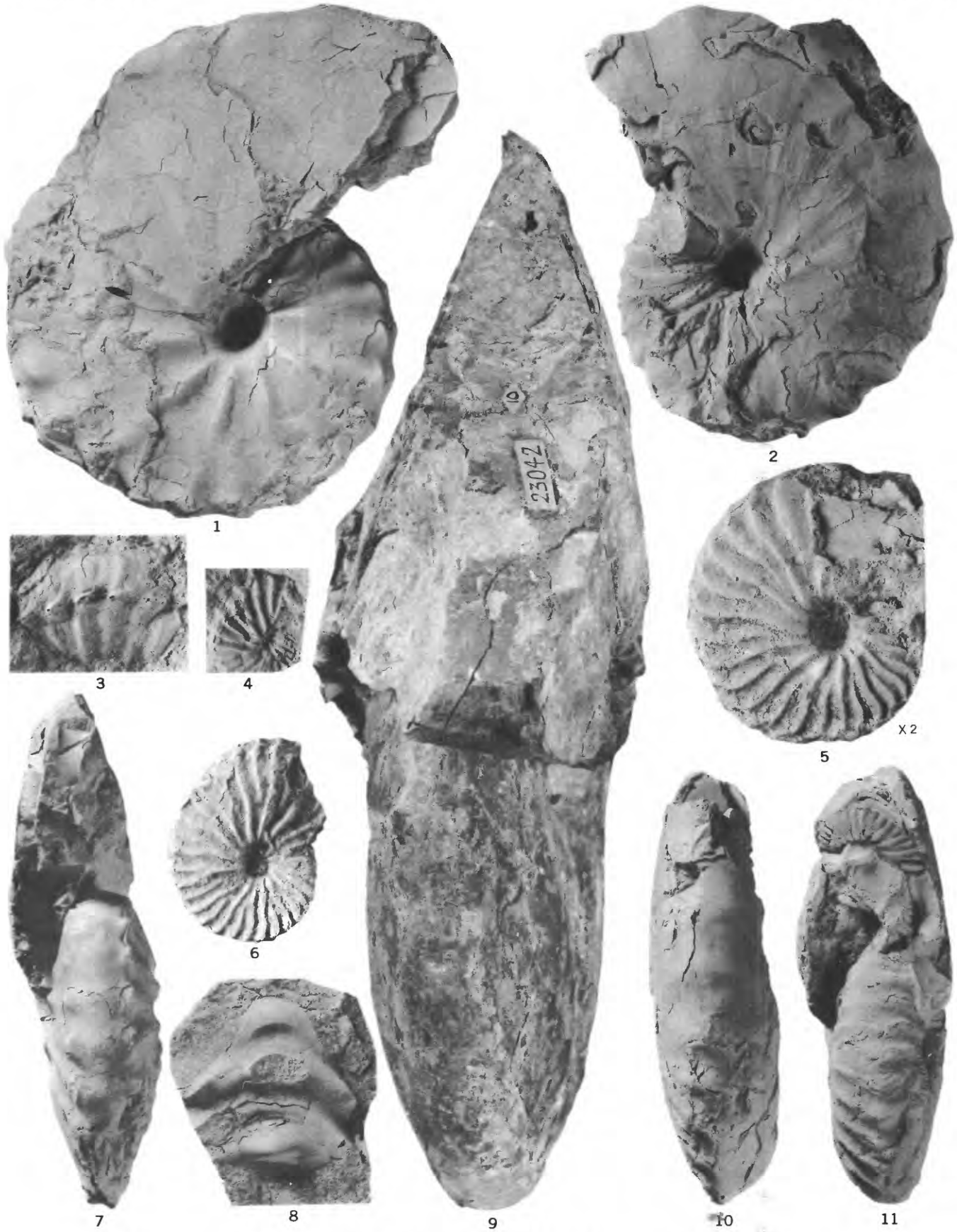
PLATE 49

FIGURES 1, 7. *Neogastroplites americanus* (Reeside and Weymouth) var. A–B. (p. 104).
Side and front views (× 1) of a specimen from the Colorado shale, 115 feet below the Big Elk sandstone member, at USGS loc. 23042, Wheatland County, Mont. USNM 129554.

2, 5, 6, 9–11. *Neogastroplites americanus* (Reeside and Weymouth) var. A (p. 101).
2, 10, 11. Side, rear, and front views (X 1) of a pathologic shell from the same horizon and locality as figure 1. USNM 129530. Injury during life resulted in the loss of one of the rows of ventrolateral nodes and simulation of a sharp-ventered shell.
5. Side view (× 2) of a specimen from the Fort St. John group at GSC loc. 24693, Adams Lookout map area, Alberta. GSC 13633.
6. Side view (× 1) of another specimen from the same horizon and locality as figure 5. GSC 13632.
9. Front view (× 1) of large specimen turned slightly to the left, from same horizon and locality as figure 1. USNM 129529. See also plate 48.

3–4. *Neogastroplites americanus* (Reeside and Weymouth) var. B (p. 104).
Two rubber casts (× 1) from natural molds in porcelanite from the Aspen shale, 70 to 100 feet beneath top, at USGS loc. 14718, Lincoln County, Wyo. USNM 129574, 129576. (*Metoicoceras whitei* Hyatt of Reeside and Weymouth, 1931, pl. 4, figs. 1, 3.)

8. *Neogastroplites americanus* (Reeside and Weymouth) (p. 98). Rostrum attributed only to one of the more compressed variants, from the same horizon and locality as figure 1. USNM 129527.



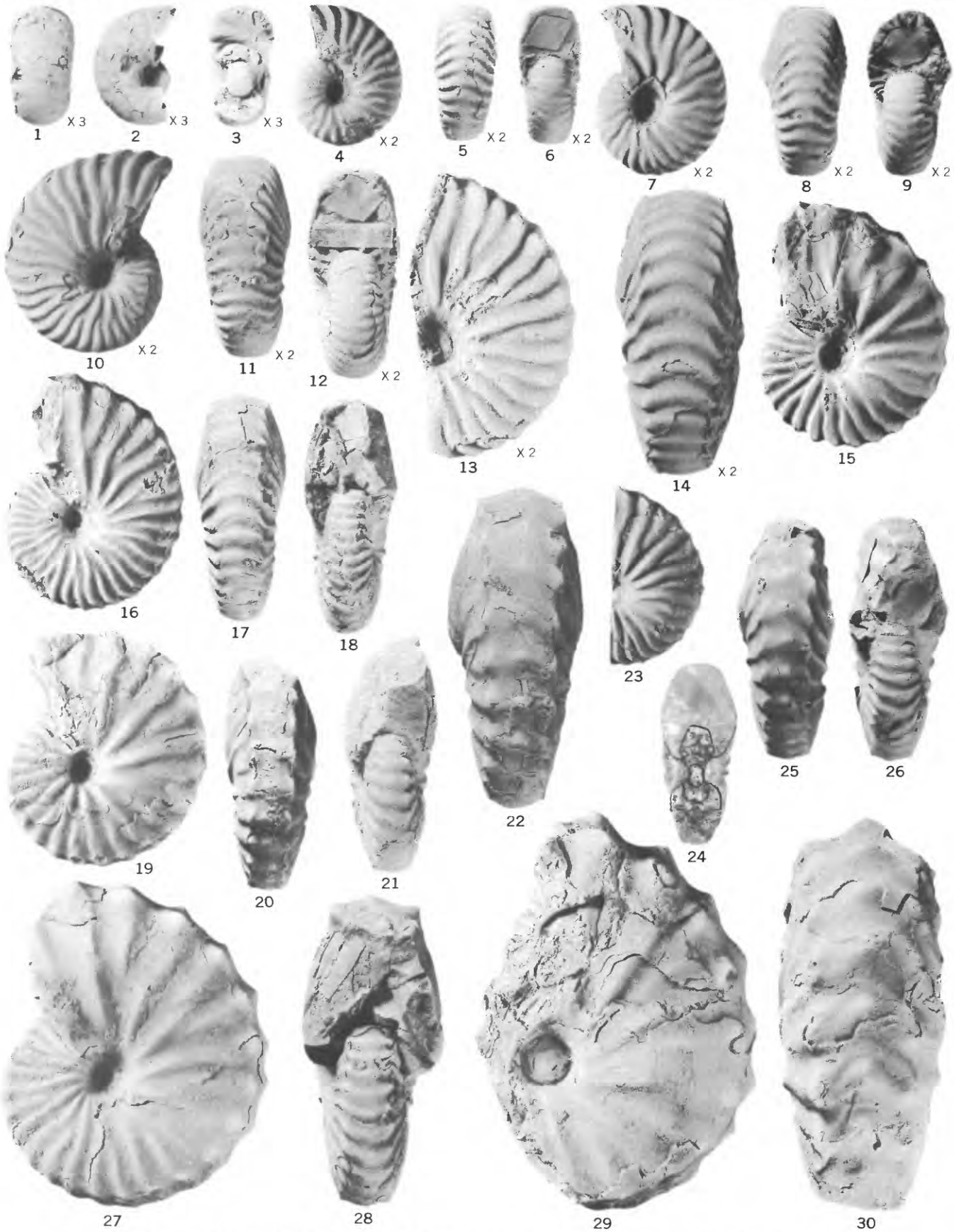
NEOGASTROPLITES AMERICANUS (REESIDE AND WEYMOUTH) VAR. A–B, A, B, AND ONE OF THE MORE COMPRESSED VARIANTS

PLATE 50

[All specimens shown on this plate are from the Colorado shale, 115 feet beneath the Big Elk sandstone member, at USGS loc. 23042, Wheatland County, Mont.]

FIGURES 1–30. *Neogastroplites americanus* (Reeside and Weymouth) var. B (p. 104).

1–3. Rear, side, and front views (× 3) of a small broken specimen showing the early whorls. USNM 129568.
4–6. Side, rear, and front views (× 2). USNM 129567.
7–9. Side, rear, and front views (× 2). USNM 129566.
10–12. Side, rear, and front views (× 2). USNM 129565.
13, 14. Side and rear views (× 2) of a broken specimen. USNM 129564.
15, 25, 26. Side, rear, and front views (× 1) of a specimen with 27 ventral ribs per whorl. USNM 129561.
16–18. Side, rear, and front views (× 1) of a specimen with 33 ventral ribs per whorl. USNM 129562.
19–21. Side, rear, and front views (× 1) of a specimen with 24 ventral ribs per whorl. USNM 129560.
22, 27, 28. Rear, side, and front views (× 1). USNM 129550.
23, 24. Side and front views (× 1), including cross section of early whorls. USNM 129563.
29, 30. Side and rear views (× 1). USNM 129558.



NEOGASTROPLITES AMERICANUS (REESIDE AND WEYMOUTH) VAR. B

PLATE 51

FIGURES 1–5, 9–12. *Neogastroplites americanus* (Reeside and Weymouth) var. B (p. 104).

1, 5, 9. Three rubber casts (× 1) from natural molds in porcelanite from the Aspen shale, 70 to 100 feet beneath top, at USGS loc. 14718, Lincoln County, Wyo. USNM 129573, 129575, 129572. (*Metoicoceras whitei* Hyatt of Reeside and Weymouth, 1931, pl. 4, figs. 5–7.)

2–4. Three views (× 1) of relatively large crushed specimen—side view with piece of outer whorl removed, front and side views of outer whorl—from Colorado shale, 115 feet beneath Big Elk sandstone member, at USGS loc. 23042, Wheatland County, Mont. USNM 129557.

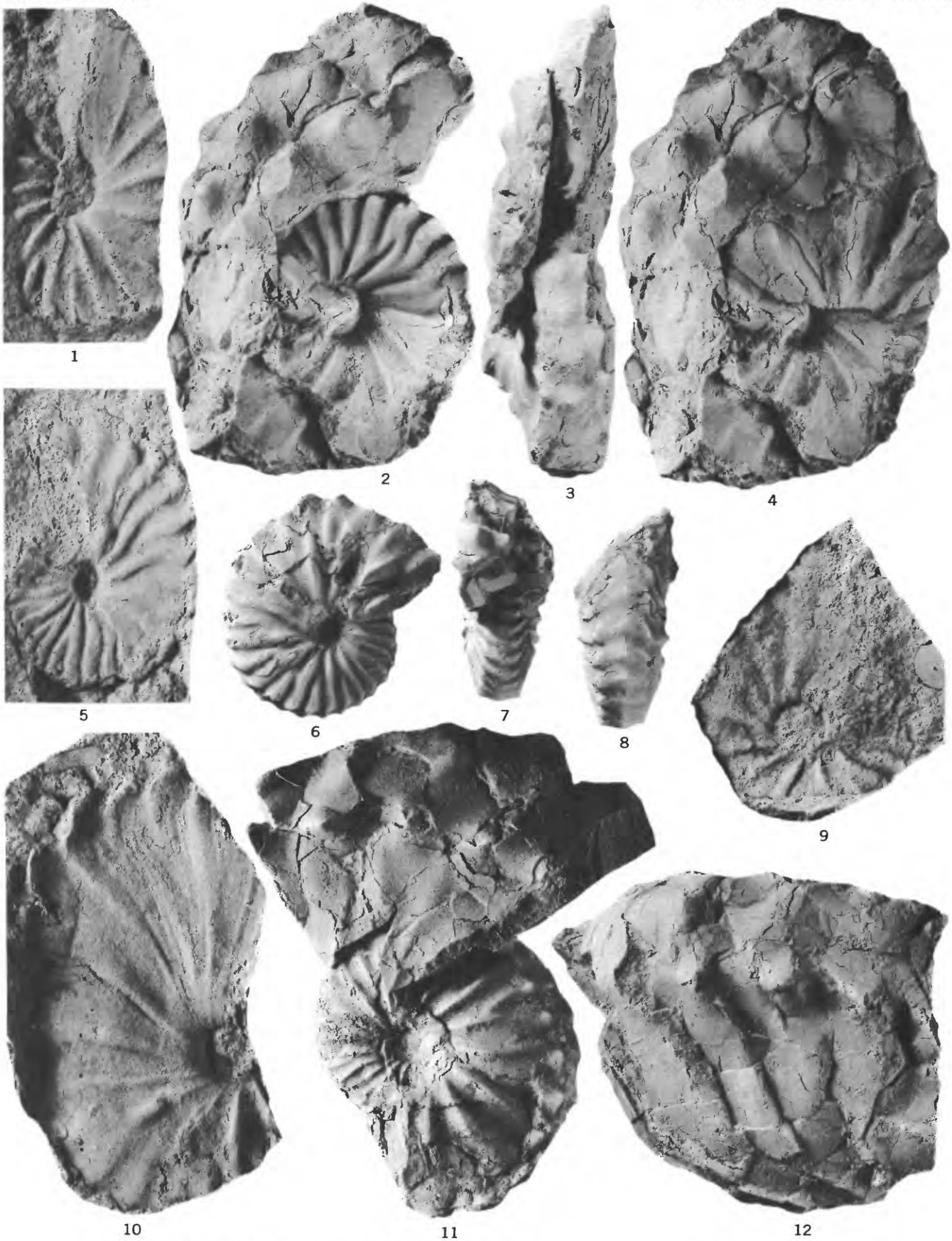
10. Rubber cast (× 1) from natural mold in porcelanite at same horizon and locality as figure 1. USNM 129577.

11. Side view (× 1) of specimen preserving part of a large outer whorl, from Mowry shale at USGS loc. 17934, Park County, Wyo. USNM 129570.

12. Side view (× 1) of fragment of a large specimen from the Mowry shale, 205 feet above base, at USGS loc. 24564, Park County, Wyo. USNM 129571.

6–8. *Neogastroplites americanus* (Reeside and Weymouth) var. B–C (p. 106).

Side, front, and rear views (× 1) of specimen from Colorado shale, 115 feet beneath Big Elk sandstone member, at USGS loc. 23042, Wheatland County, Mont. USNM 129578.



NEOGASTROPLITES AMERICANUS (REESIDE AND WEYMOUTH) VAR. B AND B–C

PLATE 52

FIGURES 1–24, 26. *Neogastroplites americanus* (Reeside and Weymouth) var. C (p. 106).

1–17, 19–21, 23, 24. Colorado shale, 115 feet beneath the Big Elk sandstone member, at USGS loc. 23042, Wheatland County, Mont.

1–3. Side, rear, and front views (× 3) of a small specimen. USNM 129590.

4–6. Side, rear, and front views (× 2) of a small specimen. USNM 129589.

7, 8, 12. Front, rear, and side views (× 2). USNM 129587.

9–11. Side, rear, and front views (× 2). USNM 129588.

13–15. Front, side, and rear views (× 1). USNM 129585.

16, 17. Side and front views (× 2), including cross section of early whorls. USNM 129586.

19–21. Rear, side, and front views (× 1) of broken specimen showing the early whorls. USNM 129584.

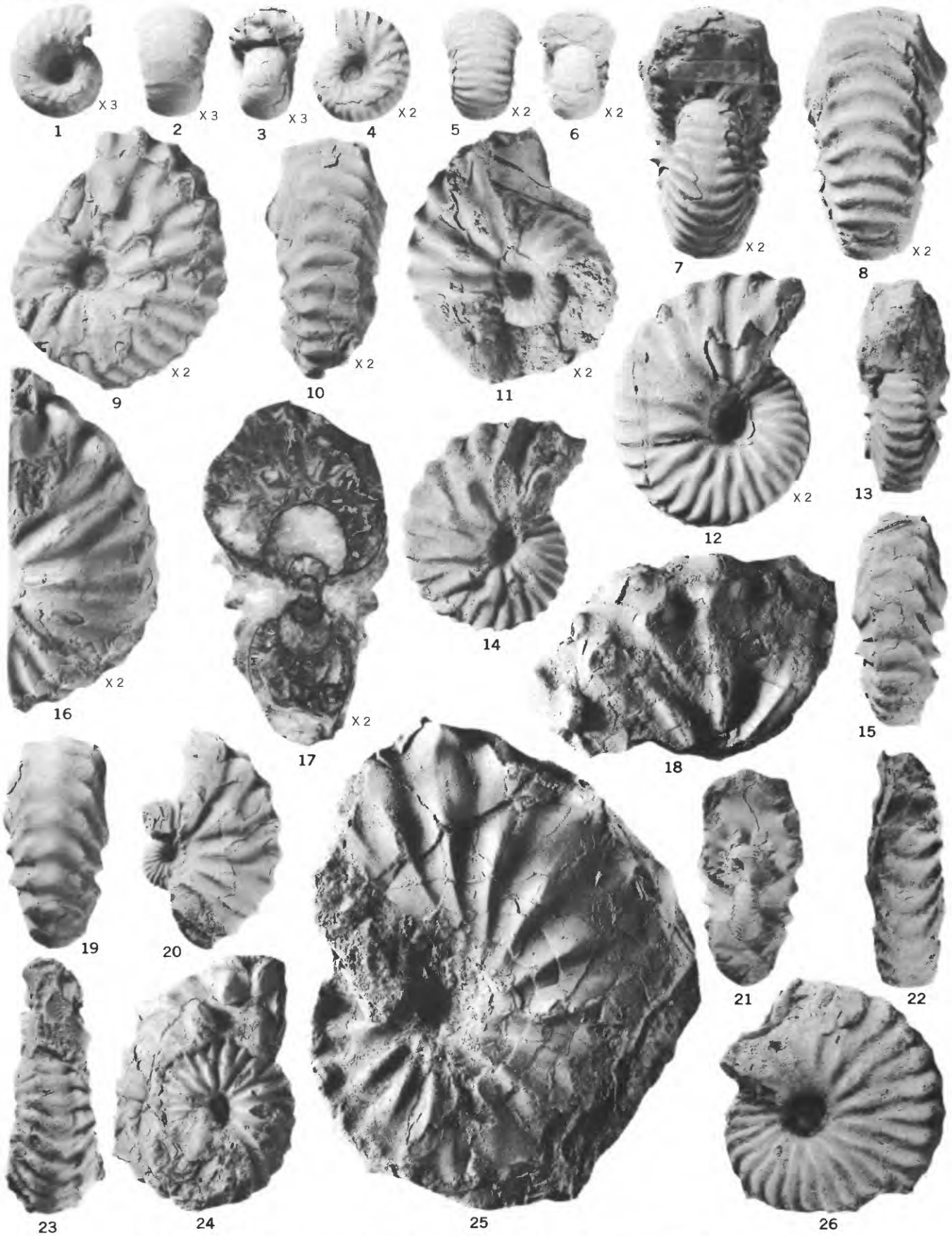
23, 24. Front and side views (× 1) of crushed specimen. USNM 129583.

18. Mowry shale, 194 feet above base, at USGS loc. 24565, Park County, Wyo. Side view (× 1) of fragment. USNM 129592.

22, 26. Fort St. John group at GSC loc. 24693, Adams Lookout map area, Alberta. Rear and side views (× 1) of crushed specimen. GSC 13634.

25. *Neogastroplites americanus* (Reeside and Weymouth) var. B–C (p. 106).

Crushed specimen (× 1) from Mowry shale, 194 feet above base, at USGS loc. 24565, Park County, Wyo. USNM 129581.



NEOGASTROPLITES AMERICANUS (REESIDE AND WEYMOUTH) VAR. C AND B–C

PLATE 53

FIGURES 1–5. *Neogastroplites americanus* (Reeside and Weymouth) var. C–D (p. 108).

1–2. Side and front views (× 1) of a broken specimen from the Colorado shale, 115 feet beneath the Big Elk sandstone member, at USGS loc. 24608, Wheatland County, Mont. USNM 129599.

3–5. Side, front, and rear views (× 1) of specimen from Colorado shale, 115 feet beneath Big Elk sandstone member, at USGS loc. 23042, Wheatland County, Mont. USNM 129597.

6–23, 26–28. *Neogastroplites americanus* (Reeside and Weymouth) var. D (p. 108).

6–22, 26–28. Colorado shale, 115 feet beneath Big Elk sandstone member, at USGS loc. 23042, Wheatland County, Mont.

6, 13. Side and front views (× 2), including cross section of early whorls. USNM 129604.

7–9. Side, rear, and front views (× 3) of a small specimen. USNM 129607.

10–12. Side, front, and rear views (× 3) of a broken specimen showing the early whorls. USNM 129606.

14–16. Side, rear, and front views (× 2). USNM 129605.

17, 18, 22. Side, front, and rear views (× 1). USNM 129602.

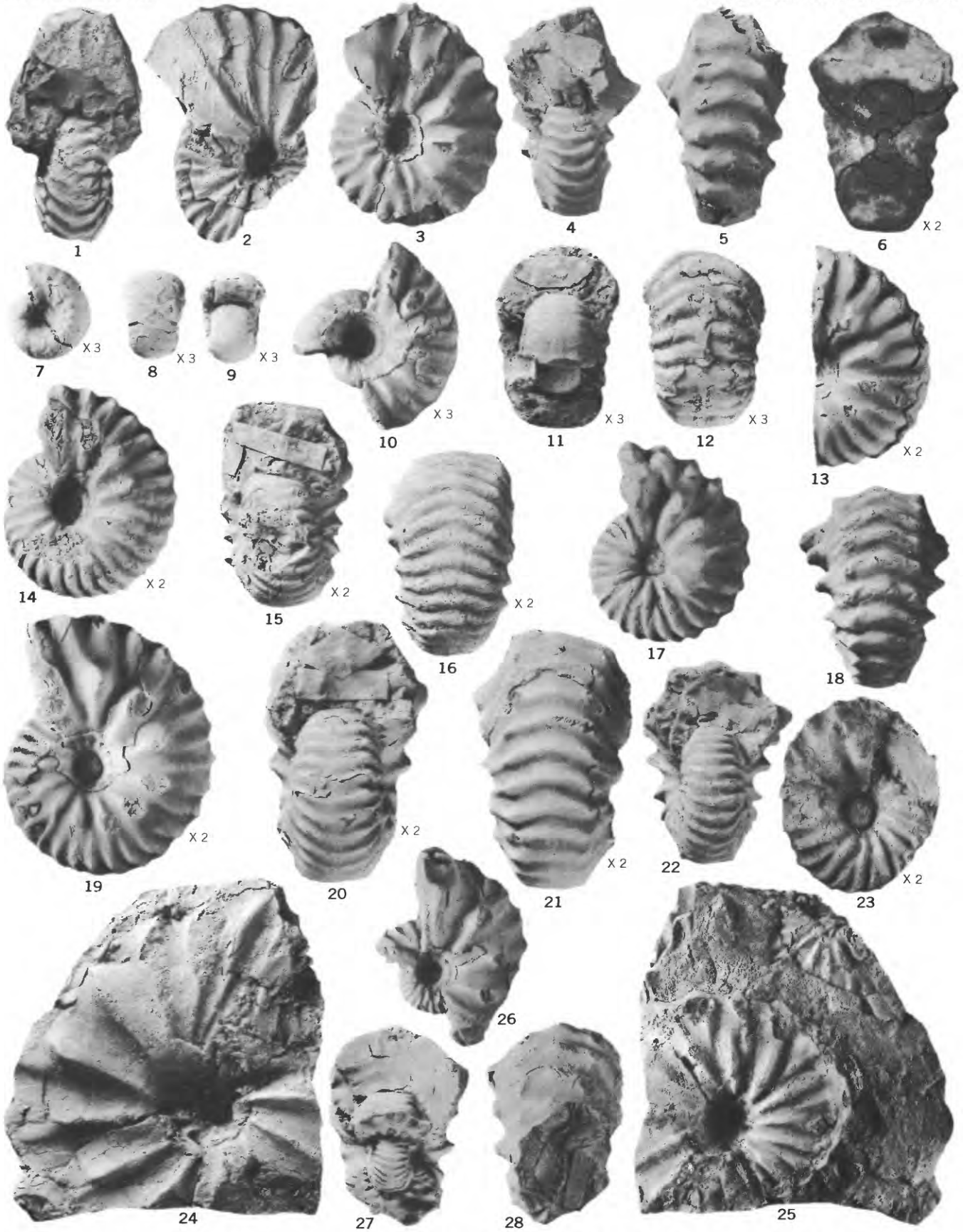
19–21. Side, front, and rear views (× 2). USNM 129603.

26–28. Side, front, and rear views (× 1) of a broken specimen showing the early whorls. USNM 129601.

23. Side view (× 2) of specimen from Fort St. John group at GSC loc. 24693, Adams Lookout map area, Alberta. GSC 13635.

24, 25. *Neogastroplites americanus* (Reeside and Weymouth) var. C (p. 106).

Two side views (× 1) of relatively large crushed specimen from the Mowry shale, 205 feet above base, at USGS loc. 24564, Park County, Wyo. USNM 129593.



NEOGASTROPLITES AMERICANUS (REESIDE AND WEYMOUTH) VAR. C–D, D, AND C

PLATE 54

FIGURES 1–5. *Neogastroplites americanus* (Reeside and Weymouth) var. D (p. 108).

1–3. Front, side, and rear views (× 1) of a specimen that preserves the rostrum, from the Colorado shale, 115 feet below the Big Elk sandstone member, at USGS loc. 23042, Wheatland County, Mont. USNM 129600.

4, 5. Rear and side views (× 1) of a part of a body chamber that preserves the rostrum, from the Mowry shale, 203 feet above the base, at USGS loc. 24544, Park County, Wyo. USNM 129609. The aptychuslike object in the body chamber is a fish scale.

6, 10–28. *Neogastroplites americanus* (Reeside and Weymouth) var. E (p. 110).

Colorado shale, 115 feet below the Big Elk sandstone member, at USGS loc. 23042, Wheatland County, Mont.

6, 13, 14. Rear, side, and front views (× 2). USNM 129619.

10–12, 15–17. Side, rear, and front views (× 3) of inner whorls and rear, side, and front views (× 3) of outer whorls of a small specimen. USNM 129620.

18, 23. Side and front views (× 2), including cross section of early whorls. USNM 129619.

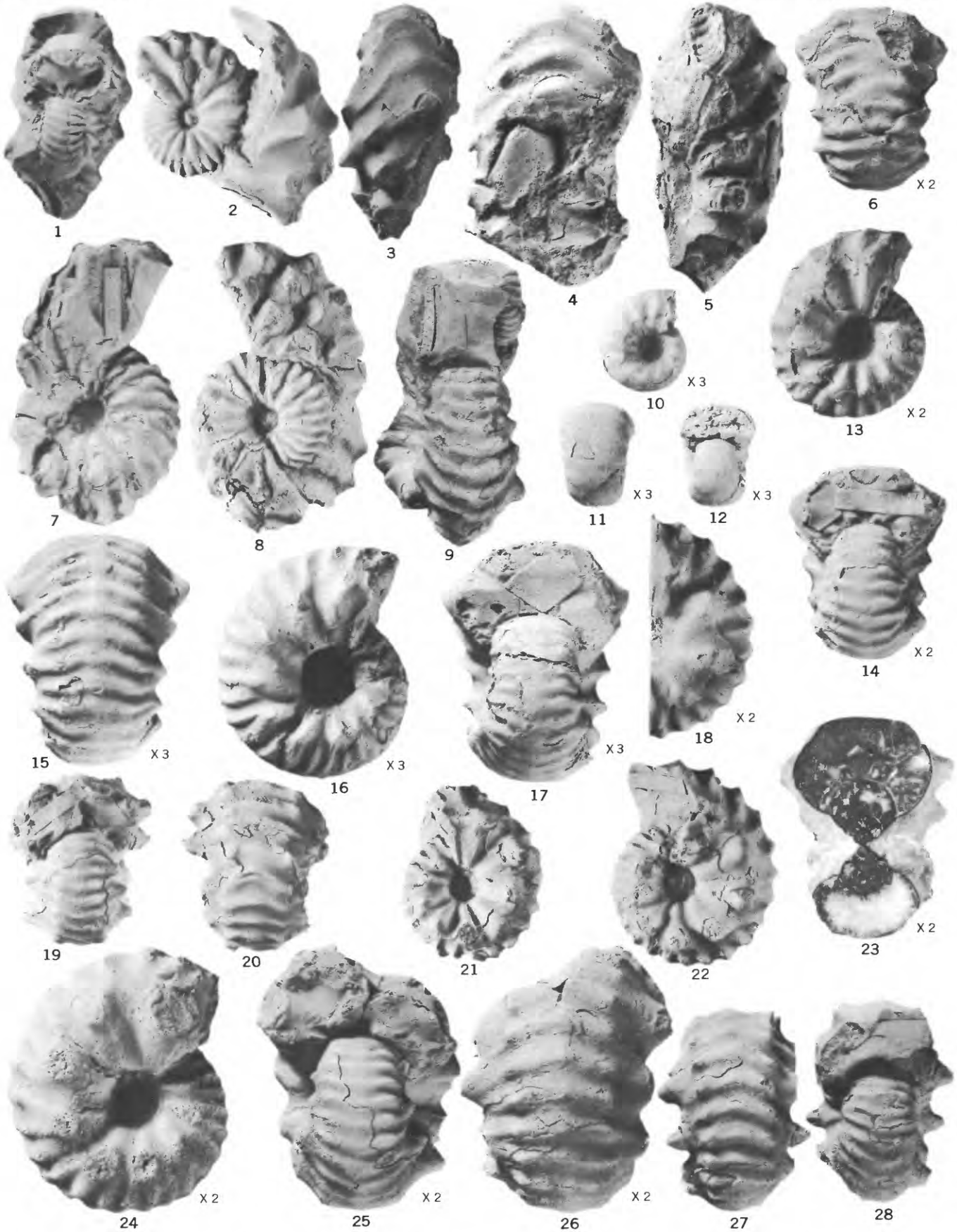
19–21. Front, rear, and side views (× 1). USNM 129616.

22, 27, 28. Side, rear, and front views (× 1). USNM 129615.

24–26. Side, front, and rear views (× 2). USNM 129617.

7–9. *Neogastroplites americanus* (Reeside and Weymouth) var. D–E (p. 109).

Two side and front views (× 1) of a crushed specimen from the Colorado shale, 115 feet below the Big Elk sandstone member, at USGS loc. 23042, Wheatland County, Mont. USNM 129612.



NEOGASTROPLITES AMERICANUS (REESIDE AND WEYMOUTH) VAR. D, E, AND D–E

PLATE 55

FIGURES 1–10. *Neogastroplites americanus* (Reeside and Weymouth) var. E (p. 110).

1–3. Side, rear, and front views (× 2) of a specimen from the Mowry shale at USGS loc. 24502, Carbon County, Mont. USNM 129624.

4, 8, 10. Side, front, and rear views (× 1) of a crushed specimen from the Colorado shale, 115 feet below the Big Elk sandstone member, at USGS loc. 23042, Wheatland County, Mont. USNM 129614.

5–7. Side, rear, and front views (× 1) of a relatively large specimen from the Mowry shale, about 200 feet above base, at USGS loc. 24568, Park County, Wyo. USNM 129625.

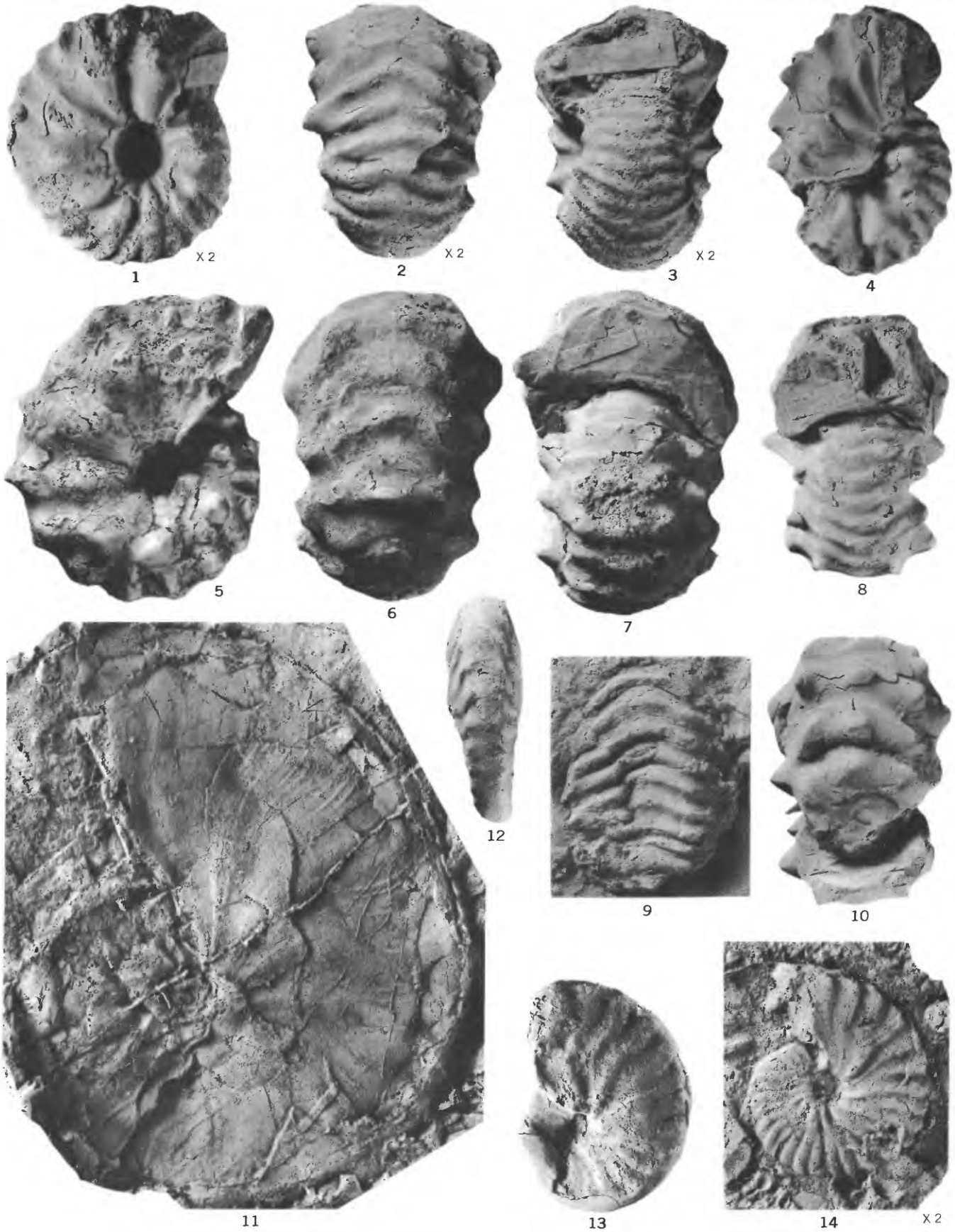
9. View (× 1) of crushed specimen attributed to var. E, from Mowry shale, 60 feet below top, at USGS loc. 23465, Crook County, Wyo. USNM 129623.

11–14. *Neogastroplites maclearni* Reeside and Cobban, n. sp., var. A (p. 112).

11. Rubber cast (× 1) from natural mold from Colorado shale, 50 feet below Big Elk sandstone member, at USGS loc. 24610, Wheatland County, Mont. USNM 129305.

12, 13. Rear and side views (× 1) of a specimen with part of the venter restored, from Colorado shale, 60 feet below Big Elk sandstone member, at USGS loc. 24609, Wheatland County, Mont. USNM 129627.

14. Rubber cast (× 2) from a natural mold from the same horizon and locality as figure 12. USNM 129628.



NEOGASTROPLITES AMERICANUS (REESIDE AND WEYMOUTH) VAR. E AND
N. MACLEARNI REESIDE AND COBBAN, N. SP., VAR. A

PLATE 56

FIGURES 1–20. *Neogastroplites maclearni* Reeside and Cobban, n. sp., var. A (p. 112).

1–5. Rear and side views (× 1) of entire specimen and side, rear, and front views (× 1) of same with part of outer whorl removed; Colorado shale, 50 feet below Big Elk sandstone member, at USGS loc. 24610, Wheatland County, Mont. USNM 129626.

6. Natural mold (× 1) of an aptychus believed to represent var. A, from same horizon and locality as figure 1. USNM 129306.

7–20. Views of specimens from the Fort St. John group at GSC loc. 17300, Grande Cache map area, Alberta.

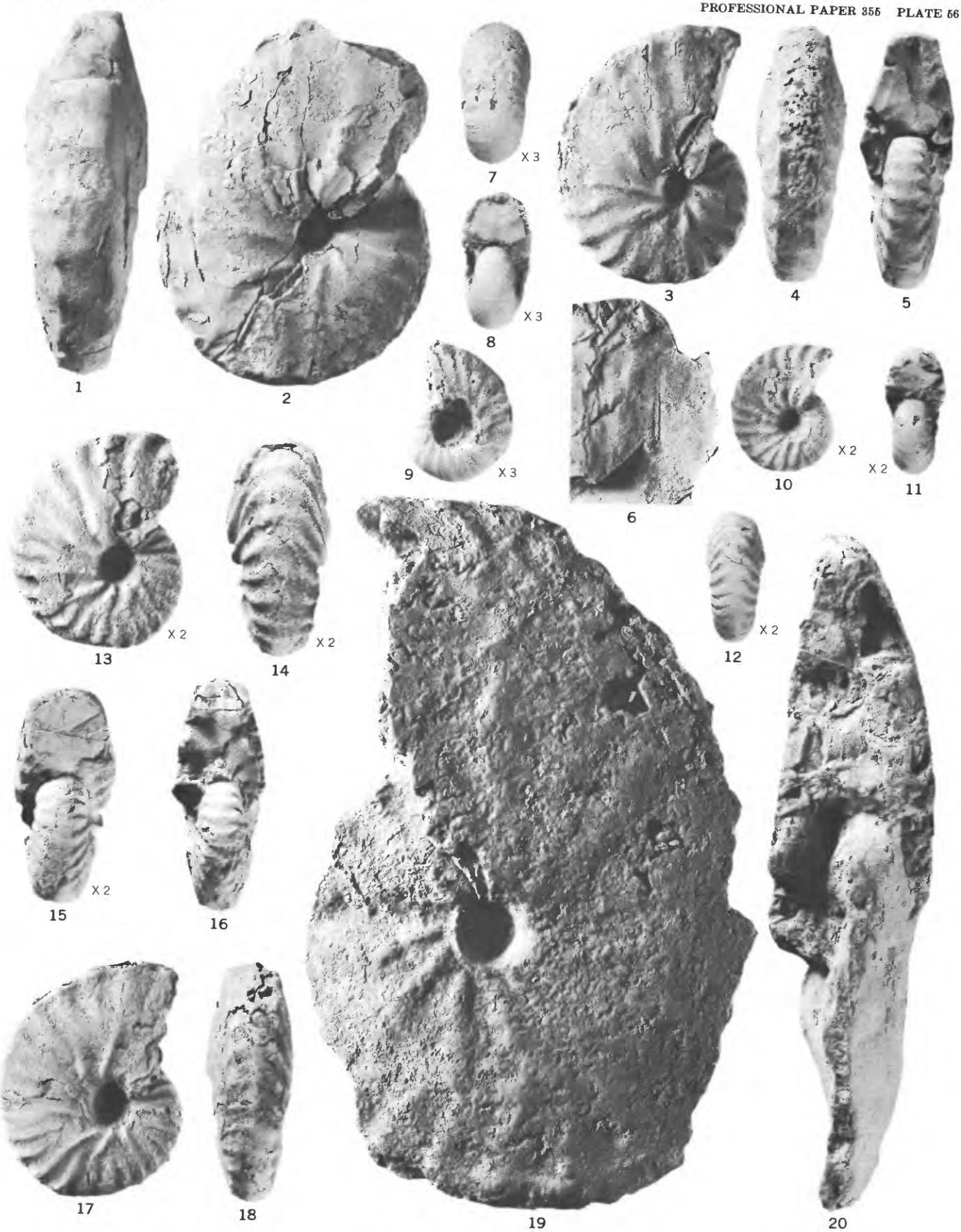
7–9. Rear, front, and side views (× 3) of a small specimen. GSC 13641.

10–12. Side, front, and rear views (× 2) of a small specimen. GSC 13640.

13–15. Side, rear, and front views (× 2). GSC 13639.

16–18. Front, side, and rear views (× 1). GSC 13638.

19, 20. Side and front views (× 1) of a rather large crushed specimen. GSC 13636.



NEOGASTROPLITES MACLEARNI REESIDE AND COBBAN, N. SP., VAR. A

PLATE 57

FIGURES 1–3. *Neogastroplites maclearni* Reeside and Cobban, n. sp., var. A (p. 112).

Rear, side, and front views (× 1) of a specimen from the Fort St. John group at GSC loc. 17300, Grande Cache map area, Alberta. GSC 13637.

4–23. *Neogastroplites maclearni* Reeside and Cobban, n. sp., var. B (p. 114).

4, 5, 12. Side, rear, and front views (× 3), showing early whorls, from same horizon and locality as figure 1. GSC 13647.

6–8. Side, rear, and front views (× 2), from same horizon and locality as figure 1. GSC 13648.

9, 10. Side and rear views (× 1) of specimen with outline of early part restored; Colorado shale, 60 feet below Big Elk sandstone member, at USGS loc. 24609, Wheatland County, Mont. USNM 129629.

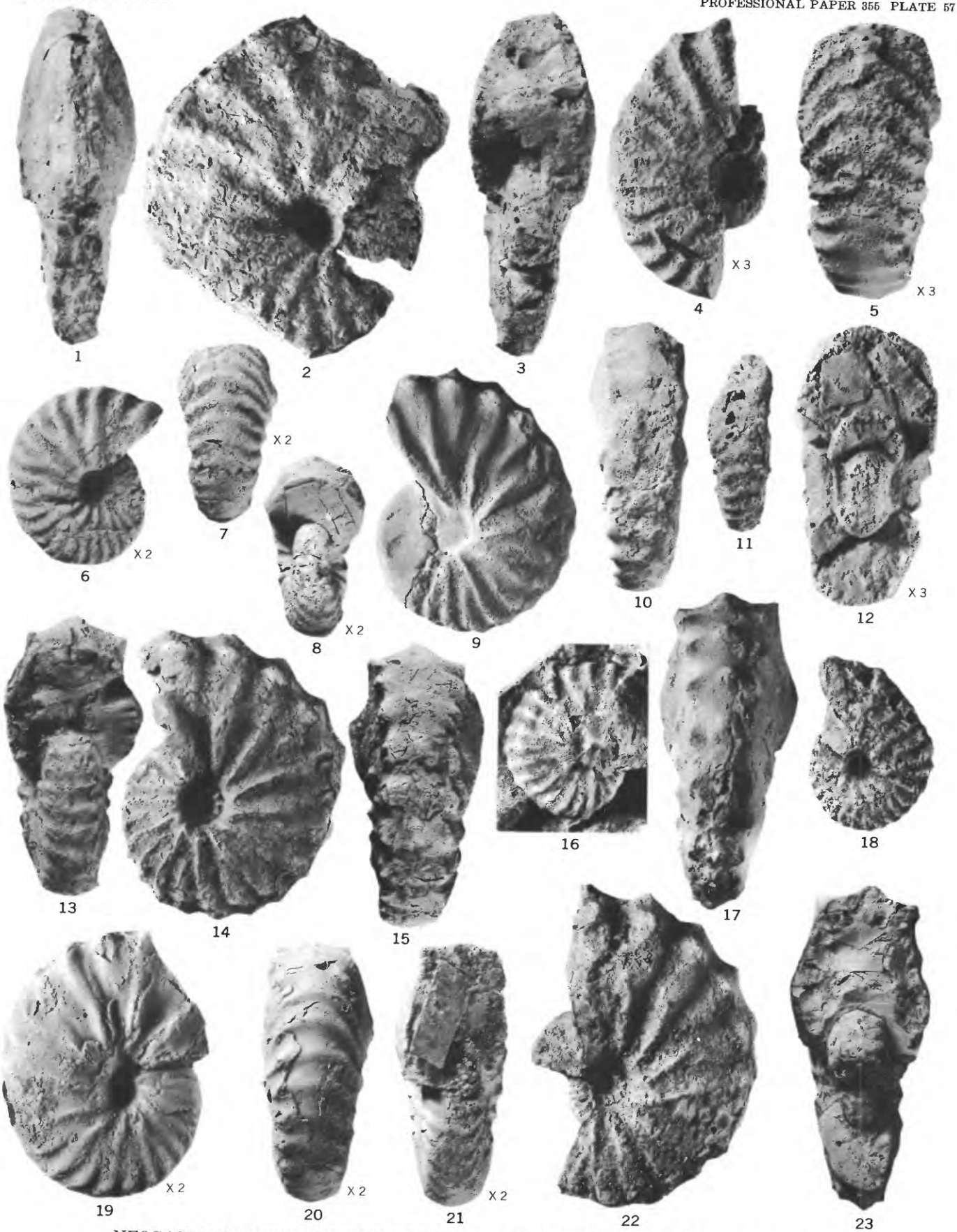
11, 18. Rear and side views (× 1) of a corroded specimen from the same horizon and locality as figure 1.

13–15. Front, side, and rear views (× 1) of the holotype from the same horizon and locality as figure 1. GSC 13645.

16. Rubber cast (× 1) from a natural mold from the Colorado shale, 40 feet below the Big Elk sandstone member, at USGS loc. 24611, Wheatland County, Mont. USNM 129630.

17, 22, 23. Rear, side, and front views (× 1), showing the early whorls, from the same horizon and locality as figure 1. GSC 13646.

19–21. Side, rear, and front views (× 2) of a specimen from the same horizon and locality as figure 16. USNM 129631.



NEOGASTROPLITES MACLEARNI REESIDE AND COBBAN, N. SP., VAR. A AND B

PLATE 58

FIGURES 1–16. *Neogastroplites maclearni* Reeside and Cobban, n. sp., var. C (p. 115).

1–3. Side, rear, and front views (× 2) of a specimen from the Fort St. John group at GSC loc. 17300, Grande Cache map area, Alberta. GSC 13655.

4, 5, 7, 11. Side and rear views (× 1) and front view (× 1 and × 2), including cross section of the early whorls, from same horizon and locality as figure 1. GSC 13654.

6. Rubber cast (× 1) from natural mold from Colorado shale, 60 feet below Big Elk sandstone member, at USGS loc. 24609, Wheatland County, Mont. USNM 129633.

8–10. Side, rear, and front views (× 1) of a specimen from same horizon and locality as figure 1. GSC 13653.

12–14. Side, rear, and front views (× 1) of a specimen from same horizon and locality as figure 6. USNM 129623.

15, 16. Side and front views (× 1) of a relatively large specimen from the same horizon and locality as figure 1. GSC 13652.

17–29. *Neogastroplites maclearni* Reeside and Cobban, n. sp., var. D (p. 116).

17–19. Side, rear, and front views (× 2) of specimen from the Fort St. John group at GSC loc. 17300, Grande Cache map area, Alberta. GSC 13660.

20–22. Side, rear, and front views (× 1) of specimen from same horizon and locality as figure 17. GSC 13658.

23–25. Side, rear, and front views (× 3) of a small specimen from same horizon and locality as figure 17. GSC 13661.

26–28. Side, rear, and front views (× 2) of specimen from same horizon and locality as figure 17. GSC 13659.

29. Rubber cast (× 1) from a natural mold from the Colorado shale, 60 feet below Big Elk sandstone member, at USGS loc. 24609, Wheatland County, Mont. USNM 129634.

NEOGASTROPLITES MACLEARNI REESIDE AND COBBAN, N. SP., VAR. C AND D

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