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ON

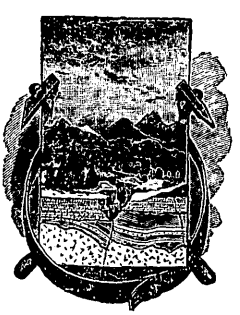
INVERTEBRATE FOSSILS

FROM

THE PACIFIC COAST

BY

CHARLES A. WHITE



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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
U. S. GEOLOGICAL SURVEY,
Washington, D. C., July 1, 1888.

SIR: I herewith transmit to you manuscript and drawings for a bulletin of the Survey. The manuscript embraces five articles, each under a separate subtitle. The subjects of these articles being to a greater or less extent different from one another, I have found it desirable to treat them separately; and yet, being more or less nearly related, they may be properly presented under the single general title which I have given them.

The subject of none of these articles is here treated exhaustively; but, as the field to which each pertains is a comparatively new one, it has been thought best to publish the facts which have been ascertained, together with suggestions of their probable significance, so that they may be used by those who shall pursue these or related subjects.

I beg to call your especial attention to the following facts and conclusions presented in these articles: An addition of nineteen new species and one new genus is made to the known fauna of the Chico-Téjon series of California. The existence is announced of new localities of strata referable to that series in Oregon and Washington Territory. The fauna of the Vancouver group is discussed, three new species are described, and the intimate relation of the Vancouver fauna with that of the Chico group is shown. A small, unique fauna from the coal-bearing formation of the Puget Sound basin is described, and facts are presented which indicate that this formation was deposited in an extraordinarily large estuary, which was probably contemporaneous with the Laramie sea.

The closing article relates to a small collection of Mesozoic fossils from Alaska, all of which are regarded as new, and as probably belonging to strata somewhat older than the Aucella-bearing strata of Alaska.

Very respectfully,

C. A. WHITE,
Geologist in charge of Mesozoic Invertebrate Paleontology.

Hon. J. W. POWELL,
Director of the U. S. Geological Survey.

INVERTEBRATE FOSSILS FROM CALIFORNIA, OREGON, WASHINGTON, AND ALASKA.

By C. A. WHITE.

PART I.

NEW FOSSIL MOLLUSCA FROM THE CHICO-TÉJON SERIES OF CALIFORNIA.

GENERAL REMARKS.

The fossils from the Chico-Téjon series of California described on the following pages of this bulletin were collected by Mr. H. W. Turner and Mr. J. S. Diller, respectively, both of whom have been engaged upon separate portions of the work of the U. S. Geological Survey in California for several years past. These fossils constitute additions to the already known molluscan fauna of that important series of strata which, through the labors of Gabb, Conrad, and others, has long been known to be a rich one. The fossils of this series are in many localities abundant, but they are generally in a bad state of preservation. Occasionally, however, localities are discovered where they are in better condition, from some of which the specimens herein described have been obtained; and we may reasonably expect from such favorable localities still further additions to this important transition fauna.[1]

In the year 1884 I visited California, and devoted the season to an investigation of the strata of this series at numerous localities in the field, and to a study of large collections of its fossils. As a result of these labors I became convinced that the whole series, which comprises the Chico, Martinez, and Téjon groups of the California Geological Survey,[2] is not only an unbroken one from base to top, but that it rep-

[1] All the hitherto published species of fossils of this series of strata are catalogued, and the greater part of them figured and described by Mr. Gabb in the two volumes of paleontology published by the State Geological Survey of California. For references to descriptions of fossils from strata equivalent with portions of this series in Oregon, Washington Territory, and British Columbia, see Parts II and III of this bulletin.

[2] Geol. Survey California, Palæontology, vol. 2, 1869, p. xiii.

resents both the closing epoch of the Cretaceous period and the opening one of the Tertiary.[1] Many known facts justify the opinion that the Laramie group also represents the transition from Cretaceous to Tertiary time; but although it seems to be certain that this great formation was continuously deposited from the marine Cretaceous beneath it, and into the fresh-water Tertiary deposits above it, there is, as a consequence of important surrounding physical changes then existing, an abrupt accession of its peculiar aqueous fauna at its base and almost as abrupt an extinction of it at the top.[2]

On the contrary, the Chico-Téjon series is one great continuous succession of marine strata, the deposition of which was evidently unbroken from its beginning to its close; and during this time attendant physical conditions produced no sudden changes in the aqueous life of the waters in which the deposits occurred.

No fact which I have learned since the investigations referred to were made has shaken my belief in the correctness of the opinion then expressed; but, on the contrary, further investigations have strengthened it. There seems to be no longer any reason why one should hesitate to accept it as a demonstrated fact that we have in California a continuously deposited series of strata, the lower portion of which is characteristically Cretaceous and the upper portion of which is no less characteristically Eocene Tertiary; and that the Cretaceous characteristics gradually disappear upward, leaving the surviving fauna, with its later accessions, without any commingling of Mesozoic types. It is so generally the case that wherever Cretaceous strata are found overlaid by those of Eocene age a break both faunal and stratigraphical is found to exist between them, that I can not but regard this evidence of the gradual passage from Mesozoic to Cenozoic conditions within the time represented by the Chico-Téjon series of strata as among the more fortunate of the geological discoveries which have been made since the first recognition of the principles of historic geology.

So generally has it been found to be the case that both a faunal and a stratigraphical break exist between different groups of strata of the various geological ages, that geologists have heretofore generally regarded it as a matter of course that any certain unbroken series of strata must of necessity be referred wholly to one or another geological period. Mr. Gabb, while engaged upon the large work, the Palæontology of California, seems to have acted fully in accordance with this view. He did not fail to recognize the Tertiary characteristics of a large proportion of the fossils found in the Chico-Téjon strata, the essentially unbroken character of the whole series which embraced his Chico, Martinez, and Téjon groups, or the Cretaceous character of a

[1] Bull. U. S. Geol. Survey, No. 15, 1885, pp. 7–17.

[2] It is probable that the Puget group, which is discussed on subsequent pages of this bulletin, was deposited contemporaneously with the Laramie, and that it also represents the transition from Cretaceous to Tertiary time.

considerable number of the fossil types which that series contained. He seems, however, to have regarded the presence of the latter types as a sufficient reason why the whole series should be referred to the Cretaceous, which decision was indeed not inconsistent with the generally accepted views to which reference has been made. The various controversies which have occurred with regard to the true geological age of this series of strata have arisen from the fact that it contains both Cretaceous and Tertiary types and that those types are frequently found commingled in one and the same matrix. Some observers have come in contact with strata yielding fossils of the latter types alone, and have not hesitated to refer such strata to the Tertiary period; and when it has been shown that the series also contains Cretaceous types they have seemed disposed either to deny the fact or to contend that such forms were introduced from previously existing Cretaceous strata. Others have found fossils of unmistakable Mesozoic types so numerous in certain strata of this series that they have ignored the Tertiary character of their numerous associates and referred all the strata containing them to the Cretaceous.

Besides the numerous molluscan species of Tertiary types which Mr. Gabb described and figured from the Chico-Téjon series in the two volumes of "Palæontology of California," I may refer for present comparison to the following, among others, which are described and figured in this bulletin: *Fulgur Hilgardi*, *Cominella LeContei*, and *Trophon Condoni*. And yet I have broken these fossils out of the matrix in which they were imbedded and wherein they were commingled with such Cretaceous types as *Ammonites chicoensis* Trask, *Baculites chicoensis* Trask, *Cinulia obliqua* Gabb, *Trigonia* Evans and Meek, and *Inoceramus Whitneyi* Gabb. Still, in the collections here particularly referred to, which come from well down in the Chico portion of the series, the Tertiary types are somewhat more conspicuous as to numbers than the Cretaceous types. In view of these facts it does not seem strange, even in the light of our present knowledge, that Dr. Trask, as early as 1855, collecting fossils from these strata, and at the same localities from which many of the fossils here referred to were obtained, should have announced the discovery of *Ammonites* and *Baculites* in Tertiary strata.[1]

With reference to the Chico-Téjon series of California and similar transitional series of strata elsewhere, a real difficulty is encountered when we attempt to assign them by name and limitation to a place in the systematic classification of formations which is now in general use. But we certainly ought not to allow this difficulty to prevent a grateful recognition of the important physical facts which are so happily illustrated by these transitional series of strata.

Every naturalist must admit that since the seas were first formed and life began in them, there has been a continuous genetic succession of life, and likewise a continuous deposition of rock-forming sediment. It

[1] Proc. California Acad. Nat. Sci., vol. 1, p. 85, 1st ed.; p. 92, 2d ed. (1873).

is well known that both the life and the sedimentation were frequently interrupted over large areas; and it is the evidences of these interruptions that constitute the tangible boundaries of our recognized divisions of geological time; but it is plain that neither life nor sedimentation was ever universally broken. If, therefore, it should ever be possible for us to discover strata which represent the whole genetic continuity of life during that time, it is clear that we shall then have no definable boundaries to our present recognized geological ages, periods, or epochs. This view of the case, which seems to be a wholly reasonable one, gives the greatest interest to such transition series as that of California, to which I have applied the compound name Chico-Téjon.[1] Furthermore, this series derives peculiar interest from the fact that it represents not only the transition from one epoch to another, but also from one well-recognized geological age to the next succeeding one.

DESCRIPTION OF SPECIES.

CONCHIFERA.

OSTREIDÆ.

Genus Ostrea Linnæus.

Subgenus Alectryonia Fischer de Waldheim.

OSTREA (ALECTRYONIA) DILLERI White.

PLATE I, Figs. 1, 2, and PLATE II, Figs. 1, 2.

Shell moderately large, subelliptical in marginal outline, the irregularity of which is increased by a more or less prominent and laterally extended posterior wing; both valves convex, but, as usual, the lower one more capacious than the upper; a more or less distinct depression, extending from near the beak to the posterior margin, defines the inner limit of the alate portion of the shell; the cardinal border of the alate portion long and straight, the inner surface of which presents a rather indistinctly defined flat cardinal area; ligamental groove of the lower valve short and not deep, the corresponding ridge of the upper valve often hardly perceptible. Surface of the body of the shell marked by numerous strong angular radiating ribs, which give the free margins of the valves a strongly serrate character; surface of the wing irregularly ribbed or corrugated; muscular scar large and deep.

While a large proportion of the fossil Ostreidæ which are obtained from the different geological formations possess too few salient features by which they may be satisfactorily separated into species, and some-

[1] In giving a single name to the full series, I have compounded the two group names, Chico and Téjon, which were given by the California geologists to the lower and upper portions of the series, respectively.

times even into the different recognized genera, the features of the form here described are more than usually satisfactory in this respect. It is also the only ostreid of the Alectryonia type which to my knowledge has yet been discovered in the Chico-Téjon series, while those belonging to the ordinary type of *Ostrea* are not uncommon in the strata of this series. Furthermore, this species ought to be placed among the Cretaceous types of the Chico-Téjon series, because the Alectryonia division of the genus *Ostrea* has hitherto been rarely, if ever, known in later strata than those of the Cretaceous.

Position and locality.—This form was discovered by Mr. J. S. Diller in strata of the Chico portion of the series half a mile south of the falls of Clover Creek, Shasta County.

PHOLADIDÆ.

Genus Zirphæa Leach.

ZIRPHÆA PLANA, sp. nov.

PLATE IV, Fig. 22.

Among the fossils collected by Mr. H. W. Turner from the Chico-Téjon strata at Martinez, Contra Costa Co., is a single valve of a shell which seems to possess the essential characters of Zirphæa. The shell is small, irregularly suboval in marginal outline; the anterior portion inflated, larger than the posterior portion, from which it is separated by a well-defined depression that extends from near the beak to the base of each valve, and also by the abrupt inflation of the anterior portion; cardinal border of the anterior portion somewhat reflexed. The shell substance of the specimen is mostly exfoliated, but remains of narrow, concentric, raised striæ are observable, which are separated by rather wide interspaces and which seem to have covered the whole surface.

Length, 14^{mm}; height, 11^{mm}.

GASTEROPODA.

ACTÆONIDÆ.

Genus Actæon Montfort.

ACTÆON INORNATUS, sp. nov.

PLATE IV, Figs. 16, 17, and 18.

Shell small, subovate, spire short, its sides approximately straight; volutions six or seven in number, those of the spire moderately convex, the last one large and somewhat inflated, the distal side of each volution appressed against the next preceding one, the suture being impressed; columella bearing one prominent fold about its middle, which

is fully visible only when the outer lip is broken away; surface nearly plain, but under a good lens fine revolving striæ are visible upon the lower half of the volutions of well-preserved examples.

Length, 11^{mm}; breadth of last volution, 6^{mm}.

This shell differs from *A. impressus* Gabb, from the Shasta group of California, in having only one fold upon the columella instead of two, as that species has, and also in having the surface less distinctly marked by revolving lines.

Position and locality.—The lower or Chico portion of the series, near Pence's Ranch, Butte County, where it was collected by Mr. Turner.

FISSURELLIDÆ.

Genus Vasculum, gen. nov.

Shell resembling *Capulus* or *Emarginula* in general shape, but the upper part is more or less laterally deflected; apex subcentral, directed forward, or obliquely forward, and coiled; a more or less distinct siphonal ridge with its corresponding internal groove extends from the apex to the front border of the shell, where it produces a small emargination or notch. Internal characters unknown.

The observable characters of this form seem to warrant its reference to the Fissurellidæ; but it is probable that it may have to be referred to either the Siphonariidæ or the Gadiniidæ when all its characters are known. This genus differs from other members of the Fissurellidæ in having the apex directed anteriorly, and in being more distinctly coiled. It differs from *Anisomyon* Meek in having its apex distinctly coiled, and in possessing a siphonal ridge and emargination, in which latter respects it also differs from the Capulidæ. From *Gadinia* it differs in having a plain, instead of a radiated, surface, a coiled apex, and a greater elevation.

VASCULUM OBLIQUUM, sp. nov.

PLATE IV, Figs. 19, 20, 21.

Shell suboval in marginal outline; moderately elevated, the upper portion bent to the right, so that the right side is concave vertically; left side broadly rounded; posterior and anterior sides more narrowly rounded; apex small, turned forward and slightly to the left, and closely coiled in one, or one and a half volutions; siphonal ridge narrow but somewhat prominent, the emargination at its anterior end slight. Surface marked by lines of growth, which are coarser upon the siphonal ridge than elsewhere, and curved backward, corresponding with the emargination at the front.

Transverse width at the margin, 14^{mm}; antero-posterior width, 18^{mm}; height from margin to apex, 13^{mm}.

Position and locality.—Chico Group, cañon of Chico Creek 15 miles east of Chico, Butte County, where it was collected by Mr. Diller.

STOMATELLIDÆ.

Genus Lysis Gabb.

LYSIS OPPANSUS, sp. nov.

PLATE IV, Figs. 14, 15.

Shell having the general form of the type species of the genus *Lysis*, or of *Stomatella;* the periphery of the last volution usually somewhat angulated, the spire small and slightly elevated, aperture large, inner lip broad, thickened by callus, and its surface and margin both concave. Surface marked by rounded, rugose, coarse, raised revolving striæ or small ridges, every third or fourth one of which is larger than the others; the periphery of the shell being occupied by one of the larger ones of these raised striæ or ridges increases its angular aspect, which is more apparent in some examples than others.

I was at first disposed to regard this shell as belonging to the type species as described and figured by Gabb,[1] but it differs materially in the angular character of the periphery and in the character of the surface markings, and it apparently reaches a considerably larger size.

Among his fossils from the Vancouver group on Sucia Island, Mr. Whiteaves describes and figures[2] a form under the name of *Stomatia suciensis*, together with a variety to which he gives the name of *carinifera*. He does not figure the aperture of either of them, but from his reference to the inner lip I suspect that they belong to Gabb's genus *Lysis*. The difference between the two forms which he figures is greater than one would naturally expect as a result of interspecific variation. The California specimens of the form here described also present such considerable variations as to suggest the possibility that there may be specific identity between at least a part of the California and Sucia Island forms respectively.

Position and locality.—Chico group, near Pence's Ranch, Butte County. Collected by Mr. Turner and myself.

TROCHIDÆ.

Genus Trochus Linnæus.

Subgenus Anadema H. and A. Adams.

TROCHUS (ANADEMA) GEMIFERUS, sp. nov.

PLATE IV, Figs. 8, 9.

Shell small, depressed-conical, the height being somewhat less than the greatest diameter; aperture subcircular, oblique; umbilicus small and deep; inner lip with a callus at its upper portion, which borders a part of the umbilicus, slightly thickened below, where it bears just

[1] Palæontology of California, vol. 1, 1864, p. 138, pl. 21, fig. 98.

[2] Geol. Survey Canada, Mesozoic Foss., vol. 1, 1876, p. 128, pl. 16, figs. 4, 5.

within its outer edge a small distinct tubercle-like tooth having somewhat the appearance of a small adherent pearl. Surface finely granular, and under a lens faint indications of revolving striæ appear.

Height, 13mm; greatest breadth, 16mm.

The characters of this shell do not fully agree with those which H. and A. Adams assign to *Anadema*, but they correspond more nearly with that subgenus than with any other group of shells known to me.

Position and locality.—Chico group, near Pence's Ranch, Butte County. Collected by Mr. Turner.

The shell substance of the specimens from which the foregoing description is drawn is thickly burrowed by fine pores, which are apparently those of a species of *Cliona*. The burrows are all apparently simple, are perpendicular to the outer surface, and penetrate almost to the inner surface. Only a part of the shells of other species of mollusks which were found associated with this one are thus burrowed, but the borings have been detected in still other species at other localities in the same formation. In all these cases all the borings are almost microscopic, and quite uniform in character. It is no uncommon thing to find shells of the *Ostreidæ* and other mollusks in all the Cretaceous and Tertiary formations showing ravages of *Cliona;* but in all cases which I have observed those borings are much larger and usually more intricate than those which are here referred to.[f]

Genus Stomatia Lamarck.

STOMATIA OBSTRICTA, sp. nov.

PLATE IV, Figs. 10, 11.

Shell rather small, obliquely subovate; spire short, prominent; volutions four or five in number, moderately convex, the last one large and expanded, suture impressed; aperture large, suboval, angulated posteriorly; inner lip moderately thickened; outer lip thin. Surface marked by angular revolving ridges with somewhat broad gently concave spaces between them, which are apparently marked by one or more revolving lines. Six or seven of these ridges appear upon the last volution, but only three of them upon those of the spire.

Length of the largest specimen in the collection, 20mm; breadth, 15mm.

The characters of this shell do not quite correspond with the usual generic diagnosis of *Stomatia*, but, so far as they are observable in these not perfectly preserved fossil specimens, they appear to agree more nearly with that than with any other published genus. It is a noteworthy fact, and one which Mr. Gabb fully recognized in his work upon the palæontology of California, that the molluscan fauna of the Chico-Téjon series contains many forms which, while closely like well known genera, present such differences as to make their reference to any of them unsatisfactory. This condition of things seems to me to be a

natural consequence of the transitional character of such a fauna as that of this great series. Certain genera being recognized as characteristic of certain periods, it is natural to expect that transitional modifications of those genera should occur in transitional strata.

Position and locality.—Chico group, Little Cow Creek, Shasta County, where it was collected by Mr. Diller.

NATICIDÆ.

Genus Gyrodes Conrad.

GYRODES DOWELLI, sp. nov.

PLATE III, Figs. 8, 9.

Shell of medium size, depressed, oblique, spire slightly elevated; volutions, four or five in number, the last one much expanded, broadly rounded at the outer side and abruptly rounded and somewhat shouldered at the distal side; those of the spire, convex; suture distinct, impressed; umbilicus, somewhat narrow, deep; its border abruptly rounded and marked by numerous oblique crenulations. Somewhat similar flexuous crenulations mark the upper or distal side of the volutions near the suture, with which exception the surface is plain; aperture obliquely suboval, outer lip, thin; inner lip bordering the umbilicus, thin and concave. The striæ of growth show that the outer lip was much projected near its upper or posterior end, and that it was there abruptly rounded backward to the suture, adjacent to which it thus formed a somewhat broad notch.

Position and locality.—This specimen was collected from the Chico group near Jacksonville, Oregon, and sent to the Smithsonian Institution by B. F. Dowell, esq., in whose honor the specific name is given. Fragments apparently belonging to this species have also been detected among the California collections.

APORRHAIDÆ.

Genus Rimella Agassiz.

RIMELLA MACILENTA, sp. nov.

PLATE III, Figs. 10–12.

Shell rather small, slender; the sides of the spire gently convex, each bearing about twelve abruptly raised longitudinal varices, which extend entirely across the exposed surface of the volutions in the direction of the axis of the shell, and are sometimes continuous from one volution to the next. The varices are separated by somewhat broad, concave spaces, and the entire surface is marked by fine, uniform revolving striæ, which are only a little less distinct upon the varices than

upon the interspaces. The outer lip is moderately expanded, the expansion being a little greater anteriorly than posteriorly, rounded in front, thickened at its margin, which is continuous with the right wall of the posterior canal. The inner lip is somewhat thickly covered with callus, which extends backward and forms the left wall of the posterior canal. Anterior canal short, reflexed, and only slightly projecting beyond the anterior border of the outer lip. Posterior canal long, nearly inclosed by the approaching borders of its right and left walls, the two walls together forming a ridge, which is closely adherent to the spire, and, in fully adult examples, extends from the posterior angle of the aperture nearly or quite to the apex of the spire.

The full length of an adult shell is about 25mm.

Position and locality.—Chico group, about 2 miles northward from New Idria, Fresno County, where it was collected by Mr. Turner and myself.

TURRETELLIDÆ.

Genus Mesalia Gray.

MESALIA OBSUTA, sp. nov.

PLATE IV, Figs. 6, 7.

Shell small, elongate-conical, sides gently convex; volutions eight or ten in number in fully adult shells, moderately convex, the last one rounded below; suture impressed; surface of the volutions of the spire marked by seven or eight impressed revolving lines, at the bottom of which are close-set shallow pits, giving the lines the appearance of finely stitched seams. The lower convex surface of the last volution is also marked by similar lines, which are smaller and nearer together at the anterior part of that volution.

Length of an adult shell, about 22mm; breadth of the last volution, about 9mm.

Position and locality.—Chico group, near Pence's Ranch, Butte County, where it was collected by Mr. Turner.

MELANOPSIDÆ.

Genus Faunus Montfort.

FAUNUS MARCIDULUS, sp. nov.

PLATE IV, Figs. 12, 13.

Shell small, moderately elongate; volutions about six in number, their sides gently convex, their distal border appressed against the next preceding volution; the last volution moderately ventricose, and constituting nearly one-half the full length of the shell; aperture

suboval, angular at its posterior end and ending anteriorly in a broad notch; outer lip thickened, prominent, especially its anterior portion outside the notch; callus of the inner lip moderately thick at the posterior portion, but thinner anteriorly. Surface appearing granular to the naked eye, but under a lens it presents the appearance of being shriveled or irregularly wrinkled.

Length, 8^{mm}; breadth of the last volution, 2^{mm}.

Position and locality.—Chico group, Butte County, where it was collected by Mr. Turner.

RISSOIDÆ.

Genus Ceratia H. and A. Adams.

CERATIA NEXILIA, sp. nov.

PLATE III, Figs. 13, 14.

Shell small, elongate-conical; sides of the spire slightly convex; volutions eight or nine in number, convex; suture impressed; aperture broadly suboval; outer lip thin; inner lip sinuous, and bearing only a slight coating of callus. Surface marked by numerous revolving raised lines, which are crossed at right angles by numerous linear ridges of about the same strength as the revolving lines, giving the surface a finely interlaced or reticulate appearance. On the anterior portion of the last volution the lines are finer and less prominent than upon the outer surface of the volutions, and the surface there thus loses to some extent its reticulate appearance. Upon the larger specimens supplementary revolving lines may sometimes be seen between the larger ones. No varices appear upon any of the specimens such as would suggest a reference of this to the genus *Cirsotrema*. It apparently bears considerable resemblance, however, to a form obtained by Mr. Whiteaves from the Vancouver group, on Sucia Island, to which he gave the name of *Cirsotrema tenuisculptum*,[1] and which is perhaps congeneric with it.

MURICIDÆ.

Genus Trophon Montfort.

TROPHON CONDONI, sp. nov.

PLATE III, Figs. 4, 5.

Shell moderately small; spire low, the last volution constituting much the greater part of the shell, its outer side convex above but becoming concave as it merges into the broad beak; the outer portion of the posterior side shouldered or abruptly rounded and its inner portion appressed against the preceding volution, there being a revolving depression between the outer and inner portions; aperture broadly subovate;

[1] Geol. Survey Canada, Mesozoic Foss., vol. 1, 1876, p. 127, pl. 16, figs. 3–3c.

its two lips, meeting by the thickening of each, as the shell approaches maturity, extend back upon the penultimate volution; canal narrow, rather short, and turned a little backward and to the left; beak broad, concave upon its under side, its anterior border rounded and laciniate. Surface marked by numerous small, rough, revolving ridges, which are crossed by longitudinal ridges of similar size, giving the shell a coarsely cancellate appearance.

Length of the largest specimen in the collection, 30^{mm}; breadth of the last volution, about 22^{mm}.

The specific name is given in honor of Prof. Thomas Condon of the State University of Oregon, who has done much to show the presence of the great Chico-Téjon series in various parts of Oregon.

Position and locality.—Chico group, Little Cow Creek Valley, about eighteen miles east of Redding, Shasta County, where it was collected by Mr. Diller.

BUCCINIDÆ.

Genus Cominella Gray.

COMINELLA LECONTEI, sp. nov.

PLATE IV, Figs. 4, 5.

Shell rather small, ovoid, spire short; volutions about five in number; the last one moderately ventricose and constituting much the greater part of the shell; the distal border of each volution appressed against the preceding volution, and just forward of that border there is a broad shallow revolving depression; aperture subovate, compressed, and narrowly angular behind and ending anteriorly in a short narrow canal; outer lip thin at the edge and marked within by numerous transverse raised lines. Surface marked by numerous nearly uniform impressed revolving lines, which are visible to the naked eye, and the lens shows a similar minute line between each two of the others.

Length 21^{mm}; breadth of the last volution 13^{mm}.

These shells also show the ravages of the minute *Cliona* mentioned on page 18. The specific name is given in honor of Prof. Joseph LeConte of the University of California.

Position and locality.—Chico group, near Pence's Ranch, Butte County, where it was collected by Mr. Turner.

FASCIOLARIIDÆ.

Genus Fulgur Montfort.

FULGUR HILGARDI, sp. nov.

PLATE III, Figs. 2, 3.

Shell small for a species of this genus; spire depressed-conical; volutions five in number; those of the spire so flattened upon their outer surfaces as to form an oblique cone, the sides of which are slightly con-

cave, and the base of which is upon the periphery of the last volution; suture indistinct; last volution large, subangular at the periphery and convex below it; beak long, slender, and only slightly flexed; aperture suboval, angular behind and ending in a long, open, moderately narrow canal in front; surface marked by numerous revolving raised coarse lines or slender ridges which disappear entirely upon the beak, and are often obscure on the spire above the periphery, especially in mature examples; the peripheral ridge, as well as the one upon either side of it, becomes sharply nodular as the shell reaches maturity.

Length from the apex to the end of the beak 37^{mm}; diameter of the last volution 20^{mm}.

This shell derives peculiar interest from the fact that although it belongs to a decidedly Tertiary type, it was found, together with many other Tertiary forms, commingled in the same matrix with such Mesozoic forms as *Ammonites chicoensis*, *Belemnites chicoensis*, *Trigonia Evansana*, *Inoceramus Whitneyi*, etc.

The specific name is given in honor of Prof. E. W. Hilgard of the University of California.

Position and locality.—Chico group, near Pence's Ranch, Butte County, where it was collected by Mr. Turner.

VOLUTIDÆ.

Genus Fulguraria Schumacher.

FULGURARIA GABBI, sp. nov.

PLATE III, Fig. 1.

Volutilithes navarroensis Gabb (not Shumard) Palæontology of California, vol. 1, p. 102, pl. 19, fig. 56.

Fulguraria navarroensis Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, p. 117, pl. 15, figs. 3, 3*a*.

Shell rather large, fusiform, the greatest diameter being above the mid-length of the shell; spire conical, rather short; volutions about six in number; those of the spire gently but irregularly convex; the last volution large, moderately inflated and much elongated, sides broadly convex from front to rear, except that there is a broad, gentle, oblique, revolving depression about its middle; anterior extremity narrowed, but not forming a distinct beak, and a little deflected laterally; aperture moderately broad, angular behind, and ending anteriorly in an indistinctly defined canal; columella strong in adult shells and bearing three prominent oblique folds; surface marked by obscure longitudinal varices, which do not extend to the anterior part of the shell, and are often obsolete elsewhere. Besides these varices and the numerous fine, distinct lines of growth there are many narrow revolving

ridges which are especially conspicuous upon the last volution and which sweep forward upon the anterior part of the shell. They are about eighteen in number, the spaces between them being wider than the ridges, the widest spaces being upon the broadest part of the shell. Upon this part especially these ridges become nodulous where they cross the varices, between which they are obsolete. The two or three upper ridges are smaller than any of the others, and those of the anterior part of the shell are smaller, more continuous, and therefore less nodular than those of the middle portion.

Although the foregoing description is drawn from larger examples than those of Mr. Gabb they belong to the same species which he referred to the *Volutilithes navarroensis* of Shumard, the type of which was obtained from the Cretaceous of Texas. Dr. Shumard never figured his species, and upon a late visit to his original localities in Texas I was not able to rediscover it, but after a careful reading of his description, an examination of many specimens from the Pacific coast region of the form here described, and of examples in the U. S. National Museum which I believe to be specifically identical with Shumard's *V. navarroensis*, I am of the opinion that the southern and western forms are sufficiently distinct to warrant the use of separate specific names.

While I agree with the opinion of Mr. Whiteaves[1] and of Dr. Stoliczka that this shell and its real congeners ought to be referred to the genus *Fulguraria*, I can not agree with the former and with Mr. Gabb in regarding the form here described as specifically identical with the one which was described by Dr. Shumard (op. cit.) under the name of *Volutilithes navarroensis*. It is very apparent that the two forms are closely related, but in view of their considerable differences and of the fact that the faunas to which they respectively belong are so different there seems to be sufficient reason for regarding them as distinct. The figures given by Mr. Gabb and Mr. Whiteaves respectively (op. cit.) and the one on Plate III of this bulletin all belong without doubt to the same species, although they show much variation of form. Figure 1 on Plate III of this bulletin shows a mature and more robust example than that of Mr. Gabb (op. cit.), while that of Mr. Whiteaves (op. cit.) shows a mature and still more compact example. On the other hand, the Museum examples of the southern form before referred to, while they are evidently mature, are even more slender and delicate than is indicated by Dr. Shumard's description. Even if these differences should not be properly regarded as of themselves sufficient to separate the two forms specifically, I think it is expedient to give different names to all the members of faunas which are respectively so different as are those of the Pacific and Gulf coast Upper Cretaceous

[1] A letter just received from Mr. Whiteaves says that now, with Tryon, he regards this form as belonging to Conrad's genus *Volutoderma*. As I have not had an opportunity to examine Conrad's type, I prefer at present to leave it in *Fulguraria*.

until a far greater amount of knowledge concerning their correlation is obtained than we now possess.

This species is one of the more common and characteristic shells of the Chico group, as it seems also to be of the Vancouver group. It has been found at numerous places in California, in southern Oregon, and I have lately received it from Dr. Newberry, who obtained it from the Vancouver group on Sucia Island, Washington Territory. The specimen figured on Plate III was collected by Mr. Turner from the Chico group, near Centerville, Butte County.

CANCELLARIIDÆ.

Genus Cancellaria Lamarck.

CANCELLARIA TURNERI, sp. nov.

PLATE III, Figs. 6, 7.

Shell of medium size, spire moderately elevated; beak short; volutions of the spire convex, the last one expanded and becoming obtusely angular between the outer and posterior sides, where short, more or less distinct varices appear, but they become obsolete upon both the outer and posterior sides; the outer side rounded, the posterior side flattened and forming a broad shoulder as the shell reaches maturity; aperture subovate, truncated behind, and ending anteriorly in a short canal; columella thickened and bearing three folds. Surface marked by revolving lines, which are crossed by lines of growth giving the usual cancellated appearance which is characteristic of this genus.

Length of the largest example in the collection, 31^{mm}; breadth of the last volution, 22^{mm}.

Position and locality.—Chico-Téjon series, Martinez, Contra Costa County, where it was collected by Mr. Turner.

PLEUROTOMIDÆ.

Genus Scobinella Conrad.

SCOBINELLA DILLERI, sp. nov.

PLATE IV, Figs. 1–3.

Shell of medium size, fusiform, volutions about seven in number; those of the spire irregularly convex; the last one large, elongate, and ending anteriorly in a broad beak, its greater or peripheral diameter near its upper end, concave above this peripheral portion, and broadly convex below it; aperture rather narrow, constricted and narrowly angular at its posterior end and merging into a rather short canal in front; outer lip thin, having a broad notch opposite the space between the suture and peripheral portion of the last volution, below which the margin of

the lip is broadly convex; inner lip bearing three sharp prominent folds, the full prominence of which is not visible when the outer lip is entire. Surface marked by numerous coarse raised revolving lines or small ridges, which are largest about the middle, smaller below and upon the beak, and obsolete upon the concave space between the periphery and suture. The median portion of the last volution is also marked by more or less strong longitudinal varices, which end abruptly at the periphery, to which they give a more or less nodular appearance, and gradually disappear below.

The full length of an adult shell was about 45^{mm}; greatest breadth about 19^{mm}.

Position and localities.—Chico group, Little Cow Creek Valley, 18 miles east of Redding, Shasta County, where it was collected by Mr. Diller. Mr. Turner also collected it from the same group at Curry's Cañada, south of Mount Diablo.

CEPHALO-ODA.

AMMONITIDÆ.

Genus Ammonites Bruguière.

AMMONITES TURNERI, sp. nov.

PLATE V, Figs. 1, 2.

Shell robust; volutions increasing rapidly in size, their transverse diameter being a little greater than the other, each volution embracing less than half the diameter of the preceding one; peripheral sides a little flattened; umbilicus moderately broad and deep, its sides being regularly rounded inward. Surface marked by transverse ribs and tubercles, which vary with the growth of the shell, being more distinct in the young or half-grown examples than in the adult state. In the former condition the transverse ribs are seen to extend from the umbilical margin continuously across the lateral and peripheral sides, except that between every two or three of these continuous ribs are supplementary ones which cross the peripheral side, but disappear before reaching the umbilical borders. The tubercles are situated in revolving rows upon these ribs. The first row is a little more than one-quarter of the diameter of the volution from its umbilical side, and the second is about the same distance laterally from the periphery. Between the outer lateral row of one side of the coil and that of the other there are upon the peripheral side of the shell three other rows of tubercles which are about equidistant from each other, the one upon the median line being less prominent than the other two. Upon the living chamber of the mature shell the two lateral rows of tubercles upon each side of the coil retain their distinctness, but the three upon the peripheral side disappear, leaving that side plain and broadly rounded.

This species is closely related to *A. Stoliczkanus* Gabb, but it differs from that form in the following particulars: The volutions increase more rapidly in size than those of *A. Stoliczkanus;* about two volutions less are visible in the umbilicus; the periphery is rounded instead of flattened; the transverse ribs are smaller and less elevated; the sides of the umbilicus are rounded instead of straight, and the greatest transverse diameter of the volutions is nearer to the umbilical than to the peripheral side. Besides this, *A. Stoliczkanus* comes from the Shasta group of the Lower Cretaceous, while this species comes from undoubted Chico strata, which belong to the extreme Upper Cretaceous. This latter fact is not necessarily conclusive, but the faunas of the two formations are very distinct from each other, and it is not to be expected that specific forms should be found to have had so great a range in time as is indicated by these two formations.

Position and locality.—Strata of the Chico group at Curry's Cañada, south of Mount Diablo, where it was collected by Mr. Turner, who found it associated with characteristic Chico forms and in whose honor the specific name is given.

PART II.

THE OCCURRENCE OF EQUIVALENTS OF THE CHICO-TÉJON SERIES IN OREGON AND WASHINGTON TERRITORY.

GENERAL REMARKS.

The area within which are found the strata of the great Chico-Téjon series and the paleontological equivalents of at least portions of it, is a very long but comparatively narrow one. The most southerly known limit of this area is near the lower boundary of the State of California, and its most northern known limit is upon Vancouver's Island, the distance between the two points being not far from seventeen degrees of latitude. All the known strata which are paleontologically equivalent with any portion of this series lie to the westward of the Sierra Nevada and the Cascade Ranges, except those which have been found in the valleys of John Day and Crooked Rivers, within a limited district east of the Cascade Range in Oregon.

It is not improbable that rocks referable to this series may yet be found still further, both southward and northward, than they are at present known to exist. Their further northward extension is suggested by certain fossils which have been published by Mr. Whiteaves from Queen Charlotte Islands.[1] One shell especially, to which he applies the name of *Periploma cuspidatum*, is apparently identical with *Meekia sella* Gabb, from the Chico group of California. Southward, however, at Todos Santos Bay, in Lower California, Mr. C. R. Orcutt has found Miocene strata resting upon those to which I have applied the name of Wallala Group,[2] and which I suppose to belong beneath the Chico Group. This indicates the absence of the whole Chico-Téjon series, at least at that locality, if not more generally. The occurrence of Chico fossils in the Vancouver Island region is discussed in Part III of this bulletin.

In consequence of the great disturbance and erosion which the strata of this series have suffered throughout the whole region in which they occur, of the extent to which they have been covered from view by surface soil and débris of erosion, and by volcanic outflows, the actual area within which they are exposed at the surface is a very irregular and a frequently interrupted one. The labors of Mr. J. S. Diller, of the Survey, in northern California, however, are showing that a large part

[1] Geol. Survey Canada, Mesozoic Fossils, vol. 1, part 3.

[2] See Bull. U. S. Geol. Survey, No. 22, p. 8.

of this irregularity of area there is due to original irregularity of the coast lines of the sea in which these strata were deposited.

Furthermore, the results of Mr. Diller's labors, and also those of the California State Survey, indicate that it is only the lower or Chico portion of the series which occurs in northern California. That is, while the upper or Téjon portion of the series prevails in southern California, it has not been recognized in that State north of the line of the Central Pacific Railway; and yet the Chico portion prevails in a considerable part of northern California.

LOCALITIES IN SOUTHERN, CENTRAL, AND EASTERN OREGON.

Crossing over into southern Oregon, we not only find few exposures of strata referable to this series, but those of southern Oregon are referable only to the Chico portion. The best known of these localities are in the vicinity of Jacksonville. It is also the equivalents of these lower strata only which have been found east of the Cascade Range in Oregon. But Prof. Thomas Condon, of the State University of Oregon, has discovered strata at a few localities further north in that State which represent the Téjon or Eocene portion of the series. His first discovery was made several years ago in the valley of the Willamette, at the town of Albany, which discovery was announced by myself in a former bulletin of the U. S. Geological Survey.[1] Another similar discovery has been lately made by him in the vicinity of Coos Bay, Cape Arago, at the southern side of the entrance to the bay, being the locality from which he has sent to the office of the Survey a small but interesting collection of fossil mollusca. At both the localities mentioned Professor Condon found the strata to bear specimens of *Cardita planicosta*.

The specimens of this species, which he obtained in the Willamette Valley, are figured and discussed in the bulletin just cited. A part of those which come from Cape Arago are, in form and surface characters, closely like those which were found in the Willamette Valley, but a part of them are larger and in all respects closely like the variety of *Cardita planicosta*, which Profs. W. B. and H. D. Rogers described from the Eocene of Virginia under the name of *Venericardia ascia*.[2] The Cape Arago specimens show the same broadly rounded ribs and shallow, indistinctly defined grooves between them which the Virginia specimens show; and in other features, as well as in outward form, these Oregon specimens are in no essential respect different from the Virginia specimens published by the Professors Rogers.

There seems also to be no reason to doubt that these Oregon shells are specifically identical with those which Mr. Gabb described, from the Téjon group of California, under the name of *Cardita Hornii*. Mr.

[1] The occurrence of *Cardita planicosta* Lamarck, in western Oregon: Bull. U. S. Geol. Survey, No. 18, pp. 7, 9, pl. 2.

[2] See Contributions to the Tertiary Geology of Virginia, in Trans. Am. Philos. Soc., vol. 5, n. s., p. 374, pl. 29, fig. 2.

Conrad always contended that the California shell was not specifically different from *C. planicosta*, and I see no reason for entertaining a different opinion. The feature upon which Mr. Gabb seems to have mainly relied to separate his *C. Hornii* from *C. planicosta* is the broadly rounded ribs which both the Cape Arago and Virginia specimens also show. While I have been slow to admit the specific identity of any of the fossils of the Chico-Téjon series with any which occur in either the Cretaceous or Tertiary strata of the eastern part of the continent, I think there are no substantial reasons for regarding these Carditas of the Pacific coast as specifically different from those of the Atlantic coast, which are universally regarded as identical with *C. planicosta* Lamarck.

The following is a list of the species which have been recognized in the small collection which Professor Condon sent from Cape Arago: *Nucula truncata* Gabb, *Cardita planicosta* Lamarck, *Meretrix uvasana* Conrad, *Naticina obliqua* Gabb, *Turritella uvasana* Conrad, *Fusus californicus* Gabb, *Perissolax Blakei* (Conrad) Gabb. It will be seen by reference to the California reports that all these species, assuming that the *Cardita planicosta* of Cape Arago is identical with *C. Hornii*, are characteristic species of the Téjon group, and that no Cretaceous types occur among them.

From all the information which I have been able to gather it seems that this western form of *Cardita planicosta* occurs only in the upper portion of the Téjon group and its equivalents; that is, all the known facts which relate to the fauna of the Chico-Téjon series seem to indicate that all the Cretaceous types of the series had passed away before the introduction of *Cardita planicosta* into those western waters.

Whatever may have been the case as regards the time of introduction and extinction of those forms, respectively, it is clear that if we use the commonly accepted divisions of Cenozoic time at all, that portion of the series which bears *Cardita planicosta* ought to be regarded as of Eocene age, as Mr. Conrad and Professor Heilprin have contended. And if the equivalents of those later strata which are found in other parts of the Pacific coast region are referred to the Téjon group, the reason for doing so is that they bear characteristic Téjon species as well as recognized Eocene types. It is for this reason that I refer all the Eocene strata which have been recognized as such in Oregon and Washington Territory by their marine invertebrate remains to the Téjon epoch.

LOCALITY NEAR DWAMISH RIVER, WASHINGTON TERRITORY.

This locality is known to me only by a small collection of fossils which were sent to the Smithsonian Institution some years ago by Mr. Theodore Blatte. Most of the specimens are labeled as coming from "near the mouth of Dwamish River" and "Fossil Bluff, Dwamish River." As the distance in a straight line from the outlet of Dwamish Lake to the

mouth of Dwamish River is not more than a dozen miles, the district within which these fossils have been found is seen to be a small one.

This locality is of considerable interest, aside from the information it furnishes as to the geographical distribution of the Téjon strata, because of the probable relation of the strata there to those of the Puget group, which is discussed in the fourth article of this bulletin. The following is a list of the species which have been recognized in this small collection: *Cylichna costata* Gabb, *Conus Hornii* Gabb, *Lunatia nuciformis* Gabb, *Leda protexta* Gabb, *Euspira alveata* (Conrad) Gabb, *Fusus diaboli* Gabb, *Turritella uvasana* Gabb, *Tellina* ———?. The specimens are not in a good state of preservation, but the above identifications have been made with a good degree of satisfaction. By reference to the California reports it will be seen that all seven of those which are specifically named in the above list are known to occur in the Téjon group. Besides this no traces of any Cretaceous types are found among them, and the strata which bear these fossils are therefore referred to the upper or Téjon portion of Chico-Téjon series.

When these formations in Oregon and Washington Territory come to be examined with that care which Mr. Diller is devoting to their equivalents in California it can not be doubted that many more localities will be discovered where their strata are exposed; and that much will be learned concerning their relations to other formations. But at present little or nothing is known of the equivalents of the Chico-Téjon series in Oregon and Washington Territory except what is referred to in the foregoing paragraphs, and what has been published concerning the Vancouver Group and its fossils, for reference to which the third article of this bulletin may be consulted.

LOCALITY NEAR ASTORIA, OREGON.

There is, however, one locality on the Columbia River, near Astoria, that deserves to be mentioned in this connection. Nearly forty years ago Mr. Conrad published some fossils from that locality as of Miocene age, a part of which are exceedingly like species that are now known to characterize the Chico-Téjon series.[1] There is apparently no reason to doubt that a large part of the species figured and described in the second work cited are really of Miocene age; but it is the species which are published in the first quoted work, and in part republished in the second, concerning the Miocene age of which doubt is felt. The true Miocene fossils appear to have been collected by members of the Exploring Expedition, while the collection of those published in the American Journal is credited by Mr. Conrad to J. K. Townsend. Mr. Conrad's descriptions of Mr. Townsend's fossils are brief and mostly unsatisfactory, but his wood-cut figures are good; and they represent forms

[1] See Am. Jour. Sci., 2d ser., vol. 5, 1848, pp. 432, 433, with 15 wood-cuts; also Wilkes's Expl. Exped., vol. 10, pp. 722–729, pl. 17–20, and remarks by Dr. Newberry in Pacific Railroad Reports, vol. 6, part 2, p. 25.

that have not to my knowledge been elsewhere recognized among the Miocene fauna of the Pacific coast.

Attention may be called especially to four or five of the species figured in the American Journal. For example, the *Nucula divaricata* of Conrad differs, if at all, from *N. truncata* Gabb only in the asserted rounding, instead of the truncation of the posterior ("anterior") extremity; and yet one of Mr. Conrad's figures shows such a truncation. The *Mactra albaria* of Conrad is exceedingly like *M. Ashburneri* Gabb. The *Loripes paralis* of Conrad recalls *L. dubia* Gabb. The *Pyrula modesta* of Conrad is possibly identical with *Ficus ? cyprœoides* Gabb; and the Survey collections contain specimens of *Solen* from the Téjon group of California which closely resemble Conrad's figure of *S. curtus*. Besides this, the *Aturia angustatus* of Conrad, from Astoria, is much like *A. Mathewsoni* Gabb of the Téjon group of California; and the presence of that genus in the Miocene strata seems out of place.

These similarities suggest at least the possibility that in the vicinity of Astoria both Miocene and Chico-Téjon strata occur.

PART III.

CRETACEOUS FOSSILS FROM VANCOUVER ISLAND REGION.

GENERAL REMARKS.

Prof. J. S. Newberry, of Columbia College, New York, has placed in my hands for investigation a collection of Cretaceous fossils from some of the small islands at the southern end of the Gulf of Georgia, adjacent to Vancouver Island. The islands from which these fossils were obtained are three in number, and are known by the names of Sucia, Waldron, and Sheep Jack, respectively. These fossils all belong to one and the same formation, as the identity of a large proportion of the species collected upon each of the islands demonstrates. The formation which they represent is also identical with the coal-bearing formation at Comox[1] and Nanaimo, on Vancouver Island, from which several authors[2] have obtained collections of fossils for publication, and which I shall designate as the Vancouver group. Although this formation is paleontologically equivalent, at least in large part, with the Chico portion of the Chico-Téjon series of California, as has been indicated by Meek, Gabb, Whiteaves (op. cit.), and by Professor Whitney,[3] I prefer to use the name Vancouver group as a local name for those strata which occur in the Vancouver Island region; and still retain the name Chico group for the California strata, which the geologists of that State applied to them.

The close relation of the Vancouver group to the Chico group of California is shown conclusively by the large number of species which are now known to be common to both. Mr. Whiteaves has identified (op. cit.) thirty-one Chico species among his collections from the Vancouver group; and in addition to these I have recognized about twenty species in Professor Newberry's collections from the latter group which are well

[1] "Koomooks," "Komooks," and "Comax" of different authors.

[2] Meek, Trans. Albany Institute, vol. 4, 1857, pp. 37–49; Shumard, Trans, St. Louis Acad. Sci., vol. 1, 1858, pp. 120–125; Meek, Proc. Acad. Nat. Sci. Phila., vol. 13, 1861, pp. 314–318; Gabb, Palæontology of California, vol. 1, 1864; vol. 2, 1869; Meek, Bull. U. S. Geol. Survey Terr., vol. 2, 1876, pp. 351–374, pl. I–V; Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, part 2, 1879.

[3] Palæontology of California, vol. 2, p. xiv.

known to occur in the Chico group of California. This makes no less than fifty species which are now known to be common to both the Chico and Vancouver groups, or about half of all the species which have yet been obtained from the latter group. As other species come to be discovered, it is not to be expected that the faunal relations between the strata of the northern and southern regions will be found to be materially different from what it now appears.

The following is a list of the recognized species contained in the collections sent by Professor Newberry, which constitute the basis of the present article:

List of fossils.

Name of species.	Locality where found.				
	Sucia Island.	Sheep Jack Island.	Waldron Island.	Vancouver Island.	California.
Rhynchonella ——?	+				
Ostrea ——?			+		
Anomia vancouverensis Gabb			+		
Perna excavata, sp. nov	+	+	+		
Inoceramus vancouverensis Shumard	+	+		+	+?
Mytilus pauperculus Gabb		+?			+
Cucullæa truncata Gabb	+				+
Grammatodon vancouverensis Meek	+			+	
Axinæa sagittata Gabb	+?				+
Trigonia Evansana Meek	+			+	+
Crassatella tuscana Gabb, sp	+		+	+	+
Clisocolus dubius Gabb	+				+
Clisocolus cordatus Whiteaves	+	+		+	
Meretrix uvasana Conrad	+	+			+
Cyprimeria lens Gabb			+		+
Mactra Ashburnerii Gabb	+		+	+	+
Pholadomya subelongata Meek	+		+	+	+?
Anatina sulcatina Shumard	+				
Teredo suciensis Whiteaves	+?				
Dentalium Cooperi Gabb	+?				+
Cinulia obliqua Gabb	+	+			+
Margarita ornatissima Gabb	+	+			+
Scalaria Mathewsoni Gabb		+			+
Natica?		+			
Lunatia Shumardiana Gabb	+				+
Gyrodes Conradiana Gabb	+	+			+
Vanikoropsis suciensis, sp. nov	+				
Perissolax brevirostris Gabb		+			+
Fusus Kingi Gabb		+			+
Fulguraria Gabbi White	+	+			+
Baculites chicoensis Trask	+	+			+
Ammonites Newberryanus Meek	+			+	+
Ammonites Maclurii, sp. nov	+				

The first three columns of the foregoing table indicate the respective islands upon which Professor Newberry's collections were made, and the occurrence of the respective species upon them. In the fourth column the occurrence of certain of the species upon Vancouver Island is indicated, the reference in these cases being made mainly on the authority of Mr. Meek, but in part upon that of Mr. Whiteaves. The extreme right-hand column indicates which of the species of the list are now known to occur in the Chico group of California. For reference to other Chico species which occur in the Vancouver group, the works of Meek, Gabb, and Whiteaves, before cited, may be consulted.

It is an interesting fact that none of the species which in California specially characterize the upper portion of the Chico-Téjon series have yet been discovered in any of the strata of the Vancouver Island region. It is also true that only at a very few of the localities north of central California, where strata belonging to that great series are known to occur, have any of the species which are characteristic of its upper portion been found. The discovery, however, of some of the characteristic fossils of the upper portion of the series at a few localities in Oregon and Washington Territory, which have been especially discussed in the Part II of this bulletin, indicates that the upper as well as the lower portion of the series was originally deposited in this northern, as well as in the California portion of the Pacific Coast region. Still it is not improbable that the upper portion of the series failed to be deposited in a part of that northern region where strata of the lower portion are now found, in consequence of an upward movement of the sea bottom before the series was completed.

Two of the species of the foregoing list are recognized as new. These are described on the following pages and figured, together with a few of their previously known associates, on accompanying plates. As remarks upon each of the species which are already published are desirable, I have arranged them in the form of an annotated list, in which the descriptions of the new forms occur.

ANNOTATED LIST AND DESCRIPTION OF SPECIES.

BRACHIOPODA.

RHYNCHONELLIDÆ.

Genus Rhynchonella Fischer de Waldheim.

RHYNCHONELLA ——?

Among the fossils obtained upon Sucia Island is an imperfect specimen of a costate species of *Rhynchonella*. The specimen shows the general form and the fibrous shell texture so well that I have no doubt as to its generic relations; but it is too imperfect for specific description. The specimen is mainly interesting because of the comparative rarity of brachiopod remains in strata of this geological age.

CONCHIFERA.

OSTREIDÆ.

Genus Ostrea Linnæus.

OSTREA ——?

Numerous imperfect specimens of *Ostrea* were found upon Waldron Island. They belong to the typical section of the Ostreidæ, the fossil shells of which especially have usually too few distinguishing characters to enable one to give a satisfactory specific diagnosis, even when the specimens are perfectly preserved.

ANOMIIDÆ.

Genus Anomia Linnæus.

ANOMIA VANCOUVERENSIS Gabb.

Anomia vancouverensis Gabb, Palæontology of California, vol. 2, p. 202, pl. 33, fig. 102.
Anomia vancouverensis Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, part 2, p. 175, pl. 20, figs. 5 *a–d*.

Among the fossils collected upon Waldron Island are some specimens of *Anomia*, which one can hardly doubt are specifically identical with the form Mr. Gabb and Mr. Whiteaves obtained from Vancouver Island, and which they published in the works above cited.

AVICULIDÆ.

Genus Perna Bruguière.

PERNA EXCAVATA, sp. nov

PLATE VII, Fig. 1.

Among the fossils from all three of the islands upon which Professor Newberry's collections were made are imperfect specimens of a species of *Perna*. The greater part of the shell substance is exfoliated from all the specimens, so that they are mostly left in the condition of casts of the interior. Still the specimens indicate a well-marked species, possessing certain prominent features. The shell is moderately large; the greatest thickness, when both valves are together, a little above the mid-height and close to the front; beaks strong and projecting much forward; the hinge is long and its cartilage pits are numerous; posterior border broadly convex; the basal border usually a little straightened so as to give that part of the shell a truncated appearance. The anterior part of each valve is abruptly inflexed so that the front of the shell is strongly concave transversely, and also longitudinally, the latter concavity extending from the beaks nearly to the base of the shell. The largest example in the collection measures about 80^{mm} in length.

Genus Inoceramus Sowerby.

INOCERAMUS VANCOUVERENSIS Shumard.

Inoceramus vancouverensis Shumard, Trans. St. Louis Acad. Sci., vol. 2, p. 123.
Inoceramus vancouverensis Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, part 1, p. 170, pl. 20, figs. 4–4*b*.

The collections from Sucia and Sheep Jack Islands contain specimens of *Inoceramus* which doubtless belong to the form to which Dr. Shumard (op. cit.) gave the specific name *vancouverensis*. No less than five species of this genus have been recognized by different authors among the collections which have been made from the coal-bearing Cretaceous formation of the Vancouver Island region, namely, *I. vancouverensis* Shumard, *I. Cripsii* var. *subundatus* Meek, *I.* ——? Meek, *I. mytilopsis* (Conrad) Whiteaves, and *I. undulato-plicatus* (Roemer) Whiteaves. While our present knowledge of the correlation of the Cretaceous formations of Texas, aside from intrinsic evidence, makes it unlikely that Mr. Whiteaves[1] is correct in referring the last-named form to Roemer's Texas species, it is clearly different from any of the other recognized species of *Inoceramus* of the Vancouver Island Cretaceous. The other forms, however, not excepting the one which Mr. Whiteaves referred to the *I. mytilopsis* of Conrad, I regard as belonging to one and the same species.

[1] A letter from Mr. Whiteaves expresses present doubt in his own mind as to the identity of the Vancouver Island and Texan forms.

After examining numerous specimens of *I. Whitneyi* Gabb, from the Chico Group of California, I am of the opinion that this form also belongs to that Vancouver Island species.

Every one who has studied the fossil forms of *Ostrea*, *Anomia*, and *Inoceramus* knows how difficult it is, when he has large collections of specimens, to make satisfactory specific determinations or identifications. Experience like this has satisfied me that the differences between the shells of *Inoceramus* from the Chico group of California and the equivalent strata of the Vancouver Island region, which have just been referred to, and which certainly all belong to one general type, are not too great to be regarded as only the result of interspecific variation. Furthermore, all these forms come from strata which clearly belong to one and the same epoch, are associated with other species which are identical in different localities, and in some cases the specimens of *Inoceramus* which have been referred to different species have been found commingled in the same matrix.

In consequence of the great difficulty which is experienced in defining species of *Inoceramus* within the range of the respective types or sections into which the genus may be divided, I am not quite satisfied as to what name ought to be retained for the Pacific coast form. Many of the specimens are closely like the form which in the Cretaceous strata of the more eastern parts of the continent is usually referred to the *I. Cripsii* of Mantell, but as the western Cretaceous fauna as a whole is so different from the eastern one, I hesitate for the present to refer the western specimens to that species. I therefore for the present retain Dr. Shumard's name, which was the first to be applied to the western form.

MYTILIDÆ.

Genus Mytilus Linnæus.

MYTILUS PAUPERCULUS Gabb?.

Mytilus pauperculus Gabb, Palæontology of California, vol. 1, p. 183, pl. 25, fig. 165.

A few imperfect specimen of a *Mytilus* are contained in the collection made upon Sheep Jack Island, which probably belong to the *M. pauperculus* of Gabb.

ARCIDÆ.

Genus Cucullæa Lamarck.

CUCULLÆA TRUNCATA Gabb?.

Cucullæa truncata Gabb, Palæontology of California, vol. 1, p. 196, pl. 25, fig. 182.

Cucullæa (Idonearca) truncata Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, part 2, p. 165, pl. 19, figs. 2, 2*a*.

The collection from Sucia Island (whence also Mr. Whiteaves obtained some of his specimens), contains some examples of *Cucullæa*,

which I refer provisionally to *C. truncata* Gabb. The Sucia Island specimens, however, in both Professor Newberry's and Mr. Whiteaves's collections, are larger than those of Mr. Gabb.

Genus Axinæa Poli.

AXINÆA SAGITTATA Gabb ?.

Axinæa sagittata Gabb, Palæontology of California, vol. 1, p. 197, pl. 31, fig. 267*a*.

The collection from Sucia Island contains specimens of a species of *Axinæa* which seem to agree too nearly with *A. sagittata* Gabb to warrant any other reference. The surface of none of the specimens, however, shows the peculiar sagittate markings which suggested the specific name to Mr. Gabb. Still the same remark is applicable to the greater part of the examples from localities in California which I have seen.

Genus Grammatodon Meek.

GRAMMATODON VANCOUVERENSIS Meek.

Grammatodon vancouverensis Meek, Bull. U. S. Geol. Survey Terr., vol. 2, p. 356, pl. 3, fig. 5.

A single example from Sucia Island seems to belong to this species; but it does not show the character of the hinge.

TRIGONIDÆ.

Genus Trigonia Bruguière.

TRIGONIA EVANSANA Meek.

Trigonia Evansana Meek, Trans. Albany Institute, vol. 4, p. 42.
Trigonia Evansana Meek, Bull. U. S. Geol. Survey Terr., vol. 2, p. 359, pl. 2, fig. 7.
Trigonia Evansana Gabb. Palæontology of California, vol. 1, p. 189, pl. 25, fig. 177.

This is one of the most characteristic species of the Chico group of California and its equivalents in Oregon and Washington Territory. Specimens of it are in Professor Newberry's collection from Sucia Island.

CRASSATELLIDÆ.

Genus Crassatella Lamarck.

CRASSATELLA TUSCANA Gabb, sp.

PLATE VI, Figs. 2, 3, and 4.

Astarte tuscana Gabb, Palæontology of California, vol. 1, p. 179, pl. 30, fig. 257.
Astarte cardinioides Whiteaves, Rept. Prog. Geol. Survey Canada for 1873–'74, p. 267.
Astarte vancouverensis Whiteaves, ibid., 267.
Astarte Conradiana var. tuscana Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, p. 160, pl. 18, fig. 6.
Compare *A. Conradiana* Gabb, Palæontology of California, vol. 1, p. 178, pl. 24, fig. 161.

Shell irregularly subelliptical in marginal outline; valves moderately and somewhat regularly convex; dorsal border greatly convex

and sloping downward and backward from the beaks; posterior border more or less distinctly truncating the shell obliquely, and then abruptly rounding to the basal border, which is broadly convex; front obliquely truncated above by the lunular depression and narrowly rounded below; umbones slightly elevated; beaks depressed, approximate, situated near the anterior end; lunule small, somewhat deeply impressed; escutcheon long and narrow, lanceolate, moderately deep, and its border well defined; cardinal tooth of the right valve strong, triangular, and placed just beneath the beak. Besides this characteristic tooth in the right valve there is an incipient one at the posterior side of the cartilage pit, and another upon the margin of the lunule, in front of the anterior dental pit; the two cardinal teeth of the left valve well developed; the lateral tooth of each valve strong, of the usual character in *Crassatella*, and extending the full length of the escutcheon; cartilage pit moderately large; the free margins of the valves crenulate internally. Surface marked by strong concentric lines and undulations of growth.

Length, 38^{mm}; height, 27^{mm}. This is the average size of the specimens from which the foregoing description is drawn; but there are some examples in the collection made upon Waldron Island, which probably belong to this species, and which reach a length almost twice as great as the others.

There seems to be no reason to doubt that this shell is identical with Gabb's *Astarte tuscana*, but yet this determination is made upon the external form alone, because Mr. Gabb neither mentions nor figures any internal characters. Neither does he mention any external ligament, which his positive reference of the shell to *Astarte* would imply he had seen. It may be mentioned, however, that the escutcheon is so narrow and clearly defined as to greatly resemble the seat of a large external ligament.

It is possible that Gabb's *Astarte Conradiana* is identical with his *A. tuscana*, as is stated by Mr. Whiteaves (op. cit.); but that question can not be satisfactorily settled without reference to Gabb's type specimens, which I have never seen. And even these would probably be insufficient, because none of them seems to have shown any of the hinge characters. These characters were imperfectly shown by Mr. Whiteaves's specimens, which apparently led him to continue the reference of the shell to *Astarte*. Our specimens, however, show it to possess the typical hinge of *Crassatella*.

The specimens of this form which are contained in Professor Newberry's collection come from Sucia and Waldron Islands.

LUCINIDÆ.

Genus Clisocolus Gabb.

CLISOCOLUS DUBIUS Gabb.

PLATE VI, Figs. 5–7.

Loripes dubius Gabb, Palæontology of California, vol. 1, p. 177, pl. 24, figs. 170, 171.
Clisocolus dubius Gabb, Palæontology of California, vol. 2, p. 189, pl. 30, fig. 87.
Clisocolus cordatus Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, p. 157, pl. 18, figs. 3–3*b*.

The collection from Sucia Island contains some specimens which agree well with the description and figures of Mr. Gabb as first published by him under the generic name of *Loripes*. The figures on Plate VI are drawn from one of the best of these examples, and they are there given for comparison with those of the form next described, which I am disposed to regard as a distinct species.

CLISOCOLUS CORDATUS Whiteaves.

PLATE VI, Figs. 8, 9.

Clisocolus cordatus Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, p. 157 pl. 18, figs. 3–3*b*.
Sphæriola? cordata Whiteaves (not Meek and Hayden), Geol. Survey Canada, Mesozoic Fossils, vol. 1, p. 157, pl. 18, figs. 3–3*b*.
Clisocolus dubius Whiteaves (not Meek and Hayden), Geol. Survey Canada, Mesozoic Fossils, vol. 1, p. 157, pl. 18, figs. 3–3*b*.

The following is Mr. Whiteaves's description of this species, from specimens which he obtained from Vancouver and Sucia Islands:

Shell globose, very gibbous, especially in the umbonal region, higher than long, thickness through the valves about equal to the height. Sides and base rounded, the latter a little flattened; umbones broad, tumid elevated and approximate; beaks placed a little in advance of the middle, subspiral, their apices divergent and curving outwards; no distinct lunule or posterior area.

It is possible that *Clisocolus dubius* and *C. cordatus* belong to one and the same species, but the great differences presented by the two examples which are figured on Plate VI seem to warrant their reference to different species. While I retain for the present the specific name which has been applied to the last-mentioned form by Mr. Whiteaves, I do not agree with him in regarding it as specifically identical with the *Sphæriola? cordata* of Meek and Hayden, even if it should appear that the last-named form really belongs to the genus *Clisocolus* instead of *Sphæriola*.[1]

It is not improbable that this form ought to be separated under a new generic name, but I am not now sufficiently acquainted with its hinge and internal characters to give a satisfactory generic diagnosis.

[1]A letter just received from Mr. Whiteaves says that he is now "convinced that this shell is specifically distinct from *Sphæriola cordata* M. and H., from *S. endotrachys* Meek, and probably also from *Clisocolus dubius* Gabb." He also agrees with my suggestion that it would be well to give it a new generic name.

The specimen of this form which is figured on Plate VI came from Sucia Island; but the collection from Sheep Jack Island also contains specimens which doubtless belong to the same form.

VENERIIDÆ.

Genus Meretrix Lamarck.

MERETRIX UVASANA Conrad.

Meretrix uvasana Conrad, Pacific Railroad Reports, vol. 5, p. 320, pl. 11, fig. 3.
Meretrix uvasana Gabb, Palæontology of California, vol. 1, p. 16, pl. 30, fig. 248.

The collections from Sucia and Sheep Jack Islands contain specimens which agree well with the figures and descriptions given by Mr. Conrad and Mr. Gabb in the works above cited.

Genus Cyprimeria Conrad.

CYPRIMERIA LENS Gabb sp.

Meretrix lens Gabb, Palæontology of California, vol. 1, p. 164, pl. 22, fig. 143.
Cyprimeria lens Whiteaves, Geol. Survey Canada, Mesozoic Fossils, p. 152, pl. 17, figs. 15, 15*a*.

A single example of this form occurs in the collection from Waldron Island.

MACTRIDÆ.

Genus Mactra Linnæus.

MACTRA ASHBURNERI Gabb.

Mactra Ashburneri Gabb, Palæontology of California, vol. 1, p. 153, pl. 22, fig. 127.
Cymbophora Ashburneri Gabb, Palæontology of California, vol. 2, p. 181.
Cymbophora Ashburneri Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, p. 141, pl. 17, fig. 8.

Specimens of this species were obtained upon Sucia and Waldron Islands. It seems to be as common in the Vancouver group as in the Chico of California.

PHOLADOMYIDÆ.

Genus Pholadomya Sowerby.

PHOLADOMYA SUBELONGATA Meek.

Pholadomya subelongata Meek, Trans. Albany Inst., vol. 4, p. 44.
Pholadomya subelongata Meek, Bull. U. S. Geol. Survey Terr., vol. 2, p. 362, pl. 2, figs. 1, 1*a*.
Pholadomya royana Whiteaves (not d'Orb.), Geol. Survey Canada, Mes. Foss., vol. 1, p. 140.
Compare *P. Breweri* Gabb, Palæontology of California, vol. 1, p. 152, pl. 22, fig. 123.

Professor Newberry obtained specimens from Waldron Island, and Mr. Whiteaves reports it as occurring on Sucia Island as well as on

Vancouver Island, but he refers it to *P. royana* d'Orbigny. It is true that this shell is closely like *P. royana* from the Upper Cretaceous of France, but I think it more expedient that the name given it by Mr. Meek should be retained.

In his description of *P. Breweri*, Mr. Gabb seems to have relied mainly upon the difference in the number of radiating ribs shown by his type and Mr. Meek's respectively to distinguish them from each other. The specimens which have been obtained from the Vancouver Island region are so variable as to the number of ribs (a common thing with other species of *Pholadomya*) that I am disposed to regard *P. subelongata* Meek and *P. Breweri* Gabb as one and the same species, as Mr. Whiteaves has done.

ANATINIDÆ.

Genus Anatina Lamarck.

ANATINA SULCATINA Shumard?.

PLATE VI, Fig. 1.

Anatina sulcatina (Shumard) Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, p. 139, pl. 17, figs. 5, 5*a*.

Shell moderately large, subelliptical in marginal outline, inequilateral; posterior end widely gaping; valves broadly convex, abruptly inflexed behind the beaks, but the inflection not reaching the mid-height of the valves; beaks not prominent, situated behind the mid-length of the shell; anterior margin regularly convex; posterior margin somewhat narrowly rounded below, but presenting a slight appearance of oblique truncation above, at the upper end of which it joins the short posterior dorsal margin; anterior dorsal margin somewhat higher than the posterior, gently convex, and rounded down to the anterior margin; surface marked by strong concentric undulations of growth, with a few faint radiating impressions; interior oblique plate well developed.

The largest example in the collections measured, when perfect, about 80^{mm}; height, 50^{mm}.

I am not certain that I ought to refer this shell to the *A. sulcatina* of Shumard, as Mr. Whiteaves has done, and as I here do provisionally. Shumard never figured his species, and I fail to satisfactorily identify it among good collections which I have made from his localities in Texas, but his description agrees so nearly with the characteristics of the shell here described that one can not say positively that it belongs to a different species. Still I think the probabilities are against its being identical with *A. sulcatina* Shumard. Shumard's shell came from the Ripley group of Texas, from which also his *Volutilithes navarroensis* came. This latter shell Mr. Gabb identified in the Chico group of California, and Mr. Whiteaves obtained it from the

equivalent of that group upon Sucia Island, where it was associated with the shell here described. On a preceding page I have given my reasons for regarding the shell published by Dr. Shumard under the name of *Volutilithes navarroensis* as distinct from the Pacific coast form with which Mr. Gabb and Mr. Whiteaves have identified it. While the Chico group and its Pacific coast equivalents may have been nearly or quite synchronously deposited with the Ripley group of Texas and other Gulf States, the fauna of the latter is certainly as a whole widely if not wholly different from that of the latter so far as species are concerned.

TEREDINIDÆ.

Genus Teredo Adanson.

TEREDO SUCIENSIS Whiteaves?

Teredo suciensis Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, p. 135, pl. 17, figs. 1, 1*a*.

Some imperfect specimens in Professor Newberry's collection from Sucia Island are probably identical with the *T. suciensis* of Whiteaves.

GASTEROPODA.

DENTALIIDÆ.

Genus Dentalium Linnæus.

DENTALIUM COOPERI Gabb?

Dentalium Cooperi Gabb, Palæontology of California, vol. 1, p. 139, pl. 21, fig. 100.

Some fragments in the collection from Sucia Island probably belong to this species, but they are too imperfect for satisfactory identification.

RINGICULIDÆ.

Genus Cinulia Gray.

CINULIA OBLIQUA Gabb.

Cinulia obliqua Gabb, Palæontology of California, vol. 1, p. 3, pl. 19, figs. 64-64*c*.
Cinulia obliqua Whiteaves, Geol. Survey Canada, Mes. Foss., vol. 1, p. 131.

The collections from Sucia and Sheep Jack Islands contain many well preserved specimens of this species. Mr. Whiteaves says it is "apparently the most abundant gasteropod of the Nanaimo and Comox coal fields." It is also one of the more common shells in the Chico group of California.

TROCHIDÆ.

Genus Margarita Leach.

MARGARITA ORNATISSIMA Gabb, sp.

Angaria ornatissima Gabb, Palæontology of California, vol. 1, p. 121, pl. 20, fig. 78.
Margarita ornatissima Whiteaves, Geol. Survey Canada, Mes. Foss., vol. 1, p. 128.

A considerable number of specimens occur in the collection from both Sucia and Sheep Jack Islands. They are without doubt identical with the *Angaria ornatissima* of Gabb, from the Chico group of California, but I agree with Mr. Whiteaves in referring the shell to the genus *Margarita*.

SCALARIIDÆ.

Genus Scalaria Lamarck.

SCALARIA MATHEWSONI Gabb.

Scalaria Mathewsoni Gabb, Palæontology of California, vol. 1, p. 212, pl. 32, fig. 27.
Scalaria Mathewsoni Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, p. 128.

The collection from Sheep Jack Island contains a single rather imperfect example, which I have no doubt belongs to this species. Mr. Gabb's type specimens were found in the Chico group of California. Mr. Whiteaves also obtained imperfect examples from Sucia Island.

NATICIDÆ.

Genus Natica Adanson.

Some imperfect specimens, apparently belonging to this genus, were found among the fossils from Sheep Jack Island.

Genus Lunatia Gray.

LUNATIA SHUMARDIANA Gabb.

Lunatia Shumardiana Gabb, Palæontology of California, vol. 1, p. 106, pl. 19, fig. 61.

A single example from Sucia Island apparently belongs to this species.

Genus Gyrodes Conrad.

GYRODES CONRADIANA Gabb.

Lunatia (? *Gyrodes*) *Conradiana* Gabb, Palæontology of California, vol. 1, p. 107, pl. 20, fig. 219.
Gyrodes Conradiana Gabb., Palæontology of California, vol. 2, p. 222.
Compare with *Gyrodes excavata* Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, p. 124, pl. 16, figs. 2, 2*a*.

Several imperfect examples occur among the collections from both Sucia and Sheep Jack Islands, which appear to be young examples of this species. I am also of the opinion that they belong to the same species which Mr. Whiteaves (op. cit.) referred to the *Natica excavata* of Michelin as published in Paléontologie française.

NERITOPSIDÆ.

Genus Vanikoropsis Meek.

VANIKOROPSIS SUCIENSIS, sp. nov.

PLATE VII, Fig. 4.

Shell small, subovoid, spire small; its apex blunt; volutions four or five in number, convex; the last one much expanded and constituting the greater part of the bulk of the shell; aperture large, oval; entire surface marked by numerous raised revolving lines.

Only a single example was found, but, as it seems to represent a well-marked species, a description and figures of it are given. It occurs among the fossils from Sucia Island.

The length of this example is 8^{mm}, and the greatest breadth across the last volution is about the same.

FASCIOLARIIDÆ.

Genus Fusus Lamarck.

FUSUS KINGI Gabb.

Fusus Kingi Gabb, Palæontology of California, vol. 1, p. 85, pl. 28, fig. 204.
Fusus Kingi Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, p. 119, pl. 15, fig. 4.

A single imperfect specimen was found on Sheep Jack Island. Mr. Whiteaves obtained it on Sucia Island also.

Genus Perissolax Gabb.

PERISSOLAX BREVIROSTRIS Gabb.

A fragment of this species occurs among the fossils collected on Sheep Jack Island. Mr. Whiteaves also obtained it from Sucia Island.

VOLUTIDÆ.

Genus Fulguraria Schumacher.

FULGURARIA GABBI White.

Volutilithes navarroensis Gabb (not Shumard), Palæontology of California, vol. 1, p. 102, pl. 19, fig. 56.
Fulguraria navarroensis Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, p. 117, pl. 15, figs. 3–3*a*.
Fulguraria Gabbi White, this bulletin, p. 23, pl. 3, fig. 1.

Specimens of this species were found on Sucia and Sheep Jack Islands; and Mr. Whiteaves obtained it also from Vancouver Island.

The supposed relation of this form to the *Volutilithes navarroensis* of Shumard is discussed on page 24 of this bulletin.

CEPHALOPODA.

BACULITIDÆ.

Genus Baculites Lamarck.

BACULITES CHICOENSIS Trask.

Baculites chicoensis Trask, Proc. Acad. Nat. Sci. San Francisco, p. 85, pl. 2, fig. 2.
Baculites chicoensis Gabb, Palæontology of California, vol. 1, p. 80, pl. 14, figs. 27, 29, 29*a*.
Baculites chicoensis Meek, Bull. U. S. Geol. Survey Terr., vol. 2, p. 364, pl. 4, figs. 2-2*c*.
Baculites chicoensis Whiteaves, Geol. Survey Canada, Mesozoic Fossils, vol. 1, p. 114.

The *Baculites* found in the Chico group of California, and to which Dr. Trask gave the name of *B. chicoensis*, is not an uncommon form in the Vancouver group, among the collections from which it has been recognized by Meek, Gabb, and Whiteaves. Professor Newberry's collections from Sucia and Sheep Jack Islands contain a considerable number of examples of *Baculites*, a part of which at least are clearly referable to *B. chicoensis*. Some of the specimens are much larger than any which I know to have been found in the Chico group of California; and they so greatly resemble *B. ovatus* Say, that one can hardly say how they differ from the typical forms of that well-known species. Among these specimens, however, are others of intermediate size which seem to connect all these forms together as one species, for none of them present differences of structure that can be reasonably regarded as of specific value.

Among these specimens are some also which show a slight flattening upon the dorsal side, upon which character Mr. Meek relied to distinguish his *B. occidentalis*, which he found associated with *B. chicoensis* in the Vancouver group. I do not, however, regard these specimens as specifically distinct from the others of the collection, and I have much doubt whether there is more than one species of *Baculites* in the Vancouver group. The dorsal flattening of *B. occidentalis* it is believed may be only a varietal character; and it seems quite probable that the difference in size between the large specimens from the Vancouver group and ordinary forms of *B. chicoensis* may also be only varietal. The constantly small size of *B. chicoensis* in the Chico group of California is perhaps due to environing conditions at the time the mollusks lived.

AMMONITIDÆ.

Genus Ammonites Bruguière.

AMMONITES NEWBERRYANUS, Meek.

Ammonites Newberryanus Meek, Trans. Albany Inst., vol. 4, p. 47.

Ammonites Newberryanus Gabb, Palæontology of California, vol. 1, p. 61, pl. 10, figs. 5, 6; pl. 27, fig. 199.

Ammonites Newberryanus Meek, Bull. U. S. Geol. Survey Terr., vol. 2, p. 367, pl. 4, fig. 3.

Ammonites Newberryanus Whiteaves, Geol. Survey Canada, Mesoozic Fossils, vol. 1, p. 109, pl. 14, figs. 1, 1*a*.

The collections contain specimens of this species from Sucia Island; and the authors cited have obtained it from Vancouver and other islands in that region. Characteristic specimens of the species have also been obtained at several localities of the Chico group in California. While not an abundant fossil in the latter strata, it may be regarded as a characteristic species of both the Chico and Vancouver groups.

This species is subject to much variation as regards its surface features. In some cases every fourth or fifth rib upon the earlier volutions is sharply raised above the others. In other specimens neither of these features appear, but the ribs and spaces are more or less uniform. These differences are sometimes so striking, that Mr. Meek (vide op. cit.) was in doubt whether the form published by Gabb really belongs to this species.

AMMONITES MACLUREI, sp. nov.

PLATE VII, Figs. 2, 3.

Volutions slender, slightly embracing, regularly rounded upon the periphery, a little less convex at the sides, and somewhat abruptly rounded into the umbilicus, near which is the greatest diameter of the volutions; umbilicus moderately broad, showing all the inner volutions; septa complex, but their details are not fully known. The whole surface is plain, and in a partially exfoliated condition it is quite smooth, but where a part of the external surface of the shell is preserved, slightly raised revolving striæ appear. They are crossed by fine striæ of growth and occasional constrictions, which show that the outer portion of the margin of the aperture projected much forward, and that it had a broad emargination at the peripheral side.

This shell bears considerable resemblance to *A. Batesi* Gabb, from the Shasta group of California; but it differs from that species in having a much narrower umbilicus, an emargination of the peripheral border of the aperture, less distinct marks and undulations of growth, and the presence of longitudinal striæ upon the whole surface. Only a single imperfect specimen of this form is known; but it is so different from any other member of either the Chico or the Vancouver fauna with which I am acquainted, that it is thought best to give it a name. It was discovered on the Sucia Island by Mr. E. W. McClure, who collected a a large part of the fossils sent by Professor Newberry.

Part IV.

THE MOLLUSCAN FAUNA OF PUGET GROUP.

GENERAL REMARKS ON THE GEOLOGY OF THE GROUP.

Besides the collection of Cretaceous fossils from the Vancouver group which form the basis of the preceding article of this bulletin, Professor Newberry has placed in my hands a collection of brackish-water fossil mollusca from the Puget Sound region, which represent a hitherto unpublished fauna. The formation from which they were obtained is known to occupy a large part of the Puget Sound basin, extending also along its eastern side, the western flank of the Cascade Range. Besides these strata which lie to the west of that range other similar deposits are found upon its eastern flank, as well as among its higher mountains. These strata are also coal-bearing, and are believed to belong to the same formation, although they have not yet furnished any molluscan fossils similar to those found upon the western side of the Cascade Range. The unique character of this molluscan fauna shows that the series of strata in which their remains are found were deposited in a separate body of water from that of any other known coal-bearing strata in the Pacific Coast region or elsewhere; and its zoölogical character indicates that that body of water was an estuary.

The most complete information which has yet been published concerning this formation has lately appeared in volume 15 of the reports of the Tenth U. S. Census, pages 759–771, Plates LXXXII–CII. That publication, which is entitled a "Report on the coal-fields of Washington Territory," is by Mr. Bailey Willis, who accomplished the work upon which his report is based under the auspices of the Northern Transcontinental Survey. The special object of his report being a presentation of the coal resources of that region, the discussions are confined mainly to the coal-bearing formations, and it therefore does not embrace a full account of the structural geology of the whole region. Still, Mr. Willis has given some very comprehensive facts as well as many elaborate details of this coal-bearing series of strata in the report referred to; and as my own field labors upon the Pacific coast have never extended north of the Columbia River, much that is embraced in the following remarks, besides the quoted paragraphs, is based upon information personally imparted by him.

The land elevations of the Pacific Coast region extend in two lines, which are approximately parallel with each other and with the coast. The eastern one consists of the Sierra Nevada in California, and of the Cascade Range in Oregon and Washington Territory. The western one, known as the Coast Range in California, extends with some interruptions through Oregon and thence northward of the Columbia River, but it there sinks to low hills before reaching the Olympic cluster of mountains, which constitute the northern end of the line, and whose higher peaks rise to more than 8,000 feet above the sea.

These mountain reliefs of the Pacific Coast region are the product of several uplifts, differing in time, extent, and locality in the different ranges and different parts of the same range. A full history of these movements has not yet been learned, but the following may be regarded as facts which are of interest in this connection.

The Cascade Range, which has been recognized as distinct from the Sierra Nevada Range, although in general line continuous with it, and which has been considered to be itself simple, is in reality quite complex. In Oregon it is composed of erupted material, which has there been observed to rest upon nearly horizontal sedimentary strata of Cretaceous age; and in southern Washington Territory it consists of enormous masses of eruptive rocks, overlying highly flexed sedimentary strata of late Mesozoic or early Tertiary age. In the northern half of the same Territory the range is made up entirely of granite, crystalline schists, and volcanic rocks. The Tertiary rocks, which prevail in the Coast Range generally, seem to be wanting in the Olympics, which in this respect, and in their composition, resemble the northern portion of the Cascade Range.

Between the two long orographic lines before referred to lie the great broad valleys of the Sacramento and San Joaquin Rivers of California, of the Willamette in Oregon, and of Puget Sound (known as the Puget Sound basin) in Washington Territory. The latter was the scene of deposition of at least the greater part of the coal-bearing series which is characterized by the molluscan fauna described in this article. This fauna has been discovered only within the present limits of Puget Sound basin; but if the strata before referred to, which are found upon the eastern side, as well as in the body of the Cascade Range of southern Washington Territory, constitute parts of the same formation, the scene of its deposition extended much beyond the present limits of Puget Sound basin. This conclusion of course implies that that portion of the Cascade Range upon which those strata are found was not then elevated, as was the northern portion, and that the outline of the area within which this series of strata was deposited was very different from what would be suggested by the present topographical features of that region.

That the present topographical features of the region differ greatly from those which prevailed during the Puget epoch is indicated by others of Mr. Willis's observations. Among these he noticed the ab-

sence of strata of the Puget group up high in both the Olympic and the Northern Cascade Mountains; which, in connection with the present known areas occupied by strata of that group, leads him to believe that while those strata were being deposited, the Olympic Mountains constituted an island, and the Northern Cascades a peninsula.

The following remarks concerning the floral relations of these Puget Sound strata with other better-known formations have been furnished by Professor Newberry:

The plant-bearing strata of the region about Puget Sound represents several distinct horizons. The collections from different localities show great differences, sometimes having nothing in common, and further collections will be needed before the different floras can be satisfactorily co-ordinated. It is plain, however, that leaving out of view the coal bearing strata of Queen Charlotte's Island, which are evidently Lower Cretaceous and probably the equivalent of the Kootanie group of Dawson, most of the beds from which I have fossil plants are in a general way about of the age of the Laramie, and apparently bridge over the interval between the Cretaceous and Tertiary.

I have found in my collections from the Puget Sound region a few species which are identical with some obtained from the Laramie on the east side of the mountains. For example, my *Sphenopteris* (*Asplenium*) *elongata*[1] occurs at Orcas Island, Chuckernuts, and at Carbonado, and this is identical with Lesquereux's *Gymnogramma Haydeni*,[2] and also identical with Saporta's *Asplenium subcretaceum*,[3] and Gardner's *Anemia subcretacea*.[4] This is a wide-spread species, and doubtless has a great vertical range, being both Upper Cretaceous and Eocene.

Again the most common plant found at Carbonado and Flett's Creek is a palm, which I can not distinguish from Lesquereux's *Calamopsis Danæ* from the Lignitic of Mississippi. With these, however, are large numbers of species which are not found east of the mountains or elsewhere. You will remember that the very large bivalves which you have studied and named [*Batissa Newberryi*] came mostly from Carbonado and Flett's Creek, but the same species occurs in Newcastle, where the plants are all different.

From Whatcom Lake I have specimens of *Onoclea sensibilis*, which occurs in such abundance at Fort Union but with many other associated plants there is no other Laramie species. I think we shall ultimately find that all the local floras of the Puget Sound series are united by a few common species, and that some of these occur in the Upper Cretaceous beds of Greenland and in the floras of Sézanne and Gelinden. Nearly all the species are new, but it is easy to see that the flora taken as a whole is most like that of the Upper Cretaceous and Lower Eocene of the Old World.

So far I have found nothing common to the Puget Sound flora and distinctly Tertiary floras of the Green River, the Current Creek, and John Day beds, unless it is a *Lygodium*, that occurs at Flett's Creek, and which can hardly be distinguished from Lesquereux's *L. neuropteroides*, so common in the Green River group. But according to Gardiner this is identical with *Lygodium Kaulfussi*, Heer, and is cosmopolitan in its distribution, and therefore has great vertical range.

For the purpose of presenting the best statement of the general geology of the Puget Sound region which is at present available, the follow-

[1] Boston Jour. Nat. Hist., vol. 7, p. 511.

[2] U. S. Geol. Survey Terr. vol. 6, p. 59, pl. 5, figs. 1–3.

[3] Flor. Foss. Sézanne, 1868.

[4] Palæontographical Society, 1880, p. 45.

ing quotations are made from Mr. Willis's published report before referred to, pages 759–761:

The Coal Measures of the Puget Sound basin consist of alternating beds of yellow and gray fine-grained sandstones and very fine gray arenaceous shales, interstratified with many beds of carbonaceous shale and coal; the individual strata of sandstone and shale from twenty to two hundred feet thick maintain the same general character wherever observed, and no well-defined horizon has been found which might serve as an index to correlate the widely separated exposures. Leaf impressions occur in both shales and sandstones associated with Unios.[1]

Collections made by the Northern Transcontinental Survey have been submitted to Prof. J. S. Newberry, who considers them the equivalent of the Laramie east of the Rocky Mountains, and of greater antiquity than the Tertiaries of Bridge Creek and John Day's Valley in eastern Oregon. These collections relate, however, principally to the lower measures of the Wilkeson field of bituminous coal, and it remains to be seen whether further evidence, now being gathered, will sustain the inference, drawn from stratigraphical relations, that the lignites and bituminous coals belong to one age.

The thickness of the Laramie group, as determined by Mr. George H. Eldridge, in Montana, is about 8,500 feet in the Bull Mountains, and very much less near the old shore-lines. On the Pacific coast it greatly exceeds the above maximum; but it is not possible without further study to state even an approximate total, on account of the uncertain relations of the much-disturbed strata, obscured by volcanic flows, recent drift, and a dense forest.

The best sections are those obtained in the Wilkeson and Green River fields. * * * Of these, one gives a minimum of 13,200 feet, with a probable maximum of 14,500 feet; a second, still less complete, measures 7,700 feet; and the third, on Green River, lies between 6,200 and 8,200 feet; and these sections do not in either case reach the limits of the Coal Measures, as the base of each is an anticlinal axis and the top the highest exposure, geologically speaking, beneath the volcanic flows or drift beds. Such figures challenge confirmation,[2] but they are the result of accurate surveys and careful observation, and are only invalidated by the possibility of undiscovered faults, of which the sections have yielded no proof under close examination.

The fossils indicate the maintenance of fresh and brackish water conditions through this long period of deposition, implying that the general rate of this profound subsidence was the same as that of accumulation of sediments.

The circumstances of deposition were subject to frequent and probably often local changes; the preponderance of layers of fine sandstone, apparently derived from granite, suggests clear currents and pools existing contemporaneously with shallow waters and marshes, in which muddy sediment and peat accumulated; and the succession of sandstones, shales, and coal veins in the column of strata indicate as many changes of depth and current over the same locality. In the first of the above-mentioned sections there are one hundred and twenty-seven Carbonaceous beds, of which seventeen are workable coal veins three to fifteen feet thick.

Outcrops of older rocks in the vicinity of these Coal Measures are usually of granite or crystalline schists, either serpentine or chloritic; in the San Juan archipelago there are evidences of Cretaceous strata, and a hint of their existence is found in some indistinct agatized casts of oval cross-section and about two inches long, which were brought from a conglomerate on the upper Skookumchuck southeast of Tenino; they were unfortunately lost, but were apparently casts of *Baculites*. These would

[1] These shells have much the outward aspect of *Unio*, but, as is shown on a following page and illustrated on Plate IX of this bulletin, they have the hinge characters of *Batissa*.—C. A. W.

[2] Mr. Willis has informed me since the above was written that subsequent information has led him to doubt whether these estimates of thickness are not somewhat too great.—C. A. W.

seem to be the edges of a Cretaceous deposit hidden beneath the more extensive later rocks. But one contact of the Coal Measures with underlying schists has been observed, and that is of uncertain character. * * *

The region over which this deposition occurred has since been the scene of mountain-making upheaval, of stupendous volcanic eruptions and enormous erosion, both glacial and subaërial. The definition of its boundaries and extent is a correspondingly difficult, perhaps in some directions impossible, task.

Looking at the Puget Sound basin as a whole, the Coal Measures extend from beyond the British boundary south almost to the Columbia, and from the Pacific Ocean eastward up onto the Cascade Range to elevations varying from 800 to 5,000 feet above the sea; but buried on the one hand beneath recent gravel-beds, and overflowed on the other by erupted masses, the visible part of the formation appears as an interrupted belt along the base of the Cascades and encircling the Olympic Mountains.

The geological section of the Puget Sound basin as developed in the exploration of these coal fields may be provisionally stated as follows:

(1) Present surface of humus, accumulating from beds of *Hypnum splendens*, and the contributions of ferns, shrubs, and evergreens of the damp, luxuriant forests, average thickness probably four inches, though frequently wanting where fires have occurred within two centuries.

(2) Beds of coarse and fine gravel, sand, and clay, intimately mingled and distributed by swift currents; composed almost wholly of hard volcanic material, highly polished and sometimes striated. These drift beds fill the deeply eroded valleys of all the rivers entering the sound to an unknown depth; they form well-defined terraces[1] at Wilkeson 1,600 feet above the sea, with a known thickness above the solid rock of 300 feet, and occur in terraces[1] at an elevation of 2,000 feet on the western slope from the Natchez pass.

(3) Tertiary volcanic rocks, which form the highest peaks of the Cascade Range (Mount Rainer, 14,300 feet), and detached mountain masses and ridges. They occur as intrusive dikes in the Coal Measures, often with an appearance of conformability and as flows, beneath which the coal-rocks disappear.

(4) The lignitic and bituminous Coal Measures, sandstones, and shales probably exceeding 13,000 (?) feet in thickness; Laramie?.

(5) Cretaceous strata of the San Juan Islands and conglomerate? of the Skookumchuck.

(6) Serpentine or chloritic schists, associated with limestones and marble beds, containing segregated auriferous quartz veins, and on the Skagit silicious specular iron ore. These highly metamorphosed strata form, with granite, the mass of the Cascade Range, and are similar in association to the same rocks in northern Washington Territory and those of western Idaho; they are pre-Cretaceous and possibly Paleozoic.

Granite covers a large area west of the crystalline schists of the Skagit, reaching beyond Lake Chelan to the Okinakane and eastward to the Colville region, though sometimes hidden beneath more recent material.

Turning to the eastern slopes of the Cascades, there appears a small development of Coal Measures similar to those of the Puget Sound basin near the head of the Yakima River and on the Wenatchie River. They crop out near Lake Kitchelas, Lake Klealim, and on Schwak Creek, a small tributary of the Yakima from the north; they are of limited extent, and probably not more than 1,000 feet thick. They rest conformably (?) upon 7,000 or 8,000 feet of coarse sandstone containing thin layers of conglomerate, at the base of which is a bed of coarse conglomerate 300 to 400 feet thick. The best exposures of these rocks are south of the Wenatchie, on the spur of the Cascades called the Peshasten Range, which divides that river from the Yakima. The same sandstone and conglomerate beds occur at the head of the Munastash Creek, 25 miles west of Ellensburgh, at an elevation of 5,500 feet, on the main Cascade Range.

[1] Probably morainal terraces.—B. W.

The probability that these strata east of the range correspond to the Coal Measures west of it is suggested in the following:

Comparison of sections.

West of the Cascades.	East of the Cascades.
(1) Wide-spread glacial drift.	(1) Limited glacial drift. Lake beds of the Yakima and Columbia Rivers.
(2) Tertiary volcanic rocks.	(2) Tertiary volcanic rocks.
(3) Lignitic and bituminous Coal Measures, characterized by angiospermous leaf impressions throughout the entire thickness, thirteen thousand feet or more.	(3) Coal Measures of limited extent, one thousand feet. Coarse sandstone, with thin conglomerate beds, seven thousand to eight thousand feet.
(4) Cretaceous strata and conglomerate of the Skookumchuck.	(4) Conglomerate, three hundred to four hundred feet thick.
(5) Serpentinic or chloritic schists, associated with limestone and resting on granite, common to both sides of the range.	

The extent of the Cretaceous strata requires further study, but the existence of Laramie (?) sandstones upturned high upon the mountains places their upheaval at the close of that period.

Mr. Willis has also kindly furnished me with the following paragraph from an unpublished report of his upon a district which lies eastward of Puget Sound basin:

LARAMIE (?) OF THE WENATCHIE VALLEY.

The Wenatchie River cuts a section across unmetamorphosed conglomerates and sandstones, bent in broad folds over axes having a general north and south trend. This formation flanks the Peshastan Range on both sides, occurring on the south on Schwak Creek and in the Klealim Valley, and forms some of the high crests of the Cascade Range north of the Natchez. It is the last formation deposited before the elevation of the Cascade Range and its spur, the Peshastan, and is thus identified, as well as lithologically and in its stratigraphic relations, with the Puget Sound Coal Measures, the latter having been assigned to the Laramie on the evidence of the leaf impressions by Prof. J. S. Newberry.

In the last-quoted paragraph Mr. Willis shows his reason for identifying those strata which are found within and upon both the eastern and western sides of the Cascade Range as belonging to one and the same formation. It will be seen also that, in consequence of the identification by Professor Newberry of certain Laramie species of plants and of the probable superposition of the Puget group, at least in part, upon Upper Cretaceous marine strata, he regards the Puget group as geologically equivalent with the great Laramie group, which latter name he has also provisionally applied to it. I think all the known evidence is strongly in favor of this view, which is taken by both Professor Newberry and Mr. Willis, but the character of their respective molluscan faunas makes it quite certain that the deposition of these two formations took place in different bodies of water, which, if contemporaneous, were completely separated by a land area. That area was necessarily of considerable width, but yet an arboreal flora may be reasonably

supposed to have occupied its whole breadth, and to have scattered its autumnal leaves into the Laramie sea upon the one hand and into the Puget estuary on the other, while the aqueous faunas were respectively very different. It may yet appear that land vertebrate and molluscan faunas also extended across the same area, and that remains of each found their way into the Laramie sea upon the one hand and the Puget estuary on the other.

While the evidence which is furnished by the fossil mollusca of the Laramie and Puget groups, respectively, is conclusive that they were deposited in separate bodies of water, satisfactory evidence exists also that the Laramie outlet was into Atlantic and the Puget outlet into Pacific waters. When such differences of conditions as these are known to have prevailed, resulting in or connected with marked faunal dissimilarities, I think it much better to use separate names for the formations, even if correlated evidence should be satisfactory that they were contemporaneous in their origin. It seems at least expedient also that separate local names should be applied to certain marine strata which are found in separate districts, but shown by a greater or less proportion of the species of fossils they respectively contain to have been at least approximately contemporaneous. In accordance with this view I have proposed the name "Puget group" for the deposit which forms the subject of this article, as I did that of "Vancouver group" for the formation under discussion in Part III of this bulletin.

As to the original boundaries of the Puget group comparatively little is definitely known. It is probable also that much will remain unknown upon this point, owing to the great erosion and disturbance which the strata have suffered and to the presence of large portions of the immense lava outflows which have so largely covered them. Taking into consideration the extreme points at which strata of this group have been found, including those which lie to the east of and among the Cascade Mountains, it is evident that the Puget deposit originally occupied an area of several thousand square miles. Still any definite estimate must be unsatisfactory, owing to the evidently great irregularity of the original as well as the present area.

That the body of water in which the Puget group was deposited was estuarine, and not a land-locked sea, as was the Laramie, is indicated by its molluscan fauna, all the known members of which are described and figured in this bulletin.[1] But in what manner the Puget estuary was separated from the open sea we have as yet little information. A natural inference would be that the Olympic Island formed a part of such a barrier, but the presence of marine fossils in the valley of

[1] The apparent absence of this peculiar fauna from the more eastern strata suggests that they were deposited nearer to the influx of fluviatile waters, which, being there entirely fresh and farther inland, did not afford a congenial habitat for species which prevailed in the western and brackish part of the estuary.

Dwamish River, the strata inclosing which were presumably deposited contemporaneously with at least a portion of the Puget group, would seem to show that the estuary barrier was, a part of the time at least, eastward of Olympic Island.

Besides the information contained in those of the foregoing paragraphs which are quoted from Mr. Willis's report, little is known concerning the stratigraphical relations of the Puget group to the other formations of the Pacific Coast region. Its molluscan fauna, being unique in character and composed of types which give little or no definite indication as to geological age, is comparatively worthless as an aid in correlating the Puget group with any other formation.

Mention has just been made of the presence of marine fossils in certain strata on Dwamish River, in Puget Sound basin. This locality and its fossils have been briefly discussed in Part II of this bulletin, where it is shown that the greater part of the species found there are identical with species found in the Téjon group of California. The locality is just westward of, and not distant from, a district which is occupied by the characteristic strata of the Puget group, which furnished the fossils described and figured on following pages. Mr. Willis, who has studied the stratigraphy there in connection with his work before referred to, regards the position of these marine strata with reference to those of the Puget group as having been deposited not earlier than those of the upper portion of that group. This view of the stratigraphical relations of the Dwamish River strata with those of the Puget group, together with the fact that their fossils are of marine origin, suggests that they were deposited in marine waters towards the close of the great subsidence that accompanied the deposition of the Puget group, and indicates that the latter group is a local, although a large, representative of a part, or the whole, of the Chico-Téjon series. It also seems to indicate that the western barrier of the Puget estuary was at that time and place not far from the middle of the present Puget Sound basin; but it is probable that the position of the barrier was shifted from time to time during the existence of the estuary.

It is in consideration of the following facts that the Puget fauna has been designated as of estuary origin: No trace of a characteristic open-sea fauna has been found in the Puget strata. The genera *Corbicula* and *Batissa*, which are known to range from brackish to fresh waters, but not into marine waters, constitute a conspicuous portion of that fauna. These are associated with certain forms whose living congeners are known to range from marine to brackish waters, but not into fresh waters. The strata contain an abundance of vegetable remains, which doubtless came from swamps and adjacent shores.

Now, if the strata of the Puget group were deposited, even in part contemporaneously with the Chico-Téjon series, it is probable that some of the molluscan species of that series which were capable of entering brackish waters may yet be found in the Puget strata, and that some

of the species of the Puget fauna which were capable of entering marine waters may yet be found associated with Chico-Téjon species. As a matter of fact, however, no evidence of such a commingling of the species of the two faunas has yet been discovered. So, therefore, we have no paleontological evidence of the contemporaneity of the Puget group with the Chico-Téjon series.

Although no serious doubt is entertained that the Puget group was deposited in estuarine waters, there are certain facts which are somewhat perplexing when considered in connection with an acceptance of that view. The known area within which strata of that group occur shows that the Puget estuary was of such great extent, that it is difficult to understand how so large a body of water could have been uniformly kept so nearly fresh as to afford a congenial habitat for such a molluscan fauna as it is known to have possessed, and during so long a period of time as was necessary for the accumulation of the great thickness of strata in which the remains of that fauna are found. That is, it is difficult to understand how that comparatively narrow portion of the continent between the then existing Laramie hydrographic basin on the east and the Puget estuary on the west could have furnished a sufficient flow of fluviatile waters to keep nearly fresh so large an estuary, and keep off the encroachment of adjacent marine waters. Even so large a flow as is now discharged by the Columbia River would seem to have been insufficient, unless the outlet of the great estuary was much restricted by land barriers.

Again, the evidence presented by Mr. Willis, and also that afforded by the fossils, which range without material change through a large part of the vertical series, seems to be conclusive that essentially uniform estuarine conditions were preserved over the whole area now occupied by the Puget group from the time of the deposition of its earliest to that of its latest strata. This evidence also discloses the remarkable fact that during that time there was a constant subsidence over the whole area until it had reached a maximum of twelve thousand feet or more. It is certainly difficult to see how so great a subsidence could have taken place without such a simultaneous elevation of the adjacent land area as would have materially changed the character and uniformity of the supply of fluviatile waters to the estuary, or have added a land area to the westward of it. Indeed, it is difficult to understand how even a less subsidence could have taken place without materially modifying the character of the great estuary itself, or even submerging its whole area beneath marine waters.[1]

The localities from which were obtained the molluscan fossils of the Puget group, and which are described in the pages immediately following, lie mainly in King and Pierce Counties, Washington Territory. These localities are designated upon the labels accompanying the fossils as Newcastle, Wilkeson (Flett's Creek), Carbonado, Green River, and

[1] See second foot-note on page 52.

Palace Camp, respectively; and these names occur in connection with the descriptions.

The following is a list of the species recognized in Professor Newberry's collection and herein described:

Cardium (Adacna?) ——?
Cyrena brevidens.
Corbicula Willisi.
Corbicula pugetensis.
Batissa Newberryi.
Batissa dubia.
Psammobia obscura.
Sanguinolaria? caudata.
Teredo pugetensis.
Neritina ——?
Cerithium? ——?
Undetermined gasteropod.

DESCRIPTION OF SPECIES.

CONCHIFERA.

CARDIIDÆ.

Genus Cardium Linnæus.

CARDIUM (ADACNA?) ——?

PLATE IX, Fig. 4.

The collection from the locality designated as Palace Camp contains a couple of imperfect examples of a shell which plainly belongs to the Cardiidæ. The general form and the character of the hinge and of the pallial impression, together with its brackish-water associates, suggest the propriety of referring this shell to the genus *Adacna*; but the material in hand is too imperfect to make that reference with confidence.

The shell is subelliptical in marginal outline; wider than high; and the surface is marked by numerous sharply raised radiating ribs; cardinal teeth small; lateral teeth moderately well developed; pallial sinus apparently large and deep.

Breadth, 24^{mm}; height about 16^{mm}.

The specimens are in the condition of casts only, and being also fragmentary, a full specific description is impracticable.

CYRENIDÆ.

Genus Cyrena Lamarck.

CYRENA BREVIDENS, sp. nov

PLATE X, Figs. 8–11.

Shell subtrihedral in outline by lateral view; valves moderately convex; beaks prominent, situated a little in advance of the mid-length of the shell even in the shortest examples; cardinal teeth small; pos-

terior lateral teeth small and slender; anterior lateral tooth of the left valve very short, and situated so near to the cardinal teeth as to appear like an accessory cardinal tooth; pallial sinus small and moderately deep. Surface marked by distinct concentric lines and undulations of growth.

The proportion of height to the length of the shell varies greatly in different examples. One example measures 27mm in height and 29mm in extreme length, while another measures 18mm in height and 26mm in extreme length. The average proportions are, however, between those of these two examples.

In outward aspect this shell resembles *Corbula*, but the character of the hinge is quite unlike that of *Corbula*, and the valves are also equal in shape and convexity. In the character of the lateral teeth it also differs considerably from the typical forms of *Cyrena*. The posterior laterals are of much less than ordinary size, while the anterior lateral tooth of the left valve is so close to the cardinal teeth as to serve and appear as an additional cardinal tooth. This difference in the hinge is probably of subgeneric value, but for the present I prefer to place the shell under *Cyrena*.

Locality.—Palace Camp.

Genus Corbicula Megerle.

CORBICULA WILLISI, sp. nov.

PLATE XI, Figs. 3-7.

Shell subcircular in outline, the height and length being nearly equal; beaks prominent, elevated, and situated near or a little behind the mid-length of the shell; valves strongly convex, especially in the umbonal region; front margin regularly rounded, its convexity being continuous with the somewhat less convex basal margin; posterior margin slightly convex, nearly perpendicular, and abruptly rounded to the basal margin below and to the dorsal margin above; dorsal margin short, nearly straight; cardinal teeth well developed; lateral teeth also well developed and transversely crenulated; pallial sinus small. The surface is marked by the ordinary concentric lines of growth, and the larger examples usually have besides this a greater or less number of strong concentric undulations.

Height of the largest example in the collection, 54mm; length, 51mm; but the average size is considerably less.

This is a typical American fossil form of *Corbicula*, having the crenulated lateral teeth and small pallial sinus which characterize those forms. In shape and general character it approaches the *C. umbonella* of Meek, from the Laramie group; but it is shortened more abruptly behind, and the front is more prominent.

Localities.—Carbonado, Wilkeson (Flett's Creek), and valley of Green River.

CORBICULA PUGETENSIS, sp. nov.

PLATE XI, Fig. 8.

Associated with the foregoing species at Carbonado is a form which differs so much from it as to warrant the application of a separate name. It is subovoid in marginal outline, considerably longer than high; valves moderately convex; beaks somewhat prominent, situated near the anterior end of the shell; surface marked by the ordinary concentric lines of growth.

Height of an example of ordinary size, 35mm; length, 45mm.

This species is readily distinguishable from the foregoing one, with which it is associated, by its more elongate form, the anterior position of the beaks, and the prominent posterior border. In general aspect it somewhat closely resembles *Corbicula* (*Leptesthes*) *cardiniæformis* White, from the Laramie group; but the front of this shell is even less prominent than that of the Laramie species.

Genus Batissa Gray.

BATISSA NEWBERRYI, sp. nov.

PLATE IX, Figs. 1-3.

Shell large, subelliptical in marginal outline; valves moderately convex; beaks slightly prominent, situated behind the mid-length of the shell; cardinal margin broadly arched; front margin somewhat abruptly rounded; basal margin broadly convex, and the posterior margin a little more narrowly rounded than the front; ligament large, prominent, and ending abruptly behind, as is usual in this genus; cardinal teeth three in each valve, the two posterior ones of the right valve being broad and strong, and all three teeth of the left valve being narrow; lateral teeth unknown.

Height of the most perfectly preserved example in the collection, 52mm; length, 81mm; but the average size is considerably larger than this.

The collection contains numerous examples of this species, all of which are more or less distorted by the pressure to which the material they were embedded in has been subjected. In some cases the distortion has been so extreme as to have wholly destroyed the original form of the shell. In all cases also the shell substance has been dissolved away, but most of the examples show the beaks to have been much corroded while the mollusk was yet alive, as those of living species of *Batissa* often are. This total destruction of the shell substance of these specimens of *Batissa* in the process of fossilization is noteworthy, because nearly all of the specimens of *Corbiculla* and *Cyrena* which are found associated with them, and which belong to the same family, have the shell substance preserved.

Localities.—Carbonado, Wilkeson (Flett's Creek), and Newcastle.

BATISSA DUBIA, sp. nov.

PLATE XI, Figs. 1, 2.

Among the collections from Newcastle and Wilkeson are numerous compressed and distorted examples of a shell which I refer to the genus *Batissa*, but which is evidently specifically different from *B. Newberryi*. It is a smaller shell, subcircular in marginal outline, and has its beak situated a little in advance of the mid-length of the shell. The ligament is large and prominent, and one of the examples shows traces of the cardinal teeth similar in character to those of *B. Newberryi*.

TELLINIDÆ.

Genus Psammobia Lamarck.

PSAMMOBIA OBSCURA, sp. nov.

PLATE X, Figs. 4-6.

Shell irregularly subelliptical in marginal outline; valves gently convex, but the postero-dorsal region is somewhat compressed; beaks not prominent, situated at about one-third the full length of the shell from the front; anterior margin rounded; basal margin broadly convex; dorsal margin behind the beaks nearly straight; postero-dorsal margin sloping downward and backward to the base. Surface marked by the usual distinct concentric lines of growth. Pallial line strong, and its sinus large and deep.

Height, 29^{mm}; length, 38^{mm}.

Localities.—Palace Camp and Carbonado.

Genus Sanguinolaria Lamarck.

SANGUINOLARIA? CAUDATA, sp. nov.

PLATE X, Figs. 1-3.

Among the collections made at Carbonado are some imperfect examples of a somewhat extraordinary shell, which I refer provisionally to *Sanguinolaria*. Up to the time of its reaching nearly adult size its general shape and marginal outline agree with the recognized forms of *Sanguinolaria;* but from that time until fully grown the posterior portion became so greatly extended, that extreme examples reach nearly double the length which the shell had before the posterior elongation began.

No trace of the hinge has been discovered, and the specimens found are so imperfect, that no satisfactory specific description can be given. The figures, however, on Plate X will serve to give a good idea of all that has been learned of this singular shell.

TEREDINIDÆ.

Genus Teredo Adanson.

TEREDO PUGETENSIS, sp. nov.

PLATE VIII.

The shell of this species is not known, the specimens in the collection consisting only of the tubes, solidly filled with stony material in a mass of partially carbonized and partially silicified wood. The tubes are large, most of them extending in the direction of the wood fiber, and terminate at the distal end in almost true hemispheric convexity.

The diameter of the tubes, as seen in the specimens in hand, varies from 27mm to 32mm.

Locality.—Carbonado.

GASTEROPODA.

NERITIDÆ.

Genus Neritina Lamarck.

NERITINA ——— ?

PLATE X, Fig. 12.

Among the specimens collected at Palace Camp is a single example of *Neritina*, which is in the condition of a natural cast of the interior of the shell. It is too imperfect for specific description, but its character is partially shown by the figure on Plate X.

CERITHIIDÆ.

Genus Cerithium Bruguière.

CERITHIUM? ——— ?

PLATE IX, Fig. 5.

Among the collections made at Palace Camp and Carbonado are some specimens which appear to belong to the genus *Cerithium*, one of which is represented on Plate IX. So much of the embedding material adheres to these specimens, that the aperture is obscured and the surface markings are mostly obliterated. The figure represents the largest of the specimens discovered. It is thought possible or even probable that this shell belongs to the Melaniidæ, because fossil species of *Melania* have been found elsewhere associated with unmistakably brackish-water forms, and because living species of *Melania* and *Batissa* are often found associated.

Undetermined gasteropod.—Among the specimens from Palace Camp is a fragmentary one of a gasteropod. It is much too imperfect for

description, and is mentioned here only to give as full an account as possible of this small but interesting fauna.

CONCLUDING REMARKS ON THE FAUNA.

The fauna to which one instinctively turns for the purpose of zoölogical comparison with this Puget estuary fauna is that of the Laramie group. Such a comparison is especially suggested by the known floral relations of the two groups of strata, their presumable contemporaneity of origin, and the non-marine character of the molluscan faunas of both. Upon making a comparison, however, important zoölogical differences appear. It is true there are two species of *Corbicula* in the Puget fauna that are so closely like Laramie forms as to suggest specific identity upon casual examination, but the differences between the two faunas are strikingly shown by the family and generic characters of the other members of the Puget fauna as compared with the Laramie fauna.

For example, a species of *Teredo* has been found in the Puget group, but no member of the Teredinidæ has yet been found in the Laramie. Two species of the Puget fauna are referred to the Tellinidæ, but no member of that family has yet been found in the Laramie. But the generic form which gives an especially unique character to the Puget fauna is that of *Batissa*. This genus has not hitherto been known to occur in North America in either a fossil or living condition, nor has it been found nearer to this continent than certain of the Pacific islands. Still the hinge characters observable on these Puget estuary specimens leave no room for reasonable doubt that they are strictly congeneric with true *Batissa*. Indeed, a species of that genus which is now living upon the Fiji Islands is closely related to this fossil form.

Certain interesting relationships between Asiatic and North American faunas have been noticed by naturalists, which are recalled by this occurrence of *Batissa* in the Puget fauna. Assuming that these relationships are those of genetic succession, we naturally desire to know in which direction their lines of geographical dispersion have taken place. For example, was it towards or from the present North American continent that the dispersion of *Batissa* occurred? If it was from this continent, it is remarkable that none of its progeny have survived in any of the present continental waters, and it is equally remarkable that no evidence of its former existence in North America has been discovered except those which the Puget fauna has furnished. If the dispersion of *Batissa* was towards this continent, it seems to have only reached the present Pacific Coast region about the close of the Cretaceous period and to have then and there become extinct, while it has continued its existence on certain islands of the Pacific to the present time. But all the known facts concerning the genus *Batissa* are insufficient to throw much light upon its geological history or geographical dispersion. Even the Corbiculidæ, the family to which *Batissa* belongs, has a less completely known geological history in North America than has that of the Unionidæ.

PART V.

MESOZOIC MOLLUSCA FROM THE SOUTHERN COAST OF THE ALASKAN PENINSULA.

GENERAL REMARKS.

There has lately been received at the office of the Survey a small collection of fossils from the shores of Kialagvic, or Wrangell Bay, on the southern side of the Alaskan Peninsula, and nearly opposite the western end of Kodiak Island. They were found by one of the men employed by Messrs. Ward & Howell to make collections for their natural science establishment at Rochester, N. Y., and were sent by Mr. E. E. Howell to the Survey. Seven species are represented in this collection, all of which are apparently yet undescribed. Five of the species are Cephalopods and two are Conchifers, the genera *Ammonites*, *Baculites*, *Glycimeris* ?, and *Cucullæa* being represented.

The *Ammonites* alone give any reliable indication as to the geological age of these fossils. They are certainly of Mesozoic age, and the types to which they belong seem to indicate that they come from a formation of somewhat earlier date than the Cretaceous. One of these species belongs to the type to which Bayle gave the generic name of *Lillia*, and closely resembles *Ammonites lilli*, as figured and described by Ritter von Hauer from the northeastern Alps.[1] Another is closely related to this species, and the third belongs to the type *Amaltheus* Montfort, which is also regarded as of Liassic or of Jurassic age. While there is no reason to doubt the correctness of the information which accompanies this collection of fossils as to the locality from which they were obtained, no information as to the geology of the region was received with them. In consequence of this omission, and of the fact that all the species are regarded as new, we have no means of knowing whether or not they come from a formation which is represented by any other fossils heretofore collected in Alaska.

The only other invertebrate fossils which to my knowledge have been found in the Alaskan region, and which can be regarded as of Mesozoic age, are those which have been published by Eichwald,[2] Grewingk,[3]

[1] Ueber die Cephalopoden aus dem Lias der nordöstlichen Alpen. Denkschr. math.-naturwiss. Classe k. Akad. Wiss., vol. 11, p. 40, pl. viii, figs. 1–3.

[2] Geognost.-paleont. Bemerkungen über die Halbinsel Mangischlak und die aleutischen Inseln, St. Petersburg, 1871.

[3] Verhandl. Russ. k. mineral. Gesell., pp. 344–347 pl. iv, 1848–'49.

Fischer,[1] and myself;[2] and which were collected by Doroschin, Wosnessensky, Pinart, and Dall, respectively. At least a part of the fossils collected by Doroschin, Pinart, and Dall, respectively, are shown to have come from one and the same formation by the occurrence in all of their collections of *Aucella concentrica*. This formation was referred to the Neocomian by Eichwald (op. cit.), notwithstanding the fact that other authors have usually regarded *Aucella* as a characteristic genus of the Jurassic. Eichwald also contended, in opposition to the views of many other European geologists, that the European strata which bear *Aucella* are also of Neocomian age. The occurrence of *Aucella concentrica* in the Shasta group of the California Cretaceous induced me in a former publication (op. cit.) to agree with Professor Eichwald's views as regards the Neocomian age of the Alaskan strata in question.

I do not think it impossible that the fossils which form the subject of this article belong to the same formation in Alaska which bears *Aucella concentrica*, but the two types of *Ammonites* which are found among these fossils are at least suggestive of a lower horizon. Indeed, if we had only the type character of the fossils themselves to consider, we should hardly be justified in referring them to a later age than the Jurassic.

DESCRIPTION OF SPECIES.

CONCHIFERA.

ARCIDÆ.

Genus Cucullœa Lamarck.

CUCULLÆA INCREBESCENS, sp. nov.

PLATE XIV, Figs. 5, 6.

The collection contains only a single, somewhat imperfect, left valve of this species, but its unusual shape makes it desirable to figure and briefly describe it. The valve is greatly inflated; height from base to hinge not more than half the full transverse length; the area broad, strongly concave; hinge strong. Surface marked by strong concentric lines of growth.

The only form with which it seems desirable to compare this shell is the *C. insularis* of Eichwald.[3] His figures show that the specimens of

[1] Voyages à la côte nord-ouest de l'Amérique, par M. Alph.-L. Pinart, pp. 33–36, pl. A.

[2] Bull. U. S. Geol. Survey No. 4, pp. 10–15, pl. vi.

[3] Figured and described in Geognost.-paleont. Bemerk. Mangischlak u. aleut. Inseln, p. 168, pl. xv, figs. 6–8.

that form which were collected by Doroschin were very imperfect, and Professor Eichwald says that he himself had never seen them, but that his description was made from figures drawn under Professor Pander's direction. From Eichwald's description I am disposed to regard that form as specifically distinct from the one here described.

SAXICAVIDÆ.

Genus Glycimeris Lamarck.

GLYCIMERIS? DALLI, sp. nov.

PLATE XIV, Figs. 7-9.

Shell somewhat elongate, the proportional height usually increasing with age; moderately gaping behind; test very thin; valves broadly but irregularly convex, the greatest convexity being a little in advance of the mid-length of the shell. In front of this greatest convexity there is a slight flattening of each valve, which extends from the umbones to the basal margin; umbones broad, elevated, and prominent. Beaks situated at a little less than one-quarter of the full length of the shell from the front, elevated above the hinge line, and incurved. Front margin irregularly rounded, but the front portion of each valve is obliquely truncated in front; basal margin irregularly convex by reason of the umbonal flattening of the valves, opposite which the margin is straightened or even slightly emarginate, while the greatest convexity is about mid-length; posterior margin somewhat narrowly rounded to both the dorsal and basal margins; dorsal margin behind the beaks long and nearly straight, except that it descends a little at the extremity to meet the posterior margin; dorsal margin in front of the beaks very short, the adjacent portion of each valve being so inflected as to produce the appearance of a deep lunule. Surface marked by numerous strong concentric undulations, which end upon reaching the truncated front portion of each valve, the surface of which is plain, and they also become obsolete upon the postero-dorsal region. Hinge unknown.

Length of the largest example in the collection, 57^{mm}; height of the same, 34^{mm}.

This shell has much of the general aspect of a Grammysia, but the gaping of the valves at the posterior end excludes it from that genus. Its short and truncated front is also so unusual a feature of *Glycimeris*, that, in the absence of any knowledge of its hinge, it suggests some doubt whether this shell really belongs to that genus.

The only shell with which it seems necessary to compare the one here described is the *Panopæa protracta* of Eichwald.[1] Professor Eichwald's

[1] Geognost.-paleont. Bemerk. Mangischlâk u. Aleut. Inseln, p. 160, pl. xiii, figs. 8, 9.

figures, nowever, show that the beaks of his species are nearıy centrally situated, while in this species they are quite near to the front. His species also does not show the obliquely truncated front, with its plain surface, which is a conspicuous character of the form here described. Professor Eichwald's specimens came from the "Schwarzen Neokomkalke von Alaska," where they were associated with numerous other species, all of which are different from any of the species described in this article. The specimens of this species came from a greenish sandstone, in which it was associated with all the species noticed in this article, none of which are recognized as identical with any other species yet found in the Alaskan region. The specific name is given in honor of Dr. W. H. Dall, the author of Alaska and its Resources.

CEPHALOPODA.

BELEMNITIDÆ.

Genus Belemnites Lamarck.

BELEMNITES ——— ?

PLATE XIII Fig. 6.

The collection contains a considerable number of fragments of *Belemnites*, but there are no specimens among them which are even approximately perfect. The greater part of them belong to a species which was evidently a very long and slender one, and which had a moderately long phragmocone. The largest example referable to this species has a diameter at about the mid-length of the phragmocone of about 12^{mm}. The full length of an example having such diameter was apparently not less than 130^{mm}.

BELEMNITES ——— ?

PLATE XIV, Fig. 4.

The collection also contains portions of very large phragmocones of a Belemnite which are more or less distorted by pressure, and which are believed to represent a different species from that which is represented by the fragments before referred to. The diameter of the largest example in the collection is 38^{mm}, and the chambers were about 5^{mm} in thickness; the septa were broadly concavo-convex and apparently very thin. The apical angle of the phragmocone appears to have been comparatively short, but the specimens are too imperfect to ascertain the angle. The collection contains no fragments of the shaft of this species.

AMMONITIDÆ.

Genus Ammonites (Lillia Bayle), Bruguière.

AMMONITES (LILLIA) HOWELLI, sp. nov.

PLATE XII, Figs. 1, 2, and PLATE XIV, Figs. 1–3.

Shell reaching a moderately large size, discoid, broadly umbilicate; each volution embracing about one-half the width of the next one within, but the minute earlier volutions embrace a less proportion of the width of the adjacent one than do the later volutions; transverse section of the volutions ovate, the diameter which lies in the plane of the coil, being about one-quarter greater than the transverse, but the difference is less than this in the small earlier volutions; the transverse diameter of the volutions is a little greatest near the umbilical side; their sides broadly convex and rounded into the umbilicus; the peripheral side regularly rounded in the case of exfoliated specimens, especially of the smaller volutions, but the larger volutions, when the shell substance is retained, show a low, rounded, peripheral ridge, with a narrow, flattened, or slightly concave space at each side of it. This ridge is apparently formed of the shell substance alone, and when the latter cleaves off from the periphery of the chambered volutions the siphuncle is more or less exposed; sides of the volutions distinctly marked by transverse ribs, the principal ones of which end a little before reaching the umbilical margin on the one hand, and just before reaching the peripheral ridge on the other. Between each two of the principal ribs (that is, those which cross the entire side of the volutions) there are one, two, or rarely three short or accessory ribs, which arise near or a little beyond the middle of the side and end near the periphery, where they are of uniform size and outward extension with the principal ribs. The ribs are therefore more than twice as numerous upon the peripheral half of the volutions as they are upon the umbilical half. The direction of the ribs across the volutions is nearly transverse, but they are usually directed a little forward. The principal ribs alone are seen upon the inner volutions, because the accessory ribs and the outer half of the principal ones are entirely covered by the next succeeding volution. The umbilical half of the principal ribs is stronger and more prominent than the peripheral half, but they are apparently never spinous. The septa are very complex; a plan of one of them is given on Plate XIV, Fig. 3. The living chamber constituted fully two-thirds of the last volution. Character of the aperture unknown.

This shell bears much resemblance to *Ammonites lilli* Hauer, from the Lias of the northeastern Alps, which is the type of Bayle's genus *Lillia*; but the volutions are a little more embracing than they are in that species and their increase in size with the growth of the shell is proportionally greater. *A. lilli* is also nearly or quite without the

accessory ribs which form a conspicuous feature of the Alaskan species.

The collection contains a considerable number of this species, but they are mostly small. The largest one measures upward of 150^{mm} in diameter of the coil. The specific name is given in honor of Mr. E. E. Howell, formerly of the U. S. Geological Survey.

AMMONITES (LILLIA) KIALAGVIKENSIS, sp. nov.

PLATE XIII, Fig. 7.

Shell closely resembling that of the preceding species in general form and aspect; broadly umbilicate; each volution embracing less than one-half the next preceding one; transverse section of the volutions elliptical, the diameter which lies in the plane of the coil, being about one-quarter greater than the transverse; sides of the volutions broadly convex, rounded somewhat abruptly into the umbilicus; peripheral side somewhat regularly rounded, but bearing a narrow, slightly raised median ridge; sides of the volutions marked by flexuous ribs, a little less than half of which become obsolete upon the umbilical border and the remainder become obsolete between the middle and that border. All of them end in a very slight enlargement just before reaching the peripheral ridge. A forward curve of the ribs from the umbilical border occupies a little more than the inner half of the side of the volution, and a less distinct backward curve occupies the outer portion. The living chamber occupies about three-quarters of the last volution. Character of the septa and of the aperture unknown.

The collection contains only two examples of this species, both of which are imperfect. The larger one has a diameter of coil of only 55^{mm}, but it is likely that fully mature shells were much larger. The proportions of its volutions, as well as the general aspect of the shell, are closely like those of the preceding species, and the difference between the two species is more conspicuously seen with reference to the ribs which traverse the volutions. In this species the ribs are distinctly flexuous; the accessory ribs are fewer in number than in *A. Howelli*, and their greatest prominence is at the peripheral end of the principal ribs, instead of being at the umbilical end, as it is in *A. Howelli*.

AMMONITES (AMALTHEUS) WHITEAVESII, sp. nov.

PLATE XIII, Figs. 1-5.

Shell discoid; umbilici small, and sharply defined by the elevation of the border; volutions so much embracing, that only a little of each of the inner volutions is visible within the umbilici; sides of the volutions broadly convex, the inner half descending only slightly toward the umbilicus, at the border of which it is abruptly raised in the form of a narrow rounded ridge; the sides of the umbilicus descend perpen-

dicularly within until they reach the next preceding volution; periphery bearing a prominent, plain, hollow keel, which is constructed of shell substance, a layer of the same being between the small cavity of the keel and that of the body of the shell; and no trace of the keel appears upon specimens from which the shell substance has been removed; sides marked by moderately elevated, rounded ribs, which become obsolete upon reaching the raised umbilical border on the one hand and the peripheral keel on the other; they are slender and close together toward their thin inner ends, but are broader and farther apart toward their peripheral ends. From the raised umbilical border the ribs are directed obliquely forward in almost a straight line, and just before reaching the middle of the side of the volution they bend somewhat abruptly backward, and just before reaching the peripheral side they bend forward again by a nearly regular curve, and become obsolete upon the periphery. Septa complex, a plan of one of which is figured on Plate XIII, Fig. 5. Aperture and extent of the living chamber unknown. Diameter of the coil at the posterior end of the living chamber of the largest example in the collection, including the peripheral ridge, 93^{mm}; greatest diameter upon the same line, measured through the umbilical ridges, 23^{mm}.

The general aspect of this species is much like that of *A. Breweri* Gabb, from the Shasta group of California; but it differs in having a prominent peripheral keel, a narrower umbilicus, a raised umbilical border, and also in other details of form and structure.

The peripheral keel of this species is not crenulated, as it usually is in *Amaltheus*, and the septa are more complex; but in essential characters it agrees with the diagnosis of that genus as emended by Professor Zittel in his Handbuch der Paleontologie.

The specific name is given in honor of Mr. J. F. Whiteaves, paleontologist to the Geological Survey of Canada.

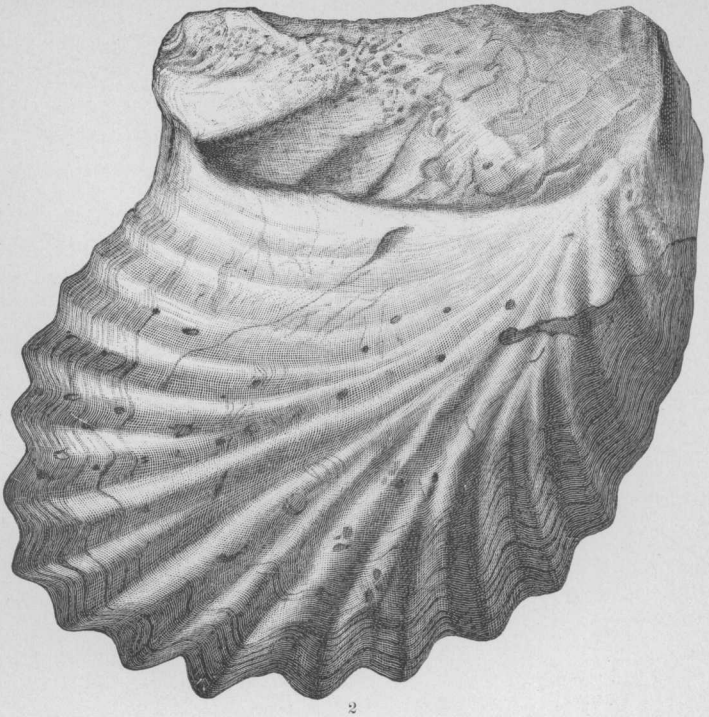
PLATES.

PLATE I.

PLATE I.

OSTREA DILLERI (page 14).

FIG. 1. Exterior view of a lower valve, natural size.
2. Exterior view of an upper valve.
For interior views of these specimens, see Pl. II.



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1

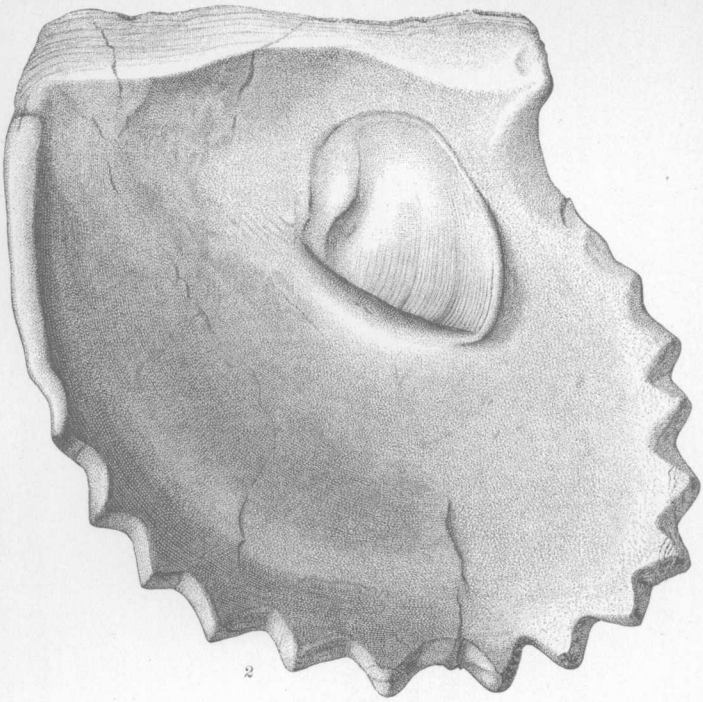
Ostrea Dilleri.

PLATE II.

PLATE II.

OSTREA DILLERI (page 14).

FIG. 1. Interior view of the specimen represented by Fig. 1, Pl. I.
2. A similar view of the specimen represented by Fig. 2, Pl. I.
For exterior views of these specimens, see Pl. I.



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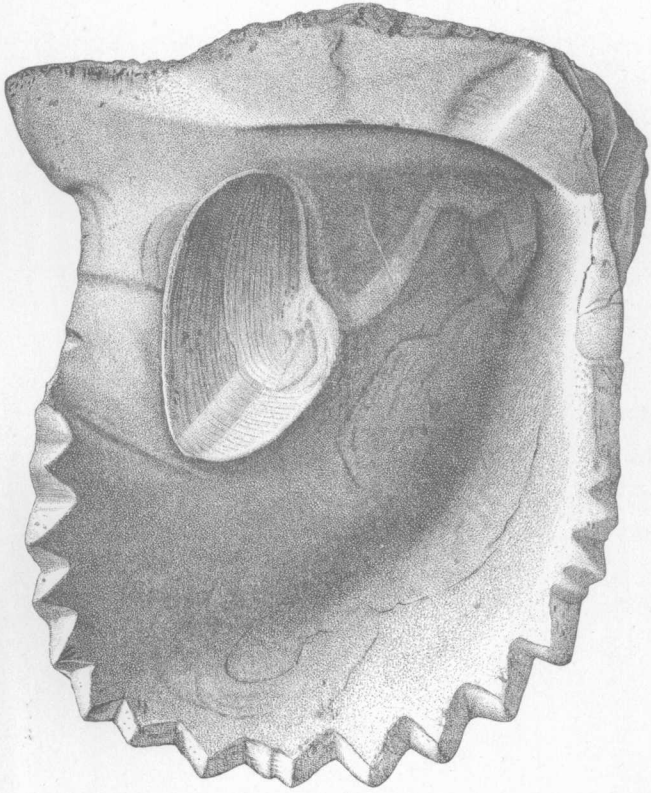

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Ostrea Dilleri.

PLATE III.

PLATE III.

FULGURARIA GABBI (page 23).

FIG. 1. Apertural view of a large example. Nearly the whole outline of the inner lip is obscured by adhering rock.

FULGUR HILGARDI (page 22).

2. Lateral view of an adult example.
3. Opposite view of the same example.

TROPHON CONDONI (page 21).

4. Lateral view of a medium-sized example.
5. Opposite view of the same example.

CANCELLARIA TURNERI (page 25).

6. Lateral view of an adult example.
7. Opposite view of the same example. The specimen has been much exfoliated, destroying the surface markings.

GYRODES DOWELLI (page 19).

8. Lateral view of an adult example.
9. Opposite view of the same example. The specimen has been slightly compressed obliquely.

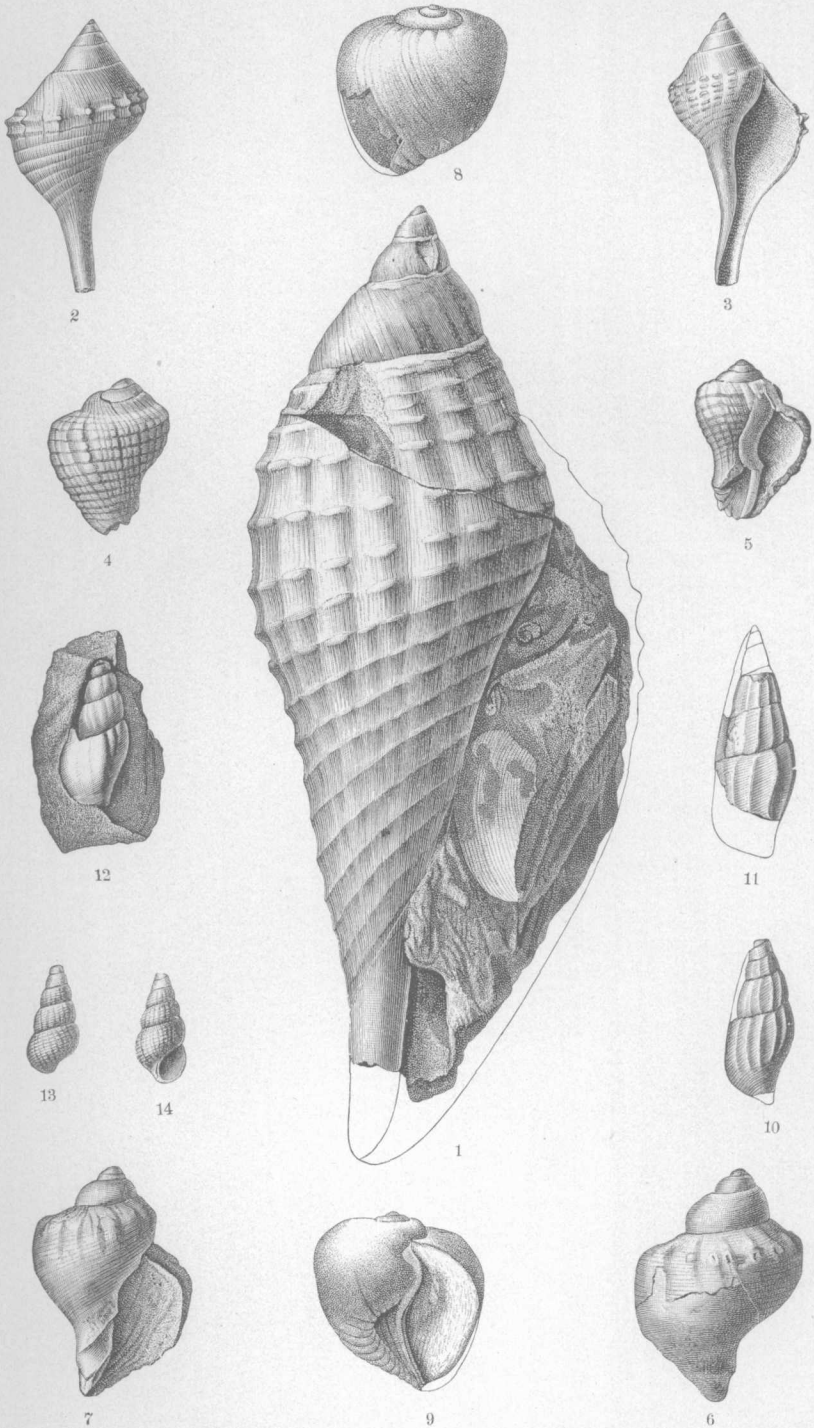
RIMELLA MACILENTA (page 19).

10. Lateral view of an example not quite mature.
11. A mature example, with outlines showing the shape of the outer lip and of the posterior canal.
12. A natural cast, showing a part of the posterior canal.

CERATIA NEXILIA (page 21).

13, 14. Opposite lateral views of a medium-sized example.

All the figures on this plate are of natural size.



1. Fulguraria Gabbi
2, 3. Fulgur Hilgardi.
4, 5. Trophon Condoni.
6, 7. Cancellaria Turneri.
8, 9. Gyrodes Dowelli.
10, 11, 12. Rimella macilenta.
13, 14. Ceratia nexilia.

PLATE IV.

PLATE IV.

SCOBINELLA DILLERI (page 25).

FIG. 1. Lateral view of an example having unusually strong surface markings.
2. A similar view of another example showing the notch of the outer lip.
3. An imperfect example showing the three strong columellar folds.
All natural size.

COMINELLA LECONTEI (page 22).

4. Lateral view of an adult example.
5. Opposite view of another example. Natural size.

MESALIA OBSUTA (page 20).

6. Lateral view of a somewhat slender example.
7. Opposite view of another example. Natural size.

TROCHUS (ANADEMA) GEMIFERUS (page 17).

8. Lateral view of a partially compressed example.
9. Basal view of the same example. Natural size.

STOMATIA OBSTRICTA (page 18).

10. Lateral view of a partially exfoliated example.
11. Opposite view of another example. Natural size.

FAUNUS MARCIDULUS (page 20).

12. Lateral view of the type specimen.
13. Opposite view of the same. Enlarged.

LYSIS OPPANSUS (page 17).

14. Lateral view of a natural cast, somewhat compressed.
15. Apical view of the same. Natural size.

ACTÆON INORNATUS (page 15).

16. Lateral view; enlarged.
17. Opposite view of the same, the columellar fold not shown.
18. Another example, the outer lip broken away, showing the fold.

VASCULUM OBLIQUUM (page 16).

19. Lateral view, the coil of the apex shown at *a*.
20. Posterior view of the same example.
21. Apical view of the same example. Natural size.

ZIRPHÆA PLANA (page 15).

22. Right valve. Natural size.

19

21

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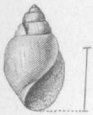

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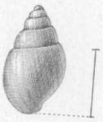

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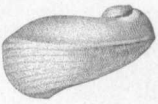

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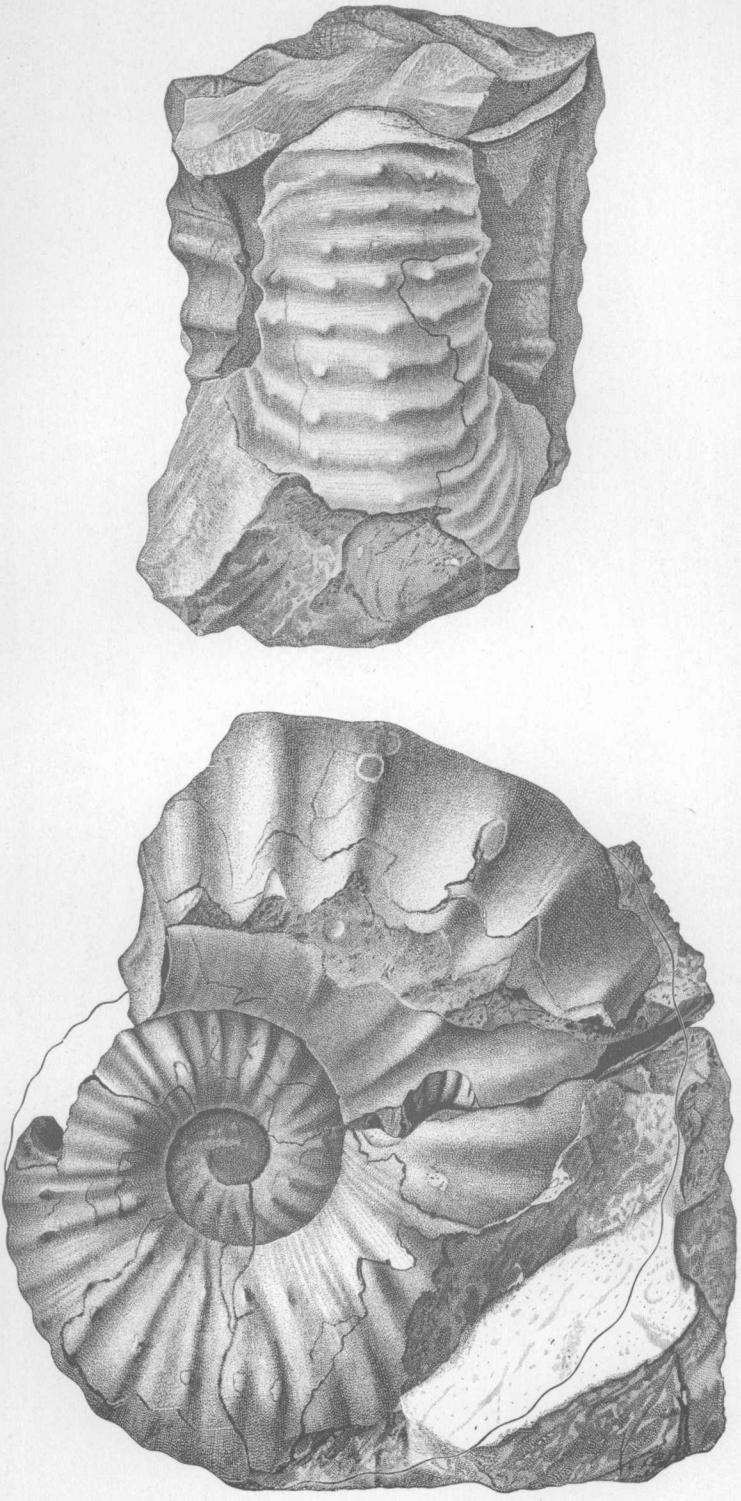
1–3. Scobinella Dilleri.
4, 5. Cominella LeContei.
6, 7. Mesalia obsuta.
8, 9. Trochus gemiferus.
10, 11. Stomatia obstricta.
12, 13. Faunus marcidulus.
14, 15. Lysis oppansus.
16, 17, 18. Actæon inornatus
19, 20, 21. Vasculum obliquum.
22. Zirpnæa plana.

PLATE V.

PLATE V.

AMMONITES TURNERI (page 26).

FIG. 1. Lateral view of the type specimen.
2. Peripheral view of the same. Natural size.



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Ammonites Turneri.

PLATE VI.

PLATE VI.

ANATINA SULCATINA? (page 43).

FIG. 1. Right side view of a large example.

CRASSATELLA TUSCANA (page 39).

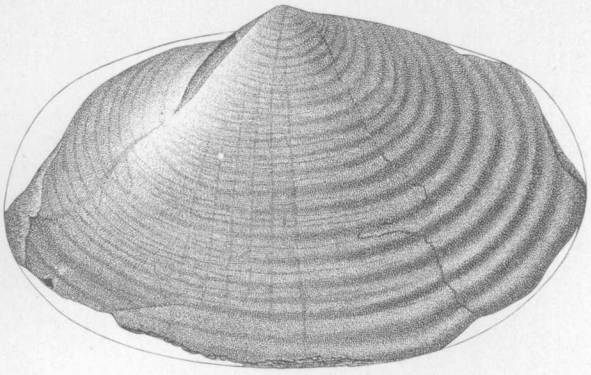
2. Left side view of a medium sized example.
3. Dorsal view of the same example.
4. View of the hinge of a right valve.

CLISOCOLUS DUBIUS (page 41).

5. Lateral view of an imperfect example.
6. Dorsal view of the same.
7. Front view of the same.

CLISOCOLUS CORDATUS (page 41).

8. Lateral view of an imperfect example of a left valve.
9. Front view of the same.



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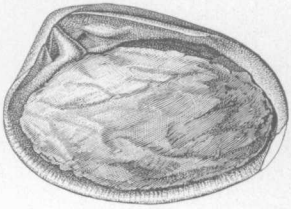

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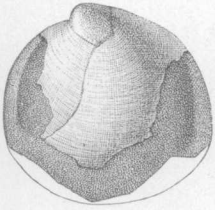

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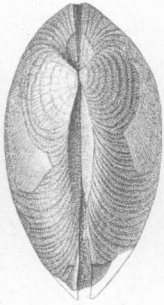

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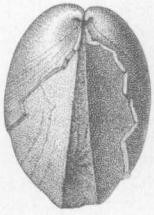


7

1. Anatina sulcatina. ?
2–4. Crassatella tuscana.

5–7. Clisocolus dubius.
8, 9. Clisocolus cordatus.

PLATE VII.

PLATE VII.

PERNA EXCAVATA (page 37).

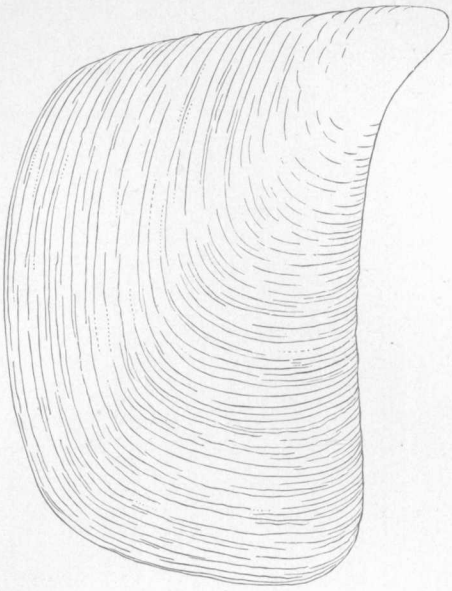
FIG. 1. Outline view of right valve. A restoration from numerous imperfect examples. Natural size.

AMMONITES MACLUREI (page 48).

2. Lateral view of a fragment.
3. Outline of a transverse section of the living chamber.
Both natural size.

VANIKOROPSIS SUCIENSIS (page 46).

4. Lateral view; enlarged.



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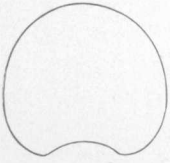

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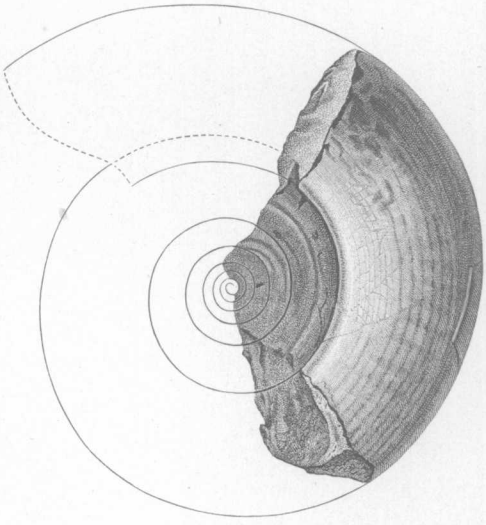

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1. Perna excavata.
2, 3. Ammonites Maclurei.

4. Vanikoropsis suciensis.

PLATE VIII.

PLATE VIII.

TEREDO PUGETENSIS (page 62).

A mass of petrified wood, showing the large borings. Natural size.

Teredo pugetensis.

PLATE IX.

PLATE IX.

BATISSA NEWBERRYI (page 60).

FIG. 1. Lateral view of a right valve.

2. Left side view of an imperfect specimen, the beak of the left valve being broken away, showing the broad cardinal teeth of the right valve.

3. A gutta-percha cast of the cardinal portion of the hinge of Fig. 2, showing the narrow teeth of the left valve.

All of natural size.

CARDIUM (ADACNA?)——? (page 58).

4. Lateral view of a natural cast. Natural size.

CERITHIUM?——? (page 58).

5. Lateral view. Natural size.

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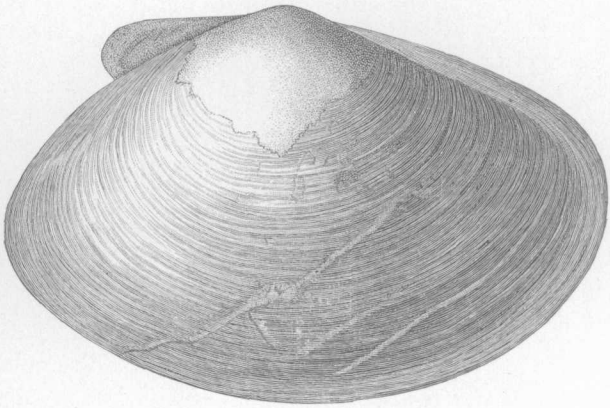

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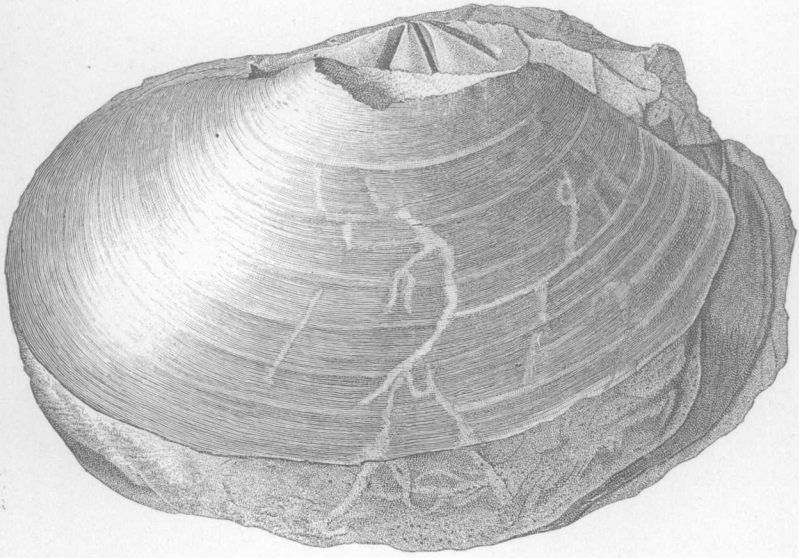


2

1–3. Batissa Newberryi.
4. Cardium (Adacna?) ——?
5. Cerithium? ——?

PLATE X.

PLATE X.

SANGUINOLARIA? CAUDATA (page 61).

FIG. 1. Right side view of an example, the posterior end of which is only slightly elongated.
2. An imperfect example, the posterior end being more elongated.
3. Another imperfect example, showing the posterior end greatly elongated.

PSAMMOBIA OBSCURA (page 61).

4. Left side view of an imperfect example.
5. Right side view of another imperfect example.
6. An imperfect natural cast, showing the pallial line and sinus and posterior muscular scar.

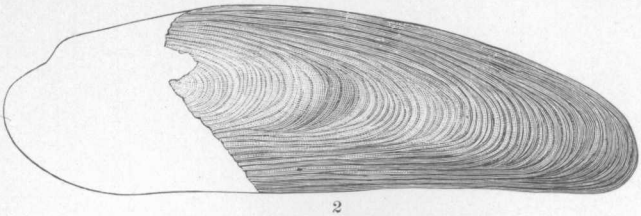
CYRENA BREVIDENS (page 58).

7. Lateral view of a right valve.
8. A similar view of another right valve.
9. A more elongate example; left valve.
10. An imperfect example, showing the hinge of the right valve and the pallial line.
11. A similar view of another example, showing the hinge of the left valve.

NERITINA ——? (page 62).

12. View of the upper side of a natural cast.

All figures on this plate are of natural size.



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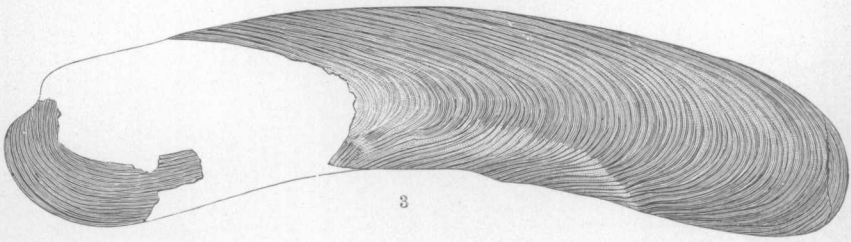

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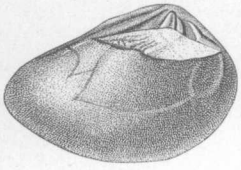

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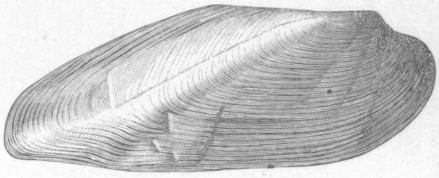

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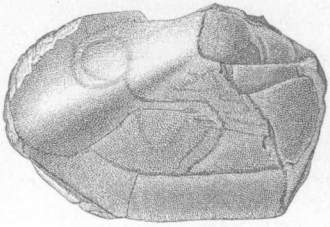

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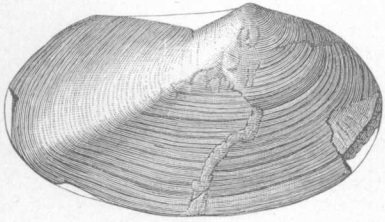

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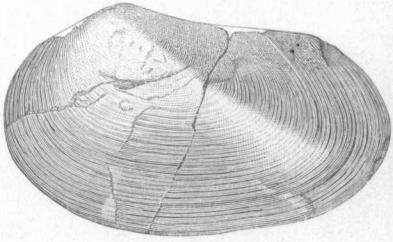


4

1–3. Sanguinolaria? caudata.
4–6. Psammobia obscura.

7–11. Cyrena brevidens.
12. Neritina ——— ?

PLATE XI.

PLATE XI.

BATISSA DUBIA (page 61).

FIG. 1. An imperfect natural cast.
2. A still more imperfect natural cast, but one which shows the large external ligament.

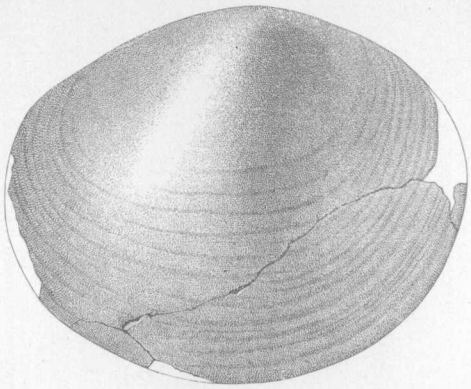
CORBICULA WILLISI (page 59).

3. A large left valve.
4. A smaller right valve.
5. A still smaller left valve.
6. An imperfect left valve, showing the cardinal and anterior lateral teeth.
7. A fragment of a right valve, showing the hinge nearly complete.

CORBICULA PUGETENSIS (page 60).

8. Lateral view of a right valve.

All the figures on this plate are of natural size.



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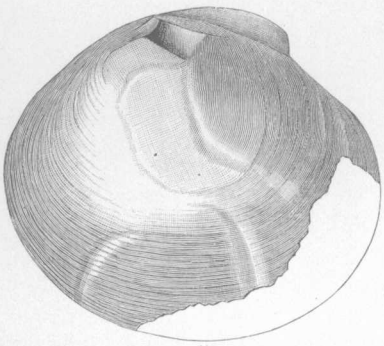

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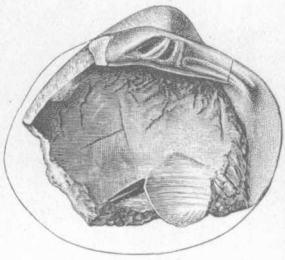

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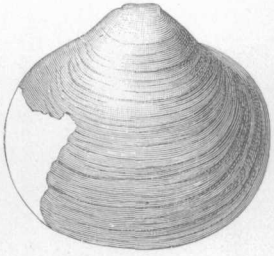

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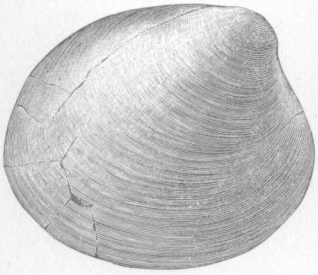

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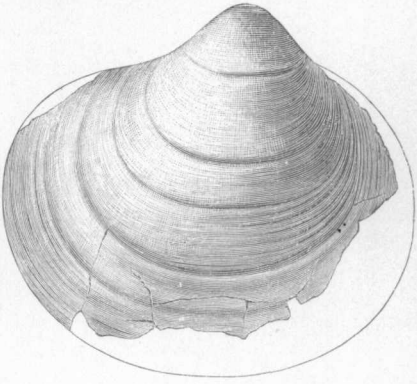


3

1, 2. Batissa dubia.
3–7. Corbicula Willisi.

8. Corbicula pugetensis.

PLATE XII.

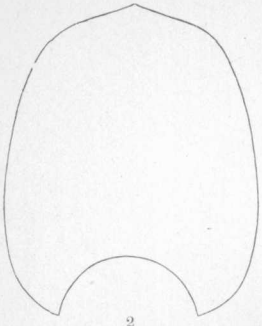
PLATE XII.

AMMONITES HOWELLI (page 68).

FIG. 1. Lateral view of a broken example. All that is shown of the outer volution belongs to the living chamber. Natural size.

2. Outline of a transverse section of the outer volution of Fig. 1. A similar outline of the inner volutions have a different shape, as is indicated by Fig. 2, Pl. XIV.

For other figures of this species, see Pl. XIV.



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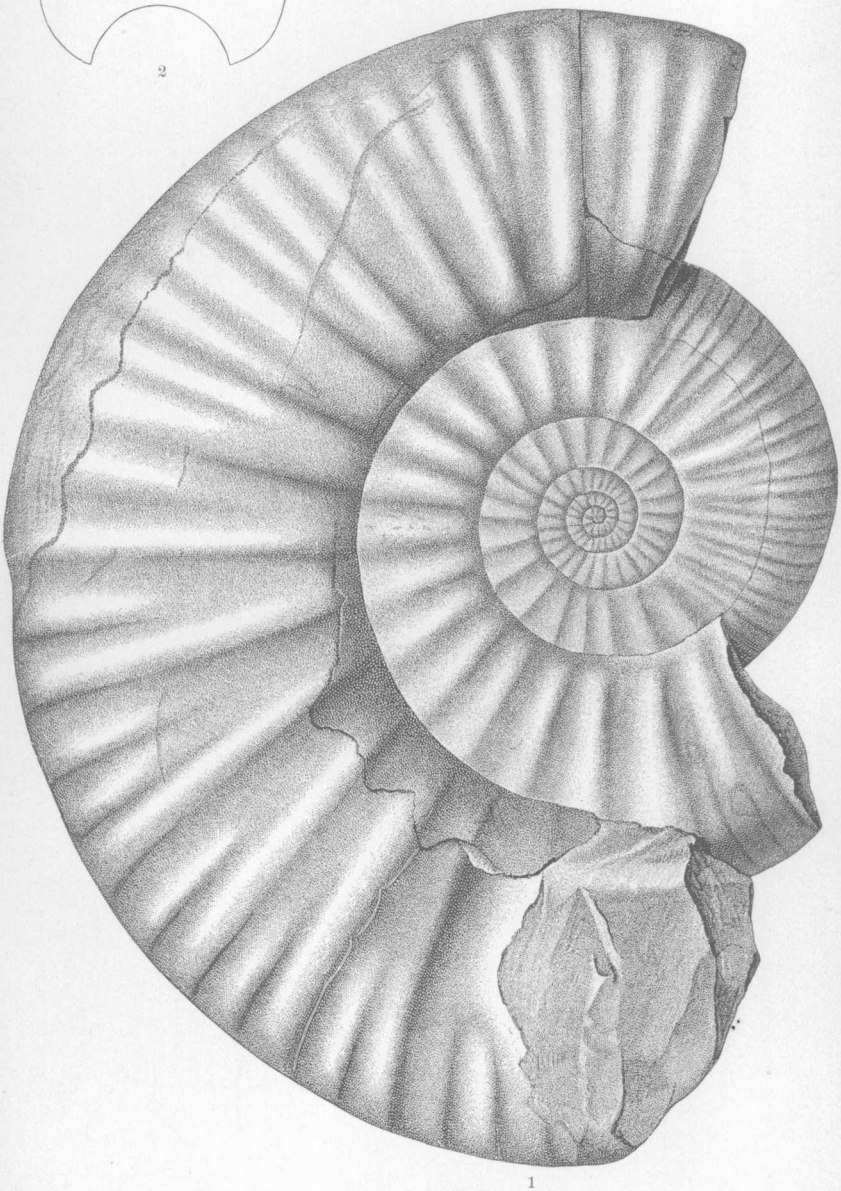

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1, 2. Ammonites Howelli.

PLATE XIII.

PLATE XIII.

AMMONITES WHITEAVESI (page 69).

Fig. 1. Lateral view of an example from which the living chamber has been all broken away.
2. Peripheral view of the same example in outline.
3. Diagram showing the hollow character of the peripheral keel.
4. Lateral view of a small example of this species.
5. Diagram of one of the septa of Fig. 4, enlarged.

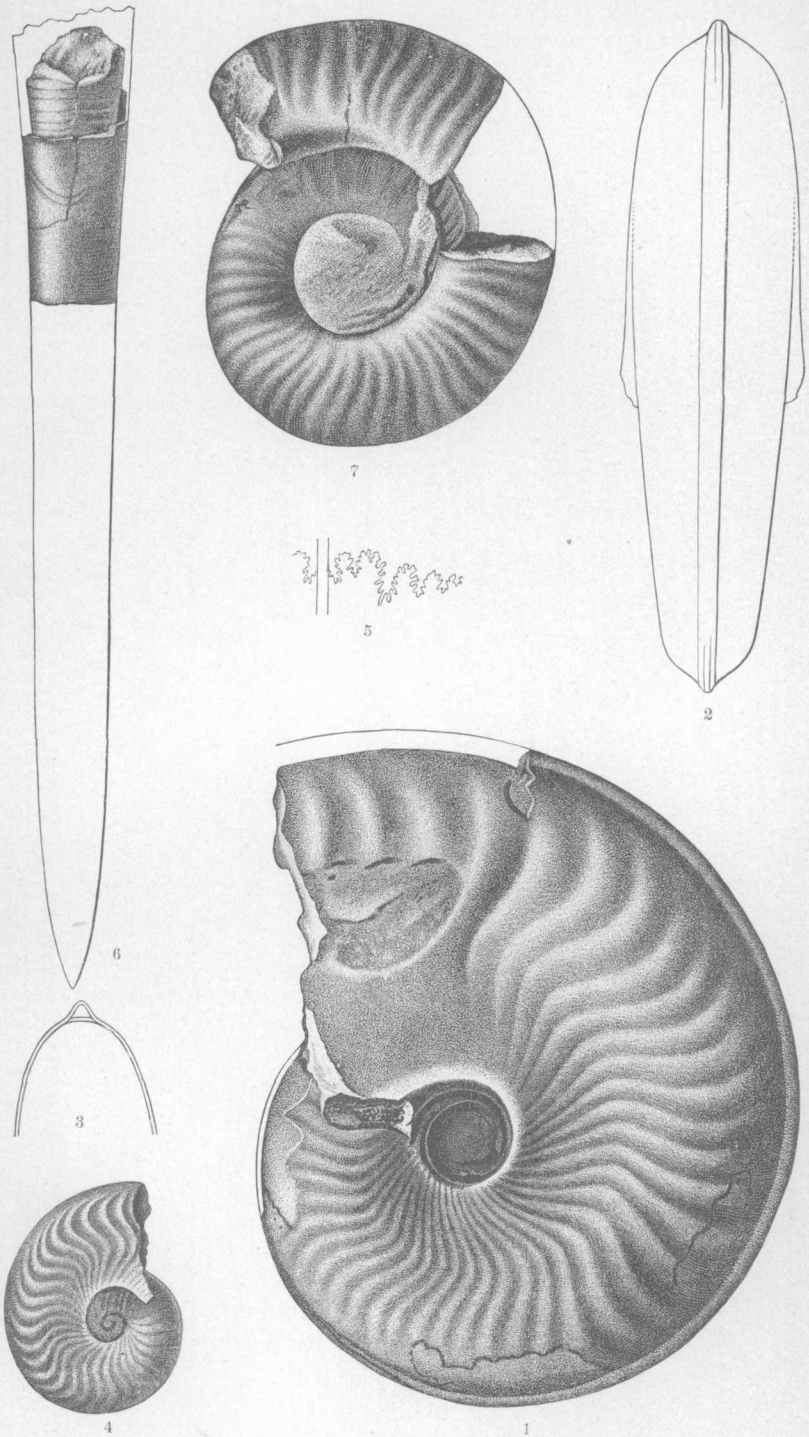
BELEMNITES ——? (page 67).

6. A fragment showing part of the phragmocone; and added outline showing the length of the shaft, as indicated by other fragments.

AMMONITES KIALAGVIKENSIS (page 69).

7. Lateral view of an imperfect example.

All the figures on this plate are of natural size, except Fig. 5.



1–5. Ammonites Whiteavesi.
6. Belemnites ———?

7. Ammonites kialagvikensis.

PLATE XIV.

PLATE XIV.

AMMONITES HOWELLI (page 68).

Fig. 1. Lateral view of an example showing only inner volutions.
2. An outline peripheral view of the same example.
3. Diagram of one of the septa of an example having about the size of Fig. 1; enlarged.

For other figures of this species, see Plate XII.

BELEMNITES ——? (page 67).

4. A fragment of a large phragmocone, which has been somewhat compressed.

CUCULLÆA INCREBESCENS (page 65).

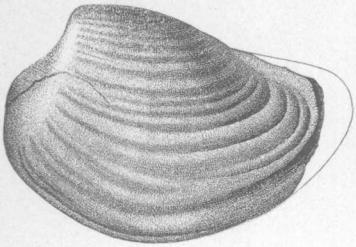
5. Lateral view of an imperfect left valve.
6. A front view of the same, with a diagram of the opposite valve, showing the great transverse depth of the valves.

GLYCYMERIS? DALLI (page 66).

7. Lateral view of a left valve.
8. A similar view of another left valve.
9. Right side view of a small example.

All the specimens are in the condition of natural casts.

All the figures on this plate are of natural size, except Fig. 3.



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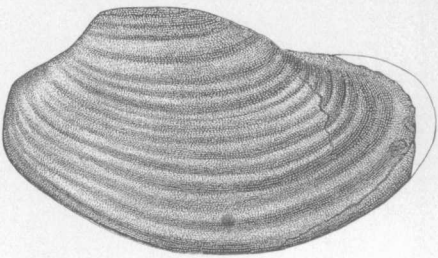

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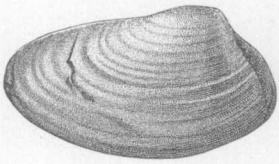

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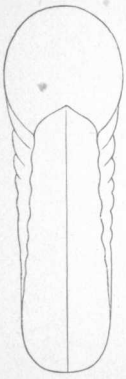

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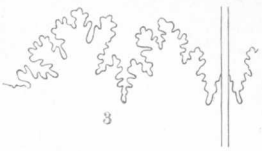

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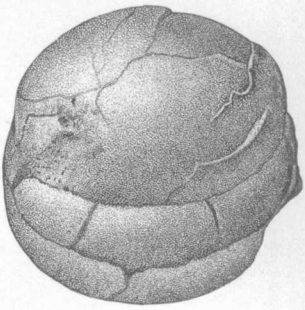

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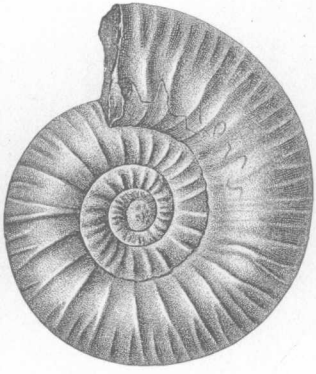

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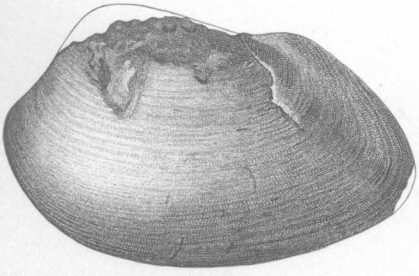

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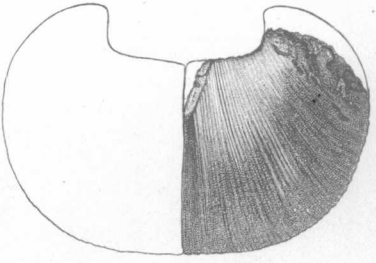

6

1–3. Ammonites Howelli.
4. Belemnites ——— ?

5, 6. Cucullæa increbescens.
7–9. Glycimeris ? Dalli.

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