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W. H. COLLINS, ACTING DIRECTOR

BULLETIN No. 63

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Contributions to Canadian Palæontology

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
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CONTENTS

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NEW SPECIES OF MARINE INVERTEBRATE FOSSILS FROM THE BEARPAW FORMATION OF SOUTHERN ALBERTA

By M. Y. Williams, University of British Columbia

Illustrations

INTRODUCTION

In a forthcoming memoir by W. S. Dyer and the writer of this article, the general geology of southern Alberta is dealt with; a chapter on stratigraphy includes lists of fossils found in the different formations of the region. Descriptions of new species of fossils have, however, been left for publication in this bulletin. The marine faunas, studied by the author, belong to the Pierre sea of Upper Cretaceous age. The marine formations represented are, from older to younger, Pakowki shale, Bearpaw shale, and a lower, marine shale division of the Fox Hills formation.

The author wishes to acknowledge his indebtedness to Dr. C. H. Crickmay, who made a preliminary study of the ammonites, and called attention to the new species herewith described. The ammonites were later studied in detail by Louis G. Millward, under the author's supervision, at the University of British Columbia.

Of twelve species of pelecypods from the Pakowki shale, thirty-four species from the Bearpaw shale, and thirty-one species from the Fox Hills formation, as identified by the author, only one new variety was discovered. It is described below.

Of the ammonites, one new species is described, one form is referred to a western rather than to an eastern species, and two species are referred to different genera from those in which they were originally placed. The account of the ammonites is taken, with modifications, from a thesis by Millward.

DESCRIPTIONS

Class, *PELECYPODA*

Order, **Teleodesmacea**

Veniella subtrapeziformis (Whiteaves) var. *dyeri* var. nov.

Plate II, figures 4-7

Small, sub-trigonal, gibbous, especially below and backward from the umbo, from which a rounded slope extends to the posterior basal extremity.

Beaks prominent, incurved, directed anteriorly, and overhanging the anterior dorsal margin. Basal margin gently arcuate, posterior dorsal margin strongly curved to the short hinge-line.

Shell thin, smooth closed, marked by varying lines of growth; lunule absent, escutcheon short and narrow.

Pallial line entire, muscular scars as in *Arctica* but not well defined in the specimens studied.

Teeth, as seen in sectioned specimens, consist of 3 cardinals and one lateral in each valve, generally similar to those of the *V. conradi* (Morton).

This form corresponds in general characters with *"Cyprina" subtrapeziformis* Whiteaves[1]. Whiteaves did not see the hinge of his species and placed it doubtfully in "Cyprina" stating that it might belong instead to *Cypricardia* or *Veniella.*

V. subtrapeziformis var. *dyeri* differs from Whiteaves' form in being smaller, more gibbous, having more overarching beaks and a more arcuate basal margin. The following measurements illustrate the differences.

Measurements in mm.	Whiteaves' species	Typical specimens of new variety				
		1	2	3	4	5
Height	15	12	14	13	13	14
Breadth at umbo	10	11	12	11	11·7	12
Length	23·5	16	17	16	17	18

Variety *dyeri* appears to belong to Stoliczka's genus *Veniella,* but differs from the general form in lacking a lunule. Its subquadrate or sub-trigonal shape separates it from *Arctica.* Within the genus *Veniella,* it is somewhat similar to *V. subtumida* Meek and Hayden, from the Fox Hills and Fort Pierre groups of Yellowstone river, but differs from that species in somewhat smaller size and less rounded and prominent posterior umbonal shape. The depression in front of the slope in *subtumida* is entirely lacking in internal casts of the present species, which have been used in comparison with the figures of internal casts of *subtumida* in United States Geol. Survey of the Territories, vol. IX, Pl. 17, figs. 5a, b.

Occurrence. In the *Baculites compressus* zone 450 feet above the base of the Bearpaw formation, as exposed on Gap creek, sec. 24, tp. 9, range 27, W. 3rd mer. Collector, W. S. Dyer. Two lots of fossils, one marked SW. ¼ sec. 24; the other marked sec. 24, presumably came from nearly the same place. Together they contain upwards of eighty separate specimens, in fair state of preservation, and several pieces of rock packed full of specimens. Strangely enough the form has not been noted elsewhere in the region.

With this species are found *Chlamys nebrascensis* M. and H., *Baculites compressus* Say, and *Dentalium gracile* H. and M.

[1]Geol. Surv., Canada, Cont. to Can. Pal., vol. I, p. 29, Pl. XXIV, figs. 2, 2a, 2b.

Class, *CEPHALOPODA*

Sub-class, TETRABRANCHIATA

Order, Ammonoidea

Ammonites were collected from the three formations laid down in the western Canadian extension of the Pierre sea. These formations are, from oldest to youngest, the Pakowki shale (=Claggett of United States), the Bearpaw shale, and the lower marine shale member of the Fox Hills "sandstone" formation. The species found are listed below.

Species	Pakowki shale	Lower beds, Bearpaw	Upper beds, Bearpaw	Lower Fox Hills shale
Baculites compressus Say	?	x	x	?
Baculites grandis H. and M.	.....	.....	x	
Baculites crickmayi n.s.	.....	.....	x	
Placenticeras intercalare Meek	.....	x	x	
Placenticeras meeki Boehm	.....	x	x	x
Rhaeboceras halli Meek	.....	.....	x	
Acanthoscaphites nodosus (Owen) var. *brevis* Meek	.....	?	x	x

Baculites compressus probably occurs in the Pakowki shale as reported by Dowling[1]. *B. asper* Morton has not been recognized, however, nor has *B. ovatus* Say.

Baculites crickmayi n.sp.

Plate I, figure 1; Plate II, figures 1, 2, 3

Fossil in the form of an internal cast. Elongated; of fairly large size, and rather rapidly tapering compared with other *Baculites*. Cross-section ovate, tapering toward the siphonal side. Surface of cast marked by broad, rounded, arcuate undulations, which commence at the dorsal and pass obliquely down and backward in a broad curve, terminating abruptly on the ventral-lateral region.

Septa not crowded, lobes and sinuses deep and divided into somewhat divergent, digitate branches. Siphonal lobe about as long as wide and provided with two terminal, more or less spreading, branches, each of which has generally three, but in some cases two, nearly equal, digitate branchlets at the end, and two similar lateral ones on the outer side. First lateral saddle two-thirds as wide as long, much narrower than the siphonal lobe, and divided at the anterior end into two nearly equal branches each of which is subdivided into three or four spreading, digitate branchlets. First lateral lobe nearly twice as long as wide, and divided at its end into two nearly equal parts, each with three spreading and digitate subdivisions. Second lateral saddle very similar in branches and subdivisions to the first and only a little larger in size. Second lateral lobe about as broad, but shorter than the first, and bearing two large, equal,

[1]Geol. Surv., Canada, Mem. 93, "Southern Plains of Alberta", p. 47.

bipartite, digitate terminal branches, and small digitate and simple lateral branches. Third lateral saddle much smaller than either of the others, with two unequal, short, digitate terminal divisions, and a few short, irregular, smaller lateral branchlets. Dorsal or antisiphonal lobe very small, much longer than wide, with one or two small lateral branches, and a trifid extremity.

As there are only two incomplete specimens, exact measurements cannot be obtained, but the larger specimen in hand has a greater diameter of 46 mm. and a lesser diameter of 36 mm. From the average taper of the cast the original shell must have been over 700 mm. in length when complete.

In cross-section the specimen rather resembles the broad variety of *B. ovatus* figured by Meek[1], but it differs from that species in the well-marked ridges on the shell and by the much more regular suture with its deeper lobes and saddles. Indeed the suture is much more deeply incised than any of those figured in the publications available to the author. The ornamentation resembles that of *B. aquilaensis*, but it differs in the cross-section and suture.

The smaller specimen shows that these sutural characters are distinct from near the larval condition. The lip of the living chamber is, apparently, like that of *Baculites compressus*.

The specimen does not resemble any previously described *Baculites* even closely enough to be referred to it as a variety. Its closest relatives appear to be *B. ovatus* and *B. compressus*, being as much like one as the other. For these reasons the author feels justified in referring it to a new species.

To designate this species the writer proposes the name *Baculites crickmayi*, after Dr. Colin H. Crickmay, who first examined the collection.

Occurrences. (1) Mid-line, between SE. and SW. $\frac{1}{4}$ sec. 25, lot 9, range 6, W. 4th mer. (2) Coulée, west of road $3\frac{3}{4}$ miles south of Irvine, Alberta. Collector, W. S. Dyer.

Genus, *Rhaeboceras* Meek[2]

Meek described the only known species of this genus as *Phylloceras ? halli*, expressing a strong doubt regarding its position in Suess' genus which was founded on Jurassic forms. Continuing, Meek cites the following variations from the generic characters of *Phylloceras* Suess:

"Its septa differ in some details, such, for instance, as the proportionally smaller size of its first lateral lobe as compared with the siphonal lobe, and the more nearly bipartite termination of the former: also in the less obtusely-rounded terminations of the subdivisions of the lateral sinuses."

Of a large distorted specimen he says:

"I am strongly impressed with the belief that its outer volution naturally made two deflexions from the regular curve of those within." . . . . . "This deflexion, or departure, from the regular curve, makes the outer volution much less deeply embracing than the inner, and the umbilicus consequently much larger proportionally in the adult, than in the young and medium-sized specimens."

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[1]U.S. Geol. Surv., Terr., vol. IX, Pl. 20.

[2]Meek, F. B.: U.S. Geol. Surv., Terr., vol. IX, pp. 458-462 (1876).

In conclusion Meek says:

"Should complete undistorted specimens show as I think very probably will be the case, that it differs generically or subgenerically from *Phylloceras* proper, I would propose for the group into which it would in that case naturally fall, the name *Rhaeboceras*."

Rhaeboceras halli Meek

Ammonites halli

F. B. Meek and F. V. Hayden: Acad. Nat. Sci., Phil. Proc., vol. VIII (1856), p. 7; vol. XII (1860), p. 420.

F. B. Meek: Smith. Check-List of North American Cret. Fossils (1864), p. 24, Fig. 64.

Phylloceras ? halli

F. B. Meek: U.S. Geol. Surv., Terr., vol. IX (1876), pp. 458-462, Pl. 24, figs. 3a, b, c.

Description from Meek:

"Shell attaining a large size, moderately compressed discoidal; volutions with their convexity about equalling two-thirds their diameter from the ventral side to the rather narrowly rounded periphery, in young and medium sized examples, each embracing nearly the entire breadth of the next within, but the last one in the adult becoming proportionally less deeply embracing; umbilicus very narrow, and rather deep in the young but proportionally wider in the adult; surface ornamented with numerous small bifurcating, slightly flexuous costæ, that are larger near the umbilical side, and on the last turn of medium and large sized specimens become proportionally somewhat more prominent, more curved, and suddenly bifurcate near the umbilicus, and again divide and subdivide into numerous smaller ones, so that their number, including others intercalated between, amounts to from five to seven times as many where they pass straightly over the periphery, as near the umbilical side; body-chamber forming at least the entire outer volution.

Locality and Position. One hundred and fifty miles above the mouth of Milk river, on the Missouri, in Montana territory; from the Fort Pierre group of the Upper Missouri Cretaceous series."

Two specimens are found in the present collection, one being only 15 mm. in diameter and probably far from complete, and the other 11 cm. across and possessing more than 6 cm. of living chamber, measured along its central axis. This larger specimen is well preserved, and has been dissected so as to show surface markings, suture lines, umbilicus, etc., of both young and old stages of development. The two flexures of curvature are well shown, one occurring at the last septum and the other about 4 cm. back along the periphery. The expansion of the umbilicus is also well shown.

Thus in an undistorted specimen, the characters which Meek noted as separating this form from the genus *Phylloceras* are verified. Crickmay concluded after examining this specimen that *Rhaeboceras* was established as a separate genus, which is not related to *Phylloceras* as Meek supposed, but is probably descended from the *Hoplitidae*.

Occurrences. In the *Baculites compressus* zone of the Bearpaw formation, on the south branch of Box Elder creek, sec. 30, lot 10, range 29, W. 3rd mer. (Sask.). Collector, W. S. Dyer.

Family, PLACENTICEPATIDAE

Genus, *Placenticeras* Meek

Placenticeras meeki J. Boehm

Placenticeras placenta (deKay) (part.)

F. B. Meek: U.S. Geol. Surv., Terr., vol. IX (1876), pp. 465-468, Pl. 24, fig. 2.

Geol. Surv., Canada, numerous reports on western Great Plains.

Placenticeras meeki J. Boehm

J. Boehm: Deutsche Geol. Gesell. Zeitsche., vol. L (1898), p. 200 (footnote).

J. B. Reeside, jun.: U.S. Geol. Surv., Prof. Paper 151 (1927), pp. 29-30, Pl. 22, figs. 5-7; Pls. 23-24; Pl. 25, figs. 1-2.

Placenticeras whitfieldi Hyatt

A. Hyatt: U.S. Geol. Surv., Mon. 44, pp. 221-232, Pl. 45, figs. 3-16; Pl. 46; Pl. 47, figs. 1-4 (1903).

A. W. Grabau and H. W. Shimer: North American Index Fossils, vol. II (1910), p. 218, figs. 1493-1494.

In some specimens, on being broken down, lines of tubercles may be seen on the young shell. These are all small and are generally absent on the larger volutions. Hyatt, in one place[1] regards them as merely individual reversions to the primitive type, but in the specific description[2] refers them to a variety *"tuberculatum"*, stating them to be intermediate between this species and *P. intercalare.*

The species can be distinguished from *P. placenta* of the Atlantic Cretaceous by certain characters which, however, can be observed only in comparing the two species. The venter is narrower throughout life and becomes less completely rounded in the gerontic stage. This rounding also comes at a much larger size than in *P. placenta.* Tubercles are lacking in the typical forms, but when present are small, whereas those of *P. placenta* are large and elongated, much coarser, and less numerous. The suture is also more complex and sinuous than that of the eastern form.

Of the specimens preserved in the Bearpaw collection, the largest specimen, when complete, had a greater diameter of 365 mm. and a width of 75 mm.

Occurrences. (1) East side of Oldman river, sec. 20, tp. 8, range 22, W. 4th mer. (2) Immediately north of the old Canadian Pacific Railway bridge over St. Mary river. Fox Hills, lower shale—Cypress lake. Collector, M. Y. Williams.

(3) Coulée, west of road $3\frac{3}{4}$ miles south of Irvine, Alberta. (4) Sec. 22, lot 9, range 23, W. 4th mer., Oldman river. (5) Sec. 1, lot 11, range 3, W. 4th mer., Ross creek. (6) Mid-line between SE. and SW. $\frac{1}{4}$ sec. 25, lot 9, range 6, W. 4th mer. Collector, W. S. Dyer.

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[1]Hyatt, A.: U.S. Geol. Surv., Mon. 44, p. 190 (1903).

[2]Hyatt, A.: U.S. Geol. Surv., Mon. 44, pp. 211, 232 (1903).

NEW SPECIES OF INVERTEBRATE FOSSILS FROM THE NON-MARINE FORMATIONS OF SOUTHERN ALBERTA

By W. S. Dyer, Department of Mines, Toronto

Illustrations

The invertebrate fossils of the non-marine formations of southern Alberta will be listed and commented upon by the writer in a forthcoming memoir by Williams and the present writer, on the geology of southern Alberta and southwestern Saskatchewan. The non-marine formations include the Belly River, Edmonton, and St. Mary River of Upper Cretaceous age; the Paskapoo, Willow Creek, and Porcupine Hills of Eocene age; and the Ravenscrag, probably also of Eocene age. In this paper, which should be regarded as complementary to the memoir, the new species and varieties are described and figured. The writer is indebted to Frank H. McLearn of the Geological Survey, Canada, for advice and assistance during the progress of the work, and to Dr. T. W. Stanton of the United States Geological Survey for allowing free access to the extensive fossil collections in the United States National Museum in Washington.

PELECYPODA

Unio subprimaevis sp. nov.

Plate III, figure 2

This form is similar to *U. primaevis* White in possessing peculiar, posterior, radiating ridges; it also has anterior, radiating ridges of the same order. These ridges are not mentioned in White's description of the type of *U. primaevis*, but are present on forms referred to it in the United States National Museum in Washington. *U. subprimaevis* also has the umbonal ridge characteristic of *U. primaevis* and the furrow in front of it. The new species differs from White's form in being considerably smaller, and in having the umbonal ridge less prominent and the furrow correspondingly more shallow.

Dimensions of Type. Length, 26 mm.; height, 14 mm.

Horizon and Locality of Type. Foremost beds, South Saskatchewan river one mile below the mouth of Bow river.

Unio mclearni sp. nov.

Plate III, figure 15

Several specimens of a highly ornamental *Unio* were collected from the Foremost beds on South Saskatchewan river. They are similar to *Unio holmesianus* White, redescribed and figured by Stanton[1], but differ

[1]Stanton, T. W.: U.S. Geol. Surv., Prof. Paper 98.

in several details of ornamentation. The new species lacks the short, transverse ridges which in *U. holmesianus* are "nearly at right angles to the lines on the front of the shell". It also lacks the thread-like, raised lines which in White's species run from the beak down the crest of the umbonal ridge. In *U. mclearni* the V-shaped sinuses of ornamentation reach to the beak and are not preceded by the sharp, slightly undulating, concentric ridges nearly parallel with the growth lines. Still another difference is that in *U. holmesianus* the apex of the deepest sinus of ornamentation is in the broad umbonal furrow, whereas in the new species it lies in front of the furrow.

Dimensions of Type (a slightly distorted form). Length, 34 mm.; height, 29 mm.; thickness, about 22 mm.

Unio humei sp. nov.

Plate IV, figures 1 and 4

In the collections made by T. C. Weston in 1888 from Fossil coulée (about secs. 7 and 8, tp. 4, range 19, W. 4th mer.) there are certain specimens of *Unio* which in form resemble the marine shell *Arctica ovata.*

The shell is transversely ovate, moderately convex, and the valves quite thick; the anterior extremity evenly rounded, but the posterior extremity narrowly rounded; basal margin semi-oval; the posterior dorsal part of the type is partly broken away, but other specimens show it to be gently convex, the anterior dorsal margin is somewhat more abruptly rounded; beaks moderately elevated and located midway in the anterior third of the shell. Internally the shell is quite thick and heavy; the lateral teeth have not been seen and the smaller of the cardinal teeth is not well preserved; the cardinal tooth which is preserved is large.

It is rather close to the form, referred doubtfully to *Unio pyramidatoides* by Stanton[1], from the Fruitland formation of New Mexico, but is longer in proportion to height and the posterior margin is not truncated.

Dimensions of Type. Length, 78 mm.; height, 64 mm.

Horizon and Locality of Type. Pale beds; Fossil coulée (about sec. 17, tp. 4, range 19, W. 4th mer.).

GASTEROPODA

Viviparus crickmayi sp. nov.

Plate III, figure 3

This species differs from *V. tasgina,* the most closely related form, chiefly in the greater prominence of the shoulder on the upper part of the whorl.

The lower two-thirds of the body whorl is evenly rounded, but on its upper part there is a shallow, revolving depression surmounted by a moderately prominent, rounded ridge. Above the ridge the outline of the whorl turns in abruptly almost at right angles to the axis of the shell to form the shoulder. In many cases the shoulder is 3 mm. wide. It is usually quite flat, but occasionally slightly concave. Proceeding toward

[1]Stanton, T. W.: U.S. Geol. Surv., Prof. Paper 98, p. 309 et seq. (1916).

the apex of the shell the ridge and the shoulder become less prominent and the angle between the shoulder and the axis acute as in *V. tasgina*. Finally, near the apex, the ridge and the shoulder fade out entirely. The character of the apex and the first few whorls leaves no doubt of the close relationship of the species with *V. nidaga*. The apex is obtuse and the first few whorls are quite angular at the base.

Horizon and Locality. It occurs abundantly at one locality in the Willow Creek formation on Willow creek, i.e., centre of sec. 12, tp. 10, range 27, W. 4th mer. All the specimens at this locality were from a drift flock, but judging from the conditions in the field the writer believes that it could not have travelled far from its original position. A few specimens were also found in the Edmonton formation on Bow river.

Dimensions of Type. Length, 27 mm.; width, 20 mm.; apical angle, 55 degrees.

Viviparus nidaga sp. nov.

Plate III, figure 1

Some of the forms which Meek[1] regarded as *V. conradi* depart rather widely from the typical form of the species. They are larger, more elongate, and have more rounded whorls. It is possible that they are simply specimens more advanced in size or age as Meek suggests, but they approach *V. nidaga*, a new species from the Belly River formation, rather closely. In Alberta specimens have been found which definitely link the two species. The more typical form of *V. conradi* is represented by Meek's figures 15a and 15b, and the divergent form by figures 15c and 15d. *V. conradi* is rare in the Pale beds, but more common in the Foremost member of the Belly River formation.

Viviparus nidaga differs from *V. conradi*, the only species from the Belly River formation for which it might be mistaken, in the greater convexity of the whorls, in the absence of the angle at the base of the body whorl, and in the more elongate shape of the shell. The spiral whorls of the new species, however, are angular at the base. Certain species are clearly intermediate between *V. conradi* and *V. nidaga*, leaving no doubt of the close relationship of the two species.

V. nidaga is close to *V. leai*, which occurs in several post-Bearpaw formations, differing chiefly in being larger and more slender in shape and in having more angular spiral whorls. It is rare in the Pale beds and in the Foremost member of the Belly River formation. The specific name means "prairie chicken" in Sarcee Indian.

Dimensions of Type. Length, 27 mm.; breadth, 22 mm.; apical angle, 60 degrees.

Several well-preserved specimens of *Viviparus prudentius* White[2] were collected on Pincher creek by Weston in 1883, and by Dawson from Gooseberry canyon, St. Mary river, in 1881. Both localities are in the St. Mary River formation. *V. prudentius* also occurs in the Willow Creek and Paskapoo formations. This species is the culmination of the *V. nidaga-V. leai-V. prudentius* line of development, in which is shown a progressive rounding of the whorls and flattening of the spire.

[1]Meek: U.S. Geol. Surv., vol. 9, p. 579, Pl. 42, figs. 15a, b, c, d (1876).
[2]U.S. Geol. Surv., 3rd Ann. Rept., p. 467, Pl. 25, figs. 17, 18 (1883).

Viviparus tasgina sp. nov.

Plate III, figure 5

This species is midway in development between *V. nidaga* of the Belly River formation and *V. crickmayi* of the Willow Creek and Edmonton formations. This is well shown in the character of the shoulder on the upper part of the whorls. This shoulder, which is lacking in *V. nidaga*, is always present in *V. tasgina*, but never so well defined as in *V. crickmayi*. The three species are similar in the general shape of the shell and in the character of the apex and spiral whorls.

V. tasgina sometimes attains large sizes, the largest specimen found measuring 51 mm. in length, and others reach lengths of 33 and 40 mm. The increase of the apical angle with age, which was seen many times during the course of the present study, is excellently illustrated by *V. tasgina*, and it was noticed that the coarseness of the growth lines also increased with age. In the larger specimens there is a tendency for the whorl above the body whorl to be more elongated in the general direction of the axis of the shell than the younger specimens.

The species is rather rare in the Edmonton formation and one specimen from the St. Mary River formation was doubtfully referred to it. The specific name means "policeman" in Sarcee Indian.

Dimensions of Type. Length, 51 mm.; breadth, 42 mm.; apical angle, 53 degrees.

Campeloma vetula tenuis var. nov.

Plate III, figure 4

The forms found in Alberta referable to *Campeloma vetula* Meek[1] are highly variable, ranging from short, stout forms with apical angles of 50 degrees to forms with elevated spires and apical angles of 30 degrees. They are abundant in the Foremost member of the Belly River formation. The more slender forms have been separated in the paper under a new varietal name *C. tenuis*. Several of the specimens show distinctly the revolving striæ characteristic of *C. multilineata* and there is no doubt that the two species are very closely related. These striæ are very often present on the upper and lower parts of the whorl, but absent from the middle of the whorl. Occasionally, however, they are present over the whole whorl. The forms identified as *C. multilineata* by Whiteaves from the Belly River formation should be referred to this species.

It was found on examining the collection of *C. vetula* in the museum of the Geological Survey in Washington that the forms were stouter than the major part of the Canadian individuals. These latter slender forms have hence been separated, but as a new variety.

By a gradual flattening of the whorls and by the gradual appearance of an angulation at the base of the body whorl, *C. vetula tenuis* passes into *C. praecursa*.

Dimensions of Type. Length, 18 mm.; width, 11 mm.; apical angle, 47 degrees.

[1]Meek: U.S. Geol. Surv., Terr., vol. 9, p. 578, Pl. 42, figs. 14a, b (1876).

Horizon and Locality of Type. Foremost beds of the Belly River formation; northwest of centre of sec. 1, tp. 3, range 12, W. 4th mer., southern Alberta.

Campeloma praecursa sp. nov.

Plate III, figure 6

Shell of moderate size, conical in outline; the volutions, which number five or six in those specimens having the apex preserved, flat-sided; body whorl slightly angulated at the base; surface marked by fine lines of growth, which in a few specimens are crossed by obscure revolving striæ, suture very slightly impressed; aperture narrow, ovate; apparently imperforate.

This species is distinguished from *C. vetula tenuis* by the flatness of the whorls, and, in consequence, the conical outline of the shell. It is quite similar to *C. producta*, but differs in the flatness of the whorls, there being no hint of a revolving ridge as in that species. *C. praecursa* is the forerunner of *C. producta* and allied species so common in the post-Bearpaw formations, just as *C. vetula* is the forerunner of *C. multilineata.*

It has been found in both the Pale beds and Foremost members of the Belly River formation, but is more abundant in the lower member.

Dimensions of Type. Length (one whorl missing), 18 mm.; breadth, 10 mm.; apical angle, 35 degrees.

Campeloma cypressensis sp. nov.

Plate III, figure 7

This species has developed directly from *C. producta*, there being many specimens intermediate in form between the two. *C. cypressensis* is distinguished by the very prominent shoulder in the upper part of the body whorl; this shoulder is so prominent in some specimens as to form a swollen ring which is much the widest part of the shell. The body whorl is much more robust porportionately than in *C. producta*, as a consequence of which the apical angle becomes considerably larger. The most extreme specimen measured 18 mm. in length and had an apical angle of 70 degrees. It occurs only in the Ravenscrag formation in Cypress hills in sec. 29, tp. 8, range 4, W. 4th mer.

Dimensions of Type. Length, 14 mm.; breadth, 11 mm.; apical angle, 70 degrees.

Goniobasis subtortuosa mut. *tenuis* n. mut.

Plate III, figures 9, 10

The remains of a gasteropod species closely resembling *G. subtortuosa* of the Foremost beds was found in the Willow Creek formation in the bed of Willow creek a few miles west of the village of Granum (sec. 12, tp. 16, range 27, W. 4th mer.). The Willow Creek form, however, differs in being somewhat thicker shelled, more slender, and in having coarser growth lines. Owing to these differences and to its much higher geological horizon, it is herein regarded as a mutation of *G. subtortuosa.*

Dimensions of Type. Length, 12 mm.; breadth, 7 mm.; apical angle, 40 degrees.

Goniobasis williamsi sp. nov.

Plate III, figure 8

This species resembles *G. tenuicarinata* of the Willow Creek and Paskapoo formations in its ornamentation, but differs in its greater comparative breadth, more widely divergent apical angle, and in the fact that the upper carina is always larger in comparison with the second carina, and always coincides with the widest part of the whorl. It also occurs at a considerably lower horizon. *G. williamsi* also closely resembles *G. subtortuosa*, differing only in the additional ornamentation. In cases of poor preservation it is difficult to ascribe a specimen to its proper place. The species is named after Dr. M. Y. Williams who collected the type specimens. It occurs only in the Foremost member of the Belly River formation.

Dimensions of Type. Length, 17 mm.; breadth, 10 mm.; apical angle, 45 degrees.

Goniobasis judithensis minimus var. nov.

Plate III, figure 12

This variety differs from the type species only in its smaller size. Whereas Stanton[1] states that *G. judithensis* is larger than *G. tenuicarinata* and averages 22 mm. in length by 13 mm. in breadth, our forms do not average more than 10 mm. in length by 7 mm. in breadth, and the largest specimen is only 16 mm. long. It is abundant at two localities in the Pale beds and other specimens were collected from beds of doubtful ages in Oyster creek one-half mile from Oldman river.

Dimensions of Type. Length, 9 mm.; breadth (flattened), 8 mm.; apical angle, 60 degrees.

Goniobasis whittakeri sp. nov.

Plate III, figure 11

Shell variable in size, moderate to small; whorls seven, moderately convex, those near the apex slender and uniformly rounded, the lower whorls angulated at the middle, the body whorl almost flat above the angle and convex below, whorls immediately above the body whorl flat both above and below the angle; surface marked by numerous (about forty in each whorl), evenly spaced, fine, revolving striæ, an equal number above and below the angle; striæ slightly waving where crossed by faint irregular lines of growth, presenting a silky appearance to the surface of the shell; aperture ovate.

Comparatively abundant in the St. Mary River formation and a few specimens have also been found in the Edmonton formation. The forms from the St. Mary River formation described by Whiteaves[2] as a new variety of *G. tenuicarinata* are undoubtedly poorly preserved examples of this species, and the specimens referred by him (op. cit., p. 21, Pl. 3, figs. 4, 4a) to *G. nebrascensis* also belong to it.

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[1]Stanton, T. W.: U.S. Geol. Surv., Bull. 257, p. 117, Pl. 13, fig. 4 (1905).

[2]Geol. Surv., Canada, Cont. Can. Pal., vol. 1, p. 22, Pl. 3, figs. 6, 6a.

The possession of the silky ornamentation makes the species easily distinguishable from any other species in Alberta.

Dimensions of Type. Length, 17 mm.; breadth, 9 mm.; apical angle, 35 degrees.

Goniobasis webbi sp. nov.

Plate III, figure 14

This species differs from *Goniobasis convexa* (Meek and Hayden[1]) the most closely related form in its perfectly smooth surface: *G. convexa* has quite well defined revolving ridges which give it the appearance of a *Melania*. The new species is also somewhat smaller in size, and the whorls, especially the body whorl, are somewhat more angular than in *G. convexa*. Several samples of the young forms were found along with the adults. In these the apical angle is larger and the angle at the base of the body whorl sharper than in the adults. The species is named after Mr. John B. Webb who so ably assisted the author for two seasons in southern Alberta. Abundant in the Willow Creek and Edmonton formations, and one specimen was found in the St. Mary River formation.

Dimensions of Type: Length, 27 mm.; breadth, 10 mm.; apical angle, 25 degrees.

Velatella rectistriata sp. nov.

Plate IV, figures 2 and 3

This species differs from *V. baptista* White of the Fort Union of Wyoming and Colorado in the character of the colour bands. In *V. baptista* the colour bands are irregularly radiating or vein-like, whereas in the new species they radiate from the beak in straight lines. Very few specimens of the new species show the character of the spire, but from the material at hand it would appear that the spire is not so slender as in *V. baptista* and not so much coiled. Whiteaves (op. cit., p. 73) records *V. baptista* from the Belly River, but all his specimens were found to be referable to the new species.

Dimensions of Type. Length, 11 mm.; width, 9 mm.; height, 6 mm.

Horizon and Localities. This species occurs only in the Foremost beds, but examples were found at numerous localities. The best specimens were found on the north side of Oldman river in SW. ¼ sec. 23, tp. 11, range 18, W. 4th mer. It is always indicative of brackish water conditions and occurs with *Melania, Corbula,* and *Ostrea.*

Melania whiteavesi nodosa var. nov.

Plate III, figure 16

A few specimens from the Brosseau formation in North Saskatchewan river differ so decidedly from the regular form of *M. whiteavesi* that it is herein described as a new variety. The geology of North Saskatchewan

[1]*G. convexa* Meek, Rept. U.S. Geol. Surv., Terr., vol. 9, p. 562, Pl. 42, figs. 2a, b, and text figure 71 (1876).

river does not come within the scope of this report, but the new variety was worked out while studying the genus *Melania*, and it was thought best not to leave it undescribed.

The upper whorls of the variety have the ordinary appearance of the type, but in the lower whorls the transverse ribs have become almost obsolete. The revolving ridges are also not continuous, but well-developed nodes are present where the discontinuous ridges and the nearly obsolete transverse ribs cross. The result is a regular pattern of nodes over the whole whorl; these nodes are not circular or spiny, but are comparatively low and noticeably drawn out in the direction of the spiral ridge. In size and shape it is typical of *M. whiteavesi*.

Horizon and Locality. Brosseau (Ribstone Creek) formation, North Saskatchewan river above Saddle Lake creek, sec. 8, tp. 37, range 12, W. 4th mer.

Pupa sp. indet.

Plate III, figure 13

At Nobleford, Alberta, in the St. Mary River formation, one specimen of a gasteropod was found which should, undoubtedly, be referred to the air-breathing genus *Pupa*. It will very likely prove to be a new species, but as it is incomplete, it was thought best to leave the detailed description until more specimens are found. It is somewhat similar to *Pupa atavuncula* White[1] from the Upper Green River formation (Eocene), but is much larger and shows many minor differences.

[1]White, C. A.: U.S. Geol. Surv., Terr., Wyoming and Idaho, Con. Invert. Pal., pp. 46–47, Pl. 19, fig. 9 (1878).

FOSSIL PLANTS FROM THE CYPRESS HILLS OF ALBERTA AND SASKATCHEWAN

By Edward W. Berry, Johns Hopkins University

Illustrations

I recently examined a collection of fossil plants made by Professor M. Y. Williams in Cypress Hills district of Alberta and Saskatchewan, which contains several interesting things and which is, so far as I know, the first formal record of the occurrence of fossil plants in that region.

Cypress hills constitute an upland in the plains country and are situated a few miles south of the Canadian Pacific railway and about 40 miles north of the International Boundary, between 108½ and 110½ degrees west longitude.

The general section is as follows:

Oligocene conglomerate
Unconformity
Ravenscrag beds
Whitemud
Estevan sandstone
Fox Hills

It is no part of my purpose to attempt a summary of the geology. The district was surveyed by McConnell[1] who reported on it in 1886. The present collections of plants come from the Estevan and Ravenscrag.

Mammals, reptilia, and fishes to the extent of some forty species are known from the Oligocene, having been noticed first by Cope in 1891 and later by Lambe in the strata unconformably overlying the Ravenscrag, and originally considered by McConnell to be of Miocene age. More recently dinosaurs have been discovered in both the Estevan sandstone and Whitemud, which are, therefore, correlated with the Lance formation as developed in Montana. This leaves the Ravenscrag as the representative of the Fort Union of Montana, although all three were originally referred to the Laramie in its original indefinite sense.

The present collections, which are the property of the Geological Survey, Canada, are from ten localities, although some of these are represented by material which is not determinable. None is sufficiently large or varied to afford data for the discrimination of the three horizons mentioned, as may be seen from the accompanying table of distribution of the species identified, so that the conclusions here presented are of palæobotanical rather than stratigraphic interest.

Eight species are recorded from the Estevan and of these only two, represented by rather indefinite material, have been recognized in the Ravenscrag. This, at first sight, might be thought to indicate a floral difference, but all of the Estevan plants except the *Marchantites* and *Trochodendroides* sp., both of which are obscure, are found in the Lance

[1]Geol. Surv., Canada, N.S., vol. 1, pt. C (1885).

and Fort Union of the United States, where also both genera are represented by characteristic material, so that the Estevan plants thus far discovered lack precise stratigraphic significance.

Nineteen species are recorded from the Ravenscrag beds. Two of these have been discovered in the Estevan and all except the *Ginkgo* (?) stones, the fruit tentatively referred to *Paliurus* (?), and the new species of *Cercocarpus* and *Leguminosites* represent rather widespread types common in the Lance (ten of the forms), Fort Union (thirteen of the forms), Paskapoo (seven of the forms), or equivalent horizons. It would appear that the Ravenscrag beds are properly correlated with the Fort Union as it is now delimited in Montana and elsewhere in the United States. Evidently further collecting from the Ravenscrag beds will yield a large flora.

Botanically it may be noted that there are nineteen genera and fifteen families in thirteen or fourteen orders contained in the present collections from Cypress hills, including representatives of the *Bryophyta*, *Arthnophyta*, *Ginkgophyta*, *Coniferophyta*, and *Angiospermophyta*. No *Monocotyledons* have been discovered.

So far as they go they have the same ecological significance as the corresponding larger floras of the same age to the southward, in indicating a distinctly temperate flora of probably northern origin and possibly Holarctic in distribution, certainly at least common to North America and northeastern Asia.

Table of Distribution

—	Estevan	Ravenscrag	Lance	Ft. Union	Paskapoo	Pre-Lance	Post-Ft. Union	Wilcox	Raton	Post-Laramie Black Buttes	Hanna formation	Edmonton
Marchantites sp	x											
Equisetum sp	....	x										
Equisetum rhizome	?	....	x									
Ginkgo adiantoides	x	....	x	x	x	x	x	....	....	....	....	x
Ginkgo ? stones	x	x										
Taxodium dubium	....	x	x	x	x	x	x	x	....	....	....	x
Sequoia nordenskiöldi	?	x	x	x	x	x	x					
Juglans nigella	....	x	....	x	x	....	x	....	x			
Ficus viburnifolia	x	....	....	x								
Aristolochia crassifolia	....	x	x	x	x							
Trochodendroides cuneata	....	x	x	x	....	....	....	....	....	....	....	x
" *speciosa*	....	x	x	x	x							
" sp	x											
Cercocarpus ravenscragensis	....	x										
Leguminosites williamsi	....	x										
Celastrus wardii	....	x	x	x								
" *taurinensis*	....	x	x	x	....	....	....	x				
Enonymus splendens	....	x	....	....	....	....	....	x	x			
Rhamnites knowltoni	....	x	....	....	....	....	....	x	x			
Paliurus (?) sp	....	x										
Trapa microphylla	x	....	x	x	x	x	....	....	....	....	....	x
Viburnum finale	....	x	....	x								
" *limpidum*	....	x	....	x								
Apeibopsis discolor	....	x	....	....	....	x	....	....	....	x	x	
Phyllites aquaticus	....	x										

Phylum, **BRYOPHYTA**

Class, *HEPATICAE*

Order, **Marchantiales**

Genus, *Marchantites* Brongniart

Marchantites sp.

A small fragment of a narrowly linear, forked, thallose liverwort occurs in the Estevan beds along a road up a hill in SE. $\frac{1}{4}$ sec. 28, tp. 7, range 3, W. 4th mer. It is too incomplete for description. Similar but larger forms occur in the Lower Eocene of France, the Mississippi Gulf embayment, and in the Lance formation of Montana.

Phylum, **ARTHROPHYTA**

Order, **Equisetales**

Genus, *Equisetum* Linné

Equisetum sp.

The original and counterpart of the upper part of a long internode with sheath at the node. Internode preserved for a length of 3·5 cm. and 8 mm. in maximum width, showing twelve wide, rather flat ridges. The sheath is about 1 cm. long and is crowned with sharp, linear, lanceolate teeth free for 6 to 7 mm. and connate for their basal 3 or 4 mm.

The specimen is somewhat similar to the Green River *Equisetum wyomingense* Lesquereux, but differs in the greater length of both internode and sheath. It is distinct from any Tertiary species known to me. A nominal species of *Equisetum* has been recorded[1] by Knowlton from the Lance formation, and there are three nominal species known from the Fort Union. These are all poorly known—*E. canaliculatum* Knowlton is a robust form with more numerous stem ridges and short sheaths; *E. decidium* Knowlton is based upon a large, detached entire sheath; and *E. globulosum* Lesquereux is based on a very slender rhizome with tubers. The present specimens, although probably representing a new species, are too incomplete to serve as types. Ravenscrag, above a coal seam below road bridge on central branch of Fairwell creek, sec. 28, tp. 7, range 24, W. 3rd mer.

Equisetum rhizome

A cast of a rather stout *Equisetum rhizome* showing three somewhat inflated internodes each about 2·5 cm. in length comes from the Estevan, Eagle Butte near the centre of sec. 35, tp. 7, range 4, W. 4th mer. It is much like the specimens from the Lance formation of Rocky creek, Saskatchewan, which I referred to *Equisetum articum* Heer[2].

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[1]Knowlton, F. H.: Proc. Wash. Acad. Sci., vol. 11, p. 198 (1909).
[2]Berry, Edward W.: Canadian Field Nat., vol. 38, pp. 131–132, Fig. 1 (1924).

Phylum, GINKGOPHYTA

Order, Ginkgoales

Genus, *Ginkgo* Linné

Ginkgo adiantoides (Unger) Heer

Salisburia adiantoides Unger, Syn. Pl. Foss., p. 211, 1845.
Ginkgo adiantoides Heer, Fl. Foss. Arct., vol. 5, Abt. 3, 1878, p. 21, Pl. ii, f. 7-10; Ward, U.S. Geol. Surv., Sixth Ann. Rept., 1884-85 [1886], p. 549, Pl. xxxi, figs. 5, 6; idem, Bull. 37, 1887, p. 15, Pl. i, figs. 5, 6; Lesquereux, U.S. Nat. Mus., Proc., vol. 10, 1887, p. 35; Knowlton, idem, vol. 17, 1894, p. 215; Geol. Soc. Am., Bull., vol. 5, 1893, p. 579; Washington Acad. Sci., Proc., vol. 11, 1909, pp. 197, 198, 204, 213; Jour. Geol., vol. 19, 1911, p. 370; Penhallow, Rept. Tert. Pl. Brit. Col., 1908, p. 57, text fig. 12.

This species had a Holarctic distribution during the Tertiary and is recorded from a large number of horizons. It is common in both the Lance and Fort Union formations of the United States. A single distal fragment of a leaf occurs in a lignitic clay in the Estevan on Sexton Hill creek near the headwaters of Medicine Lodge creek, NE. ¼ sec. 21, tp. 7, range 3, W. 4th mer. Associated with this leaf fragment and also present at other localities are an abundance of lenticular circular fruits that may be of the same species.

Ginkgo (?) stones

Poorly preserved fruits of some uncertain plant are associated with the fragment of a *Ginkgo* leaf in the Estevan on Sexton Hill creek. They also occur in the Estevan in SW. ¼ sec. 28, tp. 7, range 3, W. 4th mer. and in the Estevan above a coal bed in SW. ¼ sec. 6, tp. 8, range 3, W. 4th mer.

These fruits very probably represent the stones of the drupaceous fruits of *Ginkgo*, although this is by no means conclusive. They are approximately circular in profile, lenticular in form, and about 1 cm. in diameter. There is an equatorial border nearly a millimetre in width—all features comparable to those of the stones of the existing *Ginkgo*.

Phylum, CONIFEROPHYTA

Order, Coniferales

Family, PINACEAE

Genus, *Taxodium* L. C. Richard

Taxodium dubium (Sternberg) Heer[1]

There is little point to discussing this composite species. It has an incredible range, both geologic and geographic, and is recorded as common in the Lance formation, although the equally common occurrences in the Fort Union are generally referred to *Taxodium occidentale* Newberry. Some of each probably represent the other.

[1]The very extensive synonymy is given in Berry, U.S. Geol. Surv., Prof. Paper 91, p. 171 (1916).

Poorly preserved material occurs in the Ravenscrag beds associated with what I have called *Sequoia nordenskiöldi* but lacking the decurrence which serves to distinguish the latter.

Occurrence. Ravenscrag beds, Ravenscrag butte, near centre of sec. 27, tp. 6, range 23, W. 3rd mer.

Phylum, ANGIOSPERMOPHYTA

Class, *DICOTYLEDONAE*

Order, **Juglandales**

Family, JUGLANDACEAE

Genus, *Juglans* Linné

Juglans nigella Heer

Juglans nigella Heer, Fl. Foss. Arct., vol. 2, Abt. 2, 1869, p. 38, Pl. ix, figs. 2-4; Dawson, Geol. Surv., Canada, 1875-76, p. 57; Lesquereux, Rept. U.S. Geol. Surv., Terr., vol. 8 (Cret. and Tert. Fl.), 1883, p. 235, Pl. xlvi-A, fig. 11; Knowlton, U.S. Nat. Mus., Proc., vol. 17, 1894, p. 222; Geol. Soc. Am., Bull., vol. 5, 1893, p. 583; Ward, U.S. Geol. Surv., Sixth Ann. Rept., 1884-85 [1886], p. 551, Pl. xl, fig. 6; idem., Bull. 37, 1887, p. 33, Pl. xv, fig. 1; Newberry, U.S. Geol. Surv., Mon. 35, 1898, p. 33, Pl. li, fig. 2 (in part), 4; Penhallow, Rept. Tert. Pl. Brit. Col., 1908, p. 60; Knowlton, U.S. Geol. Surv., Prof. Paper 101, 1918, p. 292, Pl. lv, fig. 2; Pl. lxiii, fig. 2.

The type locality for this species was in the Kenai formation of Alaska, and it has subsequently been recorded from the Raton, Fort Union, and Paskapoo formations. There are several specimens in the Ravenscrag beds at Ravenscrag butte, near centre of sec. 27, tp. 6, range 23, W. 3rd mer.

Order, **Urticales**

Family, MORACEAE

Genus, *Ficus* Linné

Ficus viburnifolia Ward

Ficus viburnifolia Ward, U.S. Geol. Surv., Sixth Ann. Rept., 1884-85 [1886], p. 552, Pl. xlv, figs. 5-9; U.S. Geol. Surv., Bull. 37, 1887, p. 42, Pl. xxii, figs. 4-8.

This species is represented by a single small specimen, which because of its small size is less cordate than the type. It agrees with the latter in venation and has a faintly dentate margin. Length 4·25 cm. Maximum width 3 cm.

Occurrence. Estevan beds, on a hill, SW. $\frac{1}{4}$ sec. 16, tp. 7, range 29 W. 3rd mer.

Order, **Aristolochiales**

Family, ARISTOLOCHIACEAE

Genus, *Aristolochia* Linné

Aristolochia crassifolia Cockerell

Plate VI, figures 1-3 (½ natural size)

Catalpa crassifolia Newberry, N.Y. Lyc. Nat. Hist., Ann., vol. 9, 1868' p. 56; [Lesquereux], U.S. Geol. and Geog. Surv., Terr., Ill., Cret. and Tert. Pl., 1878, Pl. xxii; Penhallow, Rept. Tert. Pl. Brit. Col., 1908, p. 44.

Aristolochia cordifolia Newberry, N.Y. Lyc. Nat. Hist., Ann., vol. 9, 1868, p. 74; [Lesquereux], U.S. Geol. and Geog. Surv., Terr., Ill., Cret. and Tert. Pl., 1878, Pl. xxv, fig. 7; Newberry, U.S. Geol. Surv., Mon. 35, 1898, p. 90, Pl. xxxix; Pl. xl, fig. 7; Pl. lx, fig. 4.

Aristolochia crassifolia Cockerell, Am. Mus. Nat. Hist., Bull., vol. 24, 1908, p. 90.

Cocculus haydenianus Ward, U.S. Geol. Surv., Sixth Ann. Rept., p. 556, Pl. 59, figs. 1-5, 1886; Bull. 37, p. 100, Pl. 47, figs. 1-4; Pl. 48, fig. 1, 1887; Knowlton, Wash. Acad. Sci., Proc., vol. 11, pp. 189, 198, 200, 213, 215, 1909.

Cebatha haydenianus Knowlton, U.S. Geol. Surv., Bull. 152, p. 62, 1898.

Whatever may be thought of the generic relations of this plant there is no doubt that the material which Ward referred to *Cocculus* is identical with what Newberry referred successively to *Catalpa* and *Aristolochia*. It is obviously not a *Catalpa* and after comparisons I believe it to represent *Aristolochia*. This was Ward's original idea, subsequently abandoned in favour of *Cocculus*. A feature not shown in Newberry's types but emphasized by Ward in connexion with what he called *Cocculus haydenianus* is the "marginal vein or hem" for which Ward coined the term paryphodrome. This is present in the Canadian material and is nothing but the flattened arches of the ultimate areolation. The species occur abundantly in the Lance, Fort Union, and Paskapoo formations and highly characteristic, but usually much broken remains are not uncommon in the Ravenscrag beds at Ravenscrag butte, near centre of sec. 27, tp. 6, range 23, W. 3rd mer.

Order, **Ranales**

Family, TROCHODENDRACEAE

Genus, *Trochodendroides* Berry

This term is used as a form genus for fossil representatives of the family Trochodendraceae and not as implying any direct relationship to the genus Trochodendron.

Trochodendroides cuneata (Newberry)

Plate V, figures 2, 3

Populus cuneata Newberry, N.Y. Lyc. Nat. Hist., Ann., vol. 9, 1868, p. 64; Ward, U.S. Geol. Surv., Mon. 35, 1898, p. 41, Pl. xxviii, figs. 2-4; Pl. xxix, fig. 7; U.S. Geol. Surv., Sixth Ann. Rept.; 1884-85 [1886],

p. 550, Pl. xxxiii, figs. 5-11; U.S. Geol. Surv., Bull. 37, 1887, p. 19, Pl. lv., figs. 5-8; Pl. v, figs. 1-3; Penhallow, Rept. Tert. Pl. Brit. Col., 1908, p. 77; Knowlton, Wash. Acad. Sci., Proc., vol. 11, 1909, pp. 185-215.

"*Populus nervosa* var. *β elongata* Ny." [Lesquereux], U.S. Geol. and Geog. Surv., Terr., Ill., Cret. and Tert. Pl., 1878, Pl. xiii, figs. 2-4.

"*Populus nebrascensis* Ny." [Lesquereux], op. cit., Pl. xiv, fig. 7.

Populus amblyrhyncha Ward, U.S. Geol. Surv., Sixth Ann. Rept., 1884-85 [1886], p. 550, Pl. xxxiv, figs. 5-9; Pl. xxxv, figs. 1-6; idem, Bull. 37, 1887, p. 20, Pl. vi, figs. 1-8; Pl. vii, figs. 1-3; Knowlton, Wash. Acad. Sci., Proc., vol. 11, 1909, pp. 188, 189, 194, 195, 198, 201, 202; Jour. Geol., vol. 19, 1911, p. 361; in Calvert, U.S. Geol. Surv., Bull. 471, 1912, p. 16.

Populus cyclomorpha Knowlton and Cockerell. U.S. Geol. Surv., Bull. 696, p. 487, 1919.

Populus rotundifolia Newberry, U.S. Nat. Mus., Proc., vol. 5, 1882 [1883], p. 506; U.S. Geol. Surv., Mon. 35, 1898, p. 51, Pl. xxix, figs. 1-4; Penhallow, Rept. Tert. Pl. Brit. Col., 1908, p. 79; Knowlton, Wash. Acad. Sci., Proc., vol. 11, 1909, p. 189. [Homonym, Griffith, 1847.]

Populus cuneata Newberry [Lesquereux], U.S. Geol. and Geog. Surv., Terr., Ill., Cret. and Tert. Pl., 1878, Pl. xiv, figs. 1-4.

In Ward's account of the Fort Union flora he recorded thirteen species of *Populus*, although Newberry had previously recorded eight species, only one of which Ward found represented in his extensive collections. In Knowlton's list of the Fort Union flora (1919, page 771) twenty-five species of *Populus* are listed. It seems obvious a priori that there were not twenty-five species of this genus in the Fort Union; and when one examines critically the published illustrations or the named specimens in the United States National Museum collections, it becomes equally obvious that a considerable number of these so-called species are without any basis and were frequently not recognized by their founders. Moreover, one becomes impressed with the unlikeness of many of them to *Populus*, a subject remarked on by Ward as far back as 1887.

Newberry described the present species in 1868 and its chief feature was its more or less cuneate base. It is hardly necessary to give a detailed description of my conception of the species, suffice to say that these leaves are variable in size, and to a less degree in form, orbicular in general outline, bluntly pointed or rounded at the tip, and cuneate to rounded truncate at the base with long petioles. The margin may be entire or variably toothed. There are three basal or sub-basal primaries and the lowermost lateral secondaries may be sub-primary in character. The main lateral primaries are ascending and variably subacrodrome in character.

Two extremes of this species are figured from the Ravenscrag beds at Ravenscrag butte (near the centre of sec. 27, tp. 6, range 23, W. 3rd mer.)

They agree in all features except marginal character and are intimately associated in the deposit. As can be readily seen they are unlike any existing species of *Populus*, particularly in their venation, whereas, on the

other hand, they have every feature of the existing *Cercidophyllum japonicum*, which may be crenate, dentate, or entire, or *Tetracentron sinensis*. I hope to discuss the geological history of the family Trochodendraceae with necessary illustrations in a more appropriate place.

This species is abundant and widely distributed in the Lance and Fort Union of Dakota, Montana, and Wyoming, and has also been recorded from Red Deer river, Alberta.

Trochodendroides speciosa (Ward)

Plate V, figure 8

Populus speciosa Ward, U.S. Geol. Surv., Sixth Ann. Rept., 1884-85 [1886], p. 550, Pl. xxxiv, figs. 1-4; U.S. Geol. Surv., Bull. 37, 1887, p. 20, Pl. v, figs. 4-7; Penhallow, Rept. Tert. Pl. Brit. Col., 1908, p. 79; Knowlton, U.S. Geol. Surv., Mon. 32, pt. 2, 1899, p. 694, Pl. lxxxiv, fig. 3; Wash. Acad. Sci., Proc., vol. 11, 1909, p. 189; Jour. Geol., vol. 19, 1911, p. 369.

Populus xantholithensis Knowlton, Mon. U.S. Geol. Surv., vol. 32, pt. 2, p. 695, Pl. 85, figs. 1, 2, 1899.

This is a widespread and variable form in the Lance and Fort Union formations, recorded from South Dakota, Montana, Yellowstone National park, and British Columbia (Paskapoo formation).

Several leaves from the Ravenscrag may be assigned to this species. They are from 3·2 to 7·5 cm. in width, and from 4·5 to probably 8·0 cm. in length, with rounded and occasionally markedly cordate base and rather blunt apex. The margins are crenate-dentate, commencing a short distance from the top of the petiole and frequently double. The petiole is long, the preserved part being from 2·0 to 7·5 cm., with a width of about 1 mm. The venation is palmate, the middle primary comparatively strong, with two or three pairs of lateral primaries diverging from the summit of the petiole, though the principal pair are sometimes more or less fused with the middle one near the petiole. The basal pair are much finer and delicate. The first and second pairs adjacent to the middle one have stronger secondary veins on the outer side than on the inner side. The secondaries branch, reach the margins of the teeth, and form series of polygonal loops with tertiaries. The characteristic features are the rounded teeth and palmate nervation with subacrodrome main primaries from the top of the petiole.

Occurrence. In Ravenscrag beds above a coal bed, sec. 28, tp. 7, range 24, W. 3rd mer., below the road bridge on central branch of Fairwell creek.

Trochodendroides sp.

Two specimens which fail to show details, but apparently with entire margins, possibly the same as *Trochodendroides cuneata* (Newberry) or *T. speciosa* (Ward) of the Ravenscrag beds.

Occurrence. Estevan beds, SW. ¼ sec. 16, tp. 7, range 29, W. 3rd mer.

Order, **Rosales**

Family, ROSACEAE

Genus, *Cercocarpus* H.B.K.

Cercocarpus ravenscragensis Berry n. sp.

Plate V, figure 6

Leaves small, somewhat inequilateral, obovate or spatulate; margin prominently dentate distad; teeth diminishing proximad and basal one-third of margins entire. Apex broadly rounded. Base cuneate. Length 3·5 cm. Maximum width, above middle, about 2 cm. Petiole short, stout, curved, expanded proximad, about 4 mm. in length. Midvein relatively very stout and prominent. Secondaries stout, about seven fairly regularly spaced pairs; they diverge from the midvein at acute angles, are relatively straight, and subparallel and camptodrome. Tertiaries relatively stout, not well preserved, forming a rosaceous areolation.

This form is clearly rosaceous in its venation and agrees rather well with the existing *Cercocarpus parvifolius* Nuttall of the somewhat arid uplands of western North America. The genus comprises arborescent and shrubby species and is confined to North America in the region between Idaho and Mexico. Several fossil species have been recorded, mostly from the later Tertiary, but one species has been described by Knowlton from the Raton formation of New Mexico.

Occurrence. Ravenscrag beds, north branch of Frenchman river, SE. ¼ sec. 22, tp. 7, range 22, W. 3rd mer.

Family, LEGUMINOSAE (Incertae sedis)

Leguminosites williamsi Berry n. sp.

Plate V, figure 1

Leaflet small, obovate in outline, markedly inequilateral, with a broadly rounded apex and an abruptly cuneate base. Margin entire. Texture coriaceous. Length about 2 cm. Maximum width about 1 cm. Midvein stout, curved. Secondaries relatively stout, about five ascending, camptodrome pairs.

This leaflet is new and represents a type met with in a great variety of leguminous genera. In the absence of more information than is afforded by the present material it is impossible to determine its generic affinity, although it probably represents *Cassia* or *Sophora*. It is named for the collector, Professor M. Y. Williams.

Occurrence. Ravenscrag beds, north branch of Frenchman river, SE. ¼ sec. 22, tp. 7, range 22, W. 3rd mer.

Order, **Sapindales**

Family, CELASTRACEAE

Genus, *Celastrus* Linné

Celastrus wardii Knowlton and Cockerell

Celastrus ovatus Ward, U.S. Geol. Surv., Sixth Ann. Rept., 1884-85, p. 555, Pl. liii, fig. 7, 1886; U.S. Geol. Surv., Bull. 37, 1887, p. 71, Pl. xxvi, fig. 1; Knowlton, Washington Acad. Sci., Proc., vol. 11, p. 190, 1909. [Homonym, Hill, 1865.]

Celastrus wardii Knowlton and Cockerell, U.S. Geol. Surv., Bull. 696, p. 160, 1919.

The type of this species came from the Fort Union formation near Glendive, Montana. It has been recorded from other localities in the Fort Union as well as in the underlying Lance formation. A single fragmentary specimen was collected from the Ravenscrag beds on north branch of Frenchman river, SE. ¼ sec. 22, tp. 7, range 22, W. 3rd mer.

Celastrus taurinensis Ward

Celastrus taurinensis Ward, U.S. Geol. Surv., Sixth Ann. Rept., 1884-85, p. 555, Pl. lii, figs. 15, 16, 1886; U.S. Geol. Surv., Bull. 37, p. 79, Pl. xxxiv, figs. 5, 6, 1887; ? Hollick, Geol. Surv., La., Special Rept. 5, p. 285, Pl. xlvi, fig. 1, 1899; Knowlton, Washington Acad. Sci., Proc., vol. 11, p. 213, 1909; Berry, U.S. Geol. Surv., Prof. Paper 91, p. 267, Pl. lx, figs. 1-3, 1916.

The type of this species came from the Fort Union near Glendive, Montana. It is apparently common in the Fort Union and underlying Lance formation, and has also been reported from the Wilcox Eocene of the Mississippi Gulf embayment. I believe that *Celastrus curvinervis* Ward probably represents the same botanical species.

In the present collections there are several excellent specimens from the Ravenscrag beds at Ravenscrag butte, near centre of sec. 27, tp. 6, range 23, W. 3rd mer.

Genus, *Euonymus* Linné

Euonymus splendens Berry

Euonymus splendens Berry, U.S. Geol. Surv., Prof. Paper 91, 1916, p. 267, Pl. lxii, figs. 1-5; Knowlton, U.S. Geol. Surv., Prof. Paper 101, 1917, p. 329, Pl. lxix, fig. 1.

This species is one of the commonest and most widespread plants in the Wilcox of the Mississippi Gulf embayment. What appears to be the same species has been identified by Knowlton from the Raton formation of New Mexico. A single large but incomplete specimen in the present collection is highly characteristic, but lacks the extended tip.

Occurrence. Ravenscrag beds, Ravenscrag butte, near centre of sec. 27, tp. 6, range 23, W. 3rd mer.

Order, **Rhamnales**

Family, RHAMNACEAE

Genus, *Rhamnites* Forbes

Rhamnites knowltoni Berry

Cornus studeri Lesquereux, Rept., U.S. Geol. Surv., Terr., vol. 7, 1878, p. 244, Pl. 42, figs. 4 and 5 (not Heer 1859); Ward, U.S. Geol. Surv., Bull. 37, 1887, p. 55, Pl. 26, fig. 1; Hollick, Rept., La. Geol. Surv., 1899, p. 286, Pl. 45, fig. 2; Berry, U.S. Geol. Surv., Prof. Paper 91, 1916, p. 331, Pl. 68, fig. 3.

Rhamnites knowltoni Berry, Idem, 131, p. 16, Pl. 12, fig. 7, 1922.

Small leaves represent this species. Unfortunately they are incomplete, lacking the upper part. The leaves are large in size, but variable, with entire margins. The petiole is long and thick, with a width of about 2 mm.

The species was long confused with the European Miocene *Cornus studeri* Heer, a quite different form. *Rhamnites knowltoni* occurs in the Denver, Raton, and Wilcox.

Occurrence. Ravenscrag beds, north branch Frenchman river, SE. ¼ sec. 22, tp. 7, range 22, W. 3rd mer.

Genus, *Paliurus* Jussieu

Paliurus (?) sp.

Plate V, figure 7

A single specimen shows what appears to be some winged fruit resembling that of *Paliurus*. The fruit is circular and disk-like, about 2·6 cm. in diameter but not complete, with the wing showing radial striations.

For an account of a well-preserved *Paliurus* fruit and a discussion of the geographical and geological range of the genus *See* Berry, Am. Jour. Sci., vol. 16, pp. 39-44, 1928.

Occurrence. ~~Estevan~~, above coal bed. Burnt shale associated only with abundant circular lenticular fruits not determinable but possibly representing *Ginkgo*. SW. ¼ sec. 6, tp. 8, range 3, W. 4th mer.

Order, **Myrtales**

Family, HYDROCARYACEAE (?)

Genus, *Trapa* Linné (?)

Trapa (?) *microphylla* Lesquereux

Trapa microphylla Lesquereux, Rept. U.S. Geol. Surv., Terr. (Tertiary Flora), vol. 7, p. 295, Pl. 61, figs. 16-17a, 1878.

Trapa microphylla Ward, U.S. Geol. Surv., Bull. 37, p. 64, Pl. 28, figs. 2-5, 1887; Knowlton, U.S. Geol. Surv., Mon. 32, pt. 2, p. 761, Pl. 77, figs. 3, 4, 1898; U.S. Geol. Surv., Bull. 163, p. 62, Pl. 5, fig. 7, 1900.

Only detached leaves are scattered on several specimens, and some are much like pinnules of some fern. The leaves are small, varying in size from 7 mm. to more than 13 mm. in length and from 5 mm. to 10 mm. in maximum width; orbicular or broadly ovate, rounded or more or less truncate at the base or at the apex, some a little narrowed to the base and some narrowed to the apex; entire but slightly undulate on upper margins. No petiole is preserved. The nervation is not quite distinct, some show a comparatively thick midrib with 6 or 7 secondary nerves on each side; the midrib being more or less curved and centric; the secondaries diverging from the midrib at angles of more than 30 degrees in the lower part and less than 30 degrees in the upper part, bifurcating below the middle and reaching the margins, the basal ones joining the midrib at the base and likely to be opposite, the upper ones mostly alternate. The nervilles are not clearly seen.

There can be no question of the identification of the present specimens, but most students regard their reference to the genus *Trapa* as highly problematical. The present species has been recorded from a variety of horizons from the Belly River Cretaceous to the Fort Union. Whether these records represent a single botanical species or not I am not prepared to say, but whatever it may be or how widely it may range *Trapa* (?) *microphylla* is especially abundant in the Lance and Fort Union horizons.

Occurrence. Estevan beds, along road up a hill SW. ¼ sec. 28, tp. 7, range 3, W. 4th mer.

Order, **Rubiales**

Family, CAPRIFOLIACEAE

Genus, *Viburnum* Linné

Viburnum limpidum Ward

Viburnum limpidum Ward, U.S. Geol. Surv., Sixth Ann. Rept., p. 556, Pl. 63, figs. 1-4, 1886; Bull. 37, p. 110, Pl. 53, figs. 3-6, 1887.

The leaf is not completely preserved, but the venation is distinct. It is ovate, about 70 mm. long and about 52 mm. in maximum width; narrowed and rather rounded at the base, likely to be bluntly pointed at the apex; serrate on the upper margins and entire at the base. The venation is ascending pinnate, with the midvein more or less curved in some parts; the secondary veins about seven on each side, diverging from the midvein at angles of from 35 degrees to 60 degrees, mostly curving upward, branching near and above the middle, and craspedodrome; the nervilles distinct and simple, mostly parallel each other and percurrent.

It very much resembles Ward's figures in outline, size, and especially venation. The type is from the Fort Union of Montana.

Occurrence. Ravenscrag beds, north branch, Frenchman river, SE. ¼ sec. 22, tp. 7, range 22, W. 3rd mer.

Viburnum finale Ward

Plate V, figure 4

Viburnum finale Ward, U.S. Geol. Surv., Sixth Ann. Rept., 1884-85 [1886], p. 557, Pl. lxv, fig. 8; U.S. Geol. Surv., Bull. 37, 1887, p. 115, Pl. lvii, fig. 5.

Some of the specimens from the Ravenscrag which I have referred to this species are relatively wider and with more ascending secondaries than the type, and I have figured one of these. It shows the same slight inequality of the two sides of the lamina, and differences in the distal branching of the secondaries on the two sides, exactly as in the type. Associated with it are leaves which agree more exactly with Ward's type, which latter came from the Fort Union at Iron Bluff, Glendive, Montana. The specimen from Ravenscrag butte, figured, has the complete petiole, hitherto not known. It is stout and 1·5 cm. long.

(Incertae sedis)

Genus, *Apeibopsis* Heer

Apeibopsis discolor Lesquereux

Rhamnus discolor Lesquereux, U.S. Geol. and Geog. Surv., Terr., Ann. Rept., p. 398, 1872.

Apeibopsis discolor Lesquereux, Rept. U.S. Geol. Surv., Terr. (Tertiary Flora), vol. 7, p. 259, Pl. 46, figs. 4-7, 1878.

An original and counterpart represent this species. They are ovate, rounded, and slightly cordate at the base, likely to be acutely pointed at the apex, and entire; from 5·5 to 7·0 cm. long and about 5·5 cm. in maximum width. The venation is pinnate, with rather strong midvein more or less wavy in traversing the whole length and much diminishing toward the apex; the secondary veins seven or eight on each side, diverging from the midvein at angles of from 30 degrees to 90 degrees (the more distal the larger the angles), opposite in the lower part and sub-opposite or alternate in the upper part, sub-parallel, curving upward, camptodrome, branching mostly near the margins but some near the midrib; the nervilles connecting the secondaries and tertiaries at various angles, some being nearly parallel.

The genus was proposed by Heer in 1859 for leaves from the Miocene of central Europe which he supposed were related to the existing genus *Apeiba* Aublet, a South American tropical genus of the family Malvaceae. The correctness of this identification is supported in the case of some of the fossil species by their association with characteristic fossil fruits, but this is not the case with any North American species referred to *Apeibopsis*. *Apeibopsis discolor* is not especially close to the leaves of the existing South American species of *Apeiba* and though the ancestors of the latter might be expected to be represented in North America if they occur in Europe, there is no sound basis for such a conclusion and I have, therefore, listed *Apeibopsis discolor* under Incertae sedis.

The previous records are in the much disputed Black Buttes beds of Wyoming, of post-Laramie age, and in the Hanna formation of Wyoming.

Occurrence. Ravenscrag beds, Ravenscrag butte, near centre of sec. 27, tp. 6, range 23, W. 3rd mer.

Phyllites aquaticus Berry n. sp.

Plate V, figure 5

Several specimens of a delicate plant are contained in the collection from the Ravenscrag beds. They represent filiform stems with whorls of slender linear leaves at the nodes. These are lax, with one to three longitudinal veins, and are about 0·5 mm. in width and preserved for lengths up to 2 cm. None has been observed to branch but whether their distal parts were branched as in *Ceratophyllum* is not known. One slab of material shows a whorl on each side and appears to have been a part of the same stem. If this is so then the plant was rapidly buried in place and the internodes were relatively short. The material is evidently not algal, but a vascular plant.

A NEW SPECIMEN OF EODELPHIS CUTLERI FROM THE BELLY RIVER FORMATION OF ALBERTA

By George Gaylord Simpson,
American Museum of Natural History

Illustration

INTRODUCTION

On May 30, 1916, Doctor (now Sir) Arthur Smith Woodward announced the discovery of a lower jaw of a mammal in the Belly River formation of Alberta[1]. A few months later a more detailed description and a figure of this important specimen, to which he gave the name *Cimolestes cutleri*, new species, were published[2]. In the meantime, without knowledge of Smith Woodward's work, Dr. W. D. Matthew described a similar specimen, naming it *Eodelphis browni*, new genus and species[3].

The type of *"Cimolestes" cutleri* was found by William E. Cutler in 1914 on Sand creek, Red Deer river, Alberta, and consists of part of the right ramus with P_3, M_{1-2}, and roots or alveoli of other teeth. That of *E. browni* was found by Barnum Brown in 1915, also on Sand creek, 15 miles below Steveville, and consists of the left lower jaw nearly complete but with the teeth very much worn, a small fragment of the right lower jaw, and two skull fragments. The importance of these two discoveries lay chiefly in the fact that they were, at that time, the most complete known specimens of Cretaceous mammals and that they could be definitely shown to be marsupials, confirming previous belief that this group was largely represented in the American Upper Cretaceous. *Eodelphis* is still the oldest known marsupial.

The type of *"Cimolestes" cutleri* has been redescribed by the present writer,[4] who referred it to Matthew's genus as *Eodelphis cutleri* (Smith Woodward). The distinctions between the two specimens, aside from verbal discrepancies in the original descriptions of the molars, were considered as probably too slight to warrant recognition of both trivial names, but these were retained pending some discovery which might provide definitive knowledge of molar structure in this genus.

This discovery has now been made. During the past summer (1928), C. M. Sternberg found a third *Eodelphis* jaw that clearly reveals the molar structure, permits better correlation of the two previous finds, and adds another to the four or five really adequate mammalian specimens so far found in the Cretaceous of this continent. For the privilege of studying this specimen and of preparing the present remarks, the writer is much indebted to Mr. Sternberg.

[1]Zool. Soc. London, Abstract No. 158 (May 30, 1916).
[2]Proc. Zool. Soc. London, 1916, pp. 525–528 (Sept., 1916).
[3]Bull. Am. Mus. Nat. Hist., XXXV, pp. 477–500 (July 24, 1916).
[4]Catalogue of the Mesozoic Mammalia, etc., British Museum (Nat. Hist.), pp. 147–149 (Mar. 24, 1928).

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DESCRIPTION

Eodelphis cutleri (Smith Woodward), May 30, 1916

Synonym: *E. browni* Matthew, July 24, 1916

Plate VII

New Specimen. Cat. No. 8356, Geological Survey, Canada. Part of right lower jaw with M_{1-4}, alveoli of P_3, and part of jaw posterior to teeth.

Horizon and Locality. About 100 feet below top of Belly River formation (Pale Beds), about 2 miles southwest of Steveville, Alberta. Collected by C. M. Sternberg, July, 1928.

Dentition. The molars increase much more markedly in size from front to back than in any Tertiary or Recent didelphid. M_4 is over half again as large as M_1. M_4 is slightly larger than M_3 and its heel is somewhat wider and longer than that of any of the preceding teeth. Of all the molars the trigonid is very slightly wider basally than the talonid, of about equal length, and somewhat higher. On M_1 the trigonid is longer than wide, on M_2 length and width are about equal, and on M_{3-4} the trigonid is sharply compressed antero-posteriorly, width considerably greater than length. On M_{1-2} the trigonids are evenly truncated by wear, but their bases indicate the protoconid and paraconid as subequal, the metaconid as smaller. On M_{3-4} the cusps are relatively well preserved and the trigonid consists essentially of the sharp, erect, subequal protoconid and paraconid, united by a shearing edge, while the metaconid is much reduced, almost vestigial. There is an anterior cingulum, very definite but not distinctly basined, rising toward the paraconid. The talonids are of the almost invariable didelphid type, basined, with three marginal cusps, the hypoconulid and entoconid closely approximated. In this case the latter are almost connate and on M_{3-4} are slightly higher than the hypoconid, although not so much so as indicated by Matthew, whose specimen has the hypoconids eroded.

Mandible. The mandible agrees very closely with the *E. cutleri* type, the only definite distinction, and that slight, being that the lower border is apparently more swollen beneath and just behind M_4.

Dimensions

	Mm.
Length M_{1-4}	17·0
" M_1	3·3
" M_2	4·1
" M_3	4·6
" M_4	5·1
Maximum depth of ramus below alveolar border internally (beneath M_4)	12·5

DISCUSSION

Taxonomy of Eodelphis. In no way does this new specimen differ sufficiently from the type of *E. cutleri* to permit any taxonomic distinction. Matthew's description of *E. browni* differs from the details given above chiefly as follows:

(1) He states that second and third molars are similar in size (both are worn and corroded).

(2) The paraconid and metaconid of M_3 are said to be apparently of equal height and the protoconid lower than either (inferred from bases of broken cusps).

(3) On M_4 the metaconid is recognized as lower than the paraconid, but the protoconid (which is broken) is said to be certainly lower than the paraconid and apparently also lower than the metaconid. The hypoconid (corroded) is said to be decidedly, rather than slightly, lower than the hypoconulid and entoconid.

After careful direct comparison it is clear that Matthew's specimen must originally have been exactly like the present specimen in all these particulars, although its true nature in these details could not have been established until this less worn specimen was at hand. This is insisted upon only because, as previously suspected, it causes all discrepancy in molar structure between *E. browni* and *E. cutleri* to disappear, confirms their reference to the same genus, and, as other differences are quite unimportant, necessitates their union as a single species: *Eodelphis cutleri*.

Like the type of *E. cutleri*, the present jaw is somewhat more robust than Matthew's specimen (although the teeth are not larger), and the positions of the mental foramina, though similar, are not exactly the same in any two of the three specimens. These differences, however, are certainly well within the range of individual variation.

Relationships to Later Forms. Both Smith Woodward and Matthew recognized the similarity of this species to *"Cimolestes" curtus* Marsh from the Lance. The latter does not belong in *Cimolestes* and has been placed by the writer in a new genus, *Diaphorodon*[1]. Smith Woodward believed the trigonid to be more elevated in the earlier form. Matthew stated that "the lower molar figured by Marsh as *Cimolestes curtus* is somewhat similar to the posterior molars of *Eodelphis* but the metaconid is more reduced, heel wider and shorter, its marginal cusps less differentiated, and the postero-internal cusps not so high or backwardly prominent. The tooth is considerably larger, agreeing more nearly with *Thlaeodon* in size."

Although it can hardly be doubted that *Eodelphis* and *Diaphorodon* are distinct genera, if only because of their wide geologic separation (no genus of dinosaurs is common to Lance and Belly River), the differences, in at least the posterior molars, are very slight. The difference in elevation of the trigonid is doubtful, and slight at best. The supposed differences in the heel are largely or wholly due to the corrosion, in different ways,

[1]Am. Jour. Sci., (5) XIV, p. 127 (1927).

of both types. The metaconid has nearly the same relative size in both. In fact the agreement is so striking and the molar type so peculiar that it seems probable that *Diaphorodon* and *Eodelphis* were closely related, the latter perhaps ancestral to the former.

Eodelphis is clearly a marsupial, as shown by Matthew, and, in common with most Lance marsupials, its resemblance to the later didelphids is so striking that the writer prefers to place it in the Didelphiidae, at least until it is much better known. Within the family, however, it occupies an isolated position, certainly not ancestral to any known Tertiary or Recent phylum. Aberrant specialization is seen in the stout jaw, the three incisors with the median one enlarged, the crowded nature of the premolars and enlargement of P_3,[1] the relative enlargement of the paraconid, and reduction of the metaconid. It is one of the aberrant members of the varied Cretaceous didelphid group. More generalized forms are common in the Lance, but have not yet been found in the Belly River.

[1] P_3 larger than P_2 is a primitive character seen in most fossil didelphids, but in *Eodelphis* P_3 is unsually large and heavy, although less so than in *Thlaeodon*, for instance.

FOSSILS FROM HARRISON LAKE AREA, BRITISH COLUMBIA

By C. H. Crickmay, University of California at Los Angeles

Illustrations

INTRODUCTION

This report contains a brief account of the palæontological materials acquired during a geological study of the country adjacent to Harrison lake, British Columbia; made for the Geological Survey, by the writer, during the summers of the years 1924 and 1926. The writer had no assistant in 1924. In 1926 he was ably assisted by James R. Pollock.

The writer is indebted to Mr. J. Forsyth of the Provincial Library at Victoria, to Mr. C. Brakenridge, City Engineer of Vancouver, and to Mr. L. A. Agassiz, of Agassiz, for courtesies extended to him and information freely given during the course of the work. He is especially indebted to Professor J. P. Smith for invaluable advice freely given on many occasions.

The area under consideration lies in the heart of the southern extremity of the Coast range of British Columbia. Its southern boundary is Fraser river. The other boundaries are controlled by the distance possible to cover in one-day trips from the shores of the lake and river. Harrison lake lies in a large, fiord-like valley adjoining the Fraser on its north side. It is 1 to 4 miles wide and 38 miles long; its general trend is south-south-east. Its mean surface level is 30 feet above mean sea-level. It is fed at its north end by the turbulent waters of Lillooet river, and drained from its west side near the south end by the slow-moving Harrison river. Lillooet river and Harrison lake occupy one large valley which joins the Fraser valley at right angles. South of the lake the drainage is obstructed by moraines, so that the lake is drained through a narrow side valley which has been so modified that it now carries the entire overflow of the lake. Numerous streams, of the size referred to in the west as "creeks," enter the lake along its shores, at steep gradients.

The topography is entirely mountainous except for the small areas of flat land forming the bottoms of the larger valleys. In the southern half of the district the relief averages 4,000 feet (maximum 5,100), and though the slopes are steep the peaks are rounded. In the northern, the relief is about 5,500 feet (maximum 7,500); the slopes are steep; the peaks, sharp; mountain glaciers abound. A thick forest composed mainly of Douglas fir, western hemlock, and western red cedar covers all the land, except excessively steep slopes and "cleared" areas, up to an altitude of 4,000 feet. Above this the trees are much dwarfed, and few survive above 5,000 feet.

The shores of Harrison lake are principally low, rocky cliffs. Beaches form a very small proportion of the whole. The lake is deep, averaging over 100 fathoms throughout most of its length; however, at the south end

it has been silted up so that very slight depths (such as 3 fathoms) are encountered nearly midway across. The bottom is covered with fine silt containing some vegetable matter. In late winter and early spring the water is clear; during the rest of the year it is turbid, though never so foul as to be unfit to drink. The surface level has a maximum range of variation of about 7 feet. It is lowest in late winter and early spring, highest about midsummer, falls all summer, attaining a second minimum about the end of August, but rises to a second though inferior maximum in the autumn. The first minimum is due to the fact that at this time of the year precipitation takes the form of snow and so does not reach the lake; the first maximum is caused by the sudden melting of this snow in the early summer. The second minimum is due to depletion of the supply of snow water and lack of rain at this season, and the second maximum is the result of autumn rains.

The southernmost part of the district is traversed by the Canadian Pacific railway. A good road provides communication with Harrison Hotsprings at the south end of Harrison lake. Communication up and down the lake is effected entirely by boats.

Very little was known of the geology of this district at the time the investigation was commenced. No areal mapping had been done except around Agassiz, where the geology was known only in a very general way. The first reference to the geology of the district was made in the Director's Report,[1] Geological Survey, Canada, in 1888. It stated simply that the older Cretaceous rocks were extensively developed in Harrison Lake district. In the following year proof of this statement appeared, in the announcement that Amos Bowman had in 1882 collected *Aucella mosquensis* var. *concentrica* Fischer from several localities on Harrison lake.[2] In the same year Dawson[3] listed the localities of the hot springs—St. Alice' well at the south end of the lake, and St. Agnes' well 5 miles beyond the north end. The following year Hoffmann[4] gave analyses of the waters from the two springs, which compose St. Alice' well. In 1895 Stanton[5] reported that the *Aucellae* from Harrison lake belonged to the species *A. crassicollis* Keyserling.

Since these early contributions Harrison lake has scarcely been mentioned in the literature. There is no information of any importance except Bowen's reports on his reconnaissance of 1912 in which he barely touched the south end of Harrison lake, but provided a route map of the country about Agassiz.[6] Bowen discerned a fossiliferous sedimentary series, of which he gives a section, underlying the country around Agassiz. In his "Columnar Sections"[7] he called this the Agassiz series of Palæozoic age, but in his summary report[8] he used no name for it, but said it was of Lower Cretaceous or Jurassic age. He noticed that these rocks are intruded by a

[1]Selwyn, A. R. C.: Geol. Surv., Canada, Ann. Rept., vol. III (1888).
[2]Whiteaves, J. F.: Geol. Surv., Canada, Cont. to Can. Pal., vol. I, pt. 2, No. 4 (1889).
[3]Dawson, G. M.: "The Mineral Wealth of British Columbia"; Geol. Surv., Canada, Ann. Rept., vol. III (1889).
[4]Hoffmann, G. C.: "Chemical Contributions to the Geology of Canada"; Geol. Surv., Canada, Ann. Rept., vol. IV (1890).
[5]Stanton, T. W.: "The Fauna of the Knoxville Beds"; U.S. Geol. Surv., Bull. 133 (1895).
[6]Route-map between Lytton and Agassiz; Route-map between Agassiz and Vancouver; Geol. Surv., Canada, Guide Book No. 8, pt. II (1913).
[7]Columnar Sections. N. L. Bowen, In the Coast Range. Camsell, C.: Geol. Surv., Canada, Guide Book No. 8, pt. II (1913).
[8]Bowen, N. L.: "A Geological Reconnaissance of the Fraser River Valley from Lytton to Vancouver, British Columbia"; Geol. Surv., Canada, Sum. Rept. 1912 (1914).

large mass of granite; he mentions the quartz-porphyry on the railway west of Agassiz, which he regarded as of Lower Cretaceous (?) age, and with an unconformable relation toward the Agassiz series. The age of the Agassiz series is Upper Jurassic. The quartz porphyry flows, mentioned by Bowen, are part of the Porphyrite series, and are of Middle Jurassic age.

Harrison Lake valley has been produced by erosion of disordered sedimentary series of great thickness accompanied by several masses of plutonic rocks. The long axis of the lake is located mainly on what is believed to be the site of a great overthrust. This fault dips steeply to the east; Carboniferous and Triassic rocks to the east of it are thrust over Jurassic and Cretaceous rocks to the west. This great fault, which extends beyond the limits of the area, is single throughout most of its length, but in the middle part of Harrison lake it is divided into several subparallel and oblique faults between which are wedges of rock of the nature of schuppen. These are well illustrated by the structure of the peninsula, and that of Long island. In these two areas the surface is composed of narrow selvages of Jurassic and Cretaceous sediments, bearing their characteristic fossils, and all dipping to the east yet alternating with one another in a perfectly bewildering fashion. Such an arrangement could not possibly be the result of peculiarities of deposition, and could have been formed only by a succession of thrust faults. Throughout most of the zone the rocks have been considerably crushed.

The oldest rocks lying to the east of the thrust fault are dark grey argillites with massive limestone lenses bearing Pennsylvanian fossils. These crop out over the west flank of Bear mountain, at the south end of the area. They dip steeply to the east, being bounded on the west by the thrust fault, and to the east by an overlying thick accumulation of sediments, mostly argillites but with some beds of pyroclastics. This series borders the thrust fault on the east from Trout Lake creek to Fifteenmile creek and makes up all the mountains between these creeks. The sediments dip uniformly steeply to the east (or a few degrees north of east). They are considerably crushed, in some places even to the state of foliation. So far they have yielded no fossils, but it is suspected that they are of Triassic age. The total thickness has not been determined, but is estimated at 14,000 or 15,000 feet.

Overlying the supposedly Triassic series and, therefore, succeeding them to the north and east, is a thick formation of crushed greenstones of volcanic origin. This formation occupies most of the country east of Harrison lake. These rocks have been considerably crushed and are more or less schistose throughout, but apart from this there is a great resemblance as regards thicknesses and details of lithology and succession between these rocks and Jurassic rocks lying to the west of Harrison lake, but no fossils have been obtained from the greenstones lying east of the lake.

The oldest rocks west of the great thrust occur in a small patch on the west shore of the lake immediately south of Camp cove. They consist of some 3,000 feet of sediments, mostly argillites with some tuffs and a conglomerate bed. The conglomerate contains besides other things, pebbles of the fossiliferous Pennsylvanian limestones. The series has yielded no fossils of its own date; it belongs between the top of the Pennsylvanian and the base of the Middle Jurassic. These rocks lie in the centre of a short

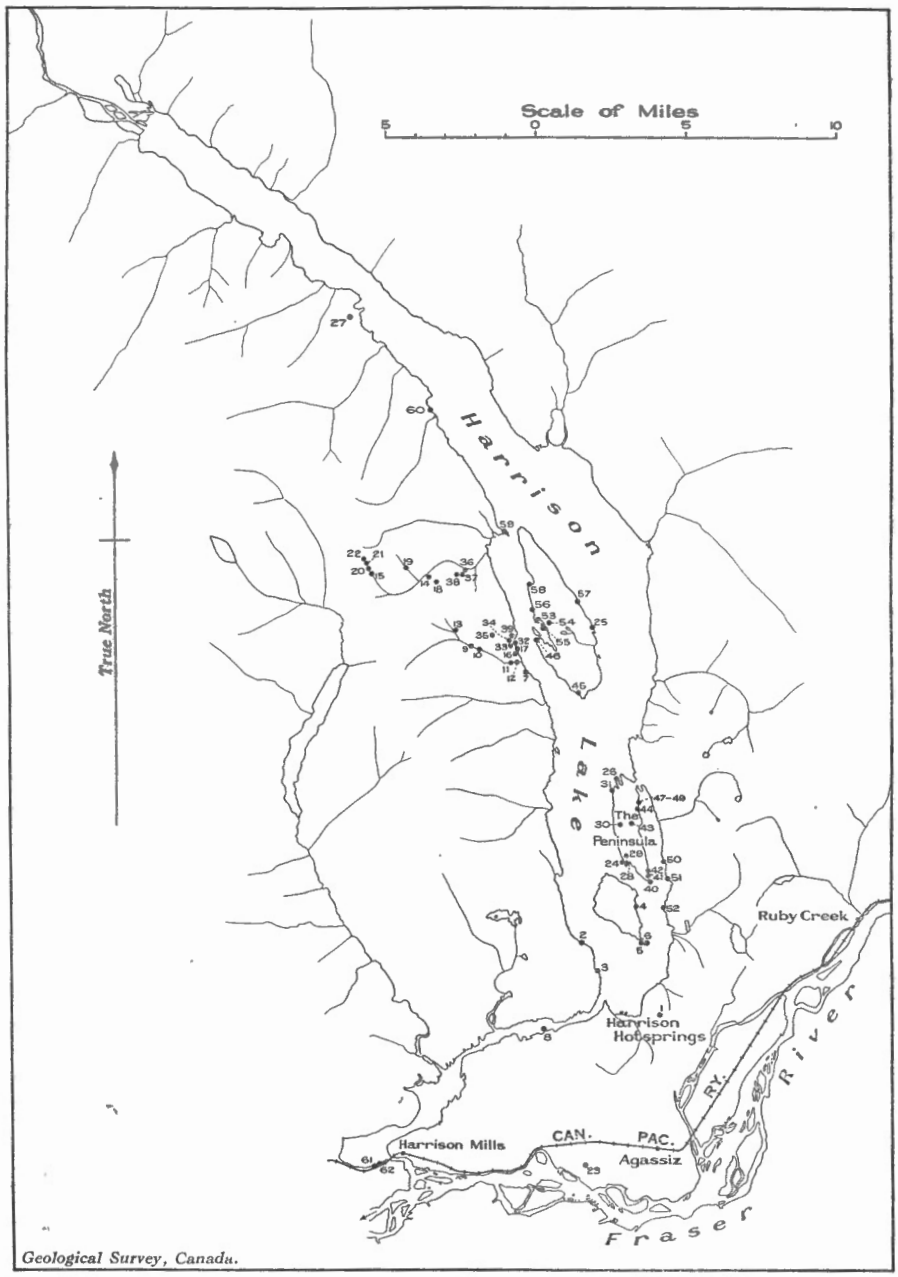


Figure 1. Index map showing positions of fossiliferous localities in the vicinity of Harrison lake, southwest British Columbia. Numbers correspond with those used in text.

anticline, and are surrounded by a thick accumulation of tuffs, agglomerates, and flows, which cover a very considerable area west of Harrison lake and occupy most of Echo island. The total thickness is about 9,000 feet. Fossils were obtained from a band of aqueous sediments in the lower part of the formation (locality No. 3, *See* Figure 1) and also from higher horizons. These show the volcanic assemblage to be of Middle Jurassic age.

To the north, near Deer creek, to the east on Echo island, and to the south on Harrison river, the volcanics are overlain conformably by well-stratified tuffs. These have an average thickness of 2,700 feet. Only a few fossils were found in them and none of these is indicative of exact dates. However, the formation is overlain conformably by dark grey argillites, the upper part of which yielded excellent fossils of early Upper Jurassic age. This deposit of argillite, which is about 2,400 feet thick, is well exposed from the mouth of Deer creek across the hills to the northwest, through the valley of Mysterious creek, and into the Chehalis Creek basin; also in another strip on the south side of Harrison river. In both sections the argillites are overlain by an accumulation of well-stratified tuffs that on Mysterious creek are about 1,800 feet thick. They have yielded early Upper Jurassic fossils.

The early Upper Jurassic argillites and tuffs on the south side of Harrison river are overlain unconformably by the rocks to which Bowen applied the name Agassiz series. The lower part of this series consists of about 3,000 feet of unfossiliferous conglomerates. These are overlain by about 5,000 feet of black argillites which contain poorly preserved, unidentifiable fossils. At this point the sequence is broken by the thrust faults. However, presumably the same formation occurs as narrow strips on the west shore of the peninsula where it yields the Argovian ammonite, *Anacardioceras*.

The argillites that on the peninsula are regarded as part of the Agassiz series and the stratified Upper Jurassic tuffs near Deer creek, are overlain unconformably by early Cretaceous deposits bearing abundant fossils, mostly of the genus *Aucella*. The lower part of the Cretaceous series consists of a basal conglomerate overlain by grey sandstones and totalling 1,260 feet in thickness. The upper part is made up of 2,200 feet of pyroclastics overlain by about 1,500 feet of sandstones composed of waste from the volcanics. These Cretaceous beds occur in a strip running northwest from the peninsula, along the west side of Long island, to Brokenback hill and beyond. This strip is cut off along its east side by the thrust fault.

The sedimentary rocks of the district are cut by plutonics thought to be of two ages. Those of one age are mostly altered quartz monzonite and occur in masses of various sizes, the largest of which is a batholith lying west of Chehalis creek. It intrudes the Middle Jurassic rocks and appears to have supplied pebbles to the basal conglomerate of the early Cretaceous. It is placed tentatively as late Jurassic.

The other plutonic intrusive is a fresh quartz diorite. It occurs in stocks in various parts of the area, notably between Agassiz and Harrison Hotsprings, and at Doctor point, also in a batholith lying mostly in the upper part of the Chehalis drainage basin. These quartz diorites cut both Jurassic and Cretaceous strata and intersect the great overthrusts

and the high-angled structures of the district. They are, therefore, subsequent to the main orogeny of the region which is thought to be Laramide.

A system of dykes of basalt cuts all the other rocks of the district. These are thought to be of fairly late date.

FOSSIL LOCALITIES AND FAUNAL LISTS

The localities, and the fossils found there, are here listed according to the known or presumed ages of the strata. Individual localities are distinguished by numbers and these numbers on the accompanying index map (Figure 1) indicate the positions of the various fossil-bearing localities.

PENNSYLVANIAN

(1) West side of Bear mountain, at an elevation of 2,000 feet, 1¼ miles due east of the Harrison Hotsprings hotel.

Large crinoid stalks—Melocrinidae?
Small crinoid stalks—Batocrinidae?

(2) West shore of Harrison lake, 2⅛ miles from Harrison River point. Conglomerates. The fossils occur in pebbles of limestone derived from a Pennsylvanian formation.

Productus cf. *clarkei* Ischernychew
Crinoidea, several species

JURASSIC

(3) West shore of Harrison lake, 1,820 yards north of Harrison River point.

Rhynchonella sp.
Entolium volcanicum Crickmay
Cylindroteuthis themis Crickmay

(4) East shore of Echo island, 1,860 yards north of the southeast corner.

Belemnites sp.

(5) South end of the first small islet southeast of Echo island.

Belemnites sp.
Pelecypoda, various unidentifiable forms.

(6) Northeast side of the second small islet southeast of Echo island.

Belemnites sp.

(7) West shore of Harrison lake, 600 yards south of the mouth of Deer creek.

Inoceramus ? sp.

(8) South shore of Harrison river on the west side of a small point 150 yards east of V. Macdonald's house, or 2¼ miles from Harrison River point.

Lilloettia sp.—crushed specimens of slightly earlier date than the described species

(9) Deer creek at 1,450 feet altitude, 1¾ miles from the mouth.
Lilloettia sp.

(10) Deer creek at 1,275 feet altitude, 1½ miles from the mouth.
Lilloettia sp.

(11) Deer creek at 300 feet altitude, 700 yards from the mouth.
Paracadoceras sp.

(12) Deer creek, ¼ mile from the mouth.
Paracadoceras harveyi Crickmay
Cadoceras catostoma Pompeckj
" *schmidti* "
" *brooksi* Crickmay
"Belemnites" sp.

(13) On the small tributary which joins Deer creek from the north at 1,700 feet elevation or 2¼ miles from the mouth.
Parallelodon sp.
Entolium hertleini Crickmay
Ammonoid fragment, cadoceratoid
"Belemnites" sp. indet.

(14) South side of Mysterious Creek valley 2½ miles from the mouth and at 1,400 feet elevation.
Parallelodon sp.
"Belemnites" sp.

(15) Billhook creek, a tributary to Mysterious creek, at 3,100 feet altitude, and 4 miles in a direct line from the mouth of Mysterious creek.
Callovian (Proplanulitan)
Anomia columbiana Crickmay
Lilloettia lilloetensis Crickmay
" *mertonyarwoodi* "
Buckmaniceras buckmani "

(16) One hundred yards from shore and 600 yards north of the mouth of Deer creek.
"Belemnites" sp.

(17) West shore of Harrison lake, 720 yards north of the mouth of Deer creek.
Pelecypoda, various, unidentifiable

(18) Southwest slope of Fossil hill at 1,850 feet.
Haidaia aff. *dawsoni* Whiteaves
"Belemnites" sp.

(19) Small creek 1 mile east of Billhook creek at 1,500 feet.
Astarte harrisonensis Crickmay
(in talus)

(20) Billhook creek at 3,270 feet elevation and slightly over 4 miles from the mouth of Mysterious creek.
Cylindroteuthis sp.

(21) Billhook creek at 3,400 feet elevation.
Haidaia aff. *dawsoni* Whiteaves
" *billhookensis* Crickmay (talus)
" *packardi* " (talus)
Ammonoid, a young cadoceratoid form

(22) Billhook creek at 3,600 feet elevation.

Pelecypoda, various, unidentifiable
Haidaia statluensis Crickmay
Ammonoid, a young cadoceratoid form
"Belemnites" sp.

(23) Southernmost tip of the more westerly of the two small hills lying west of Agassiz.

Ammonoid, indeterminable

(24) Southwest side of a narrow point which bounds on the west the small bay on the southwest shore of the peninsula, and 1,850 yards from the southeast point of the peninsula.

Parallelodon cardioceratanum Crickmay
Anacardioceras perrini Crickmay
Phylloceras columbianum Crickmay

(25) East shore of Long island, 2½ miles from its south end.

Ammonoid, a young cadoceratoid form
"Belemnites" sp.

(26) A little islet off the middle of the three points at the north end of the peninsula.

"Belemnites" sp.

(27) At 250 feet altitude on hillside half a mile south-southwest from Doctor point.

Ammonoid, indeterminable

CRETACEOUS

(28) West shore of a little bay on the southwest shore of the peninsula.

Aucella acutistriata Crickmay
" *catamorpha* "
" *spasskensoides* "
" *cascadensis* "
" *canadiana* "
Entolium aucellarum "

(29) On the hillside one-quarter mile due north of the last locality.

Aucella catamorpha Crickmay
" *spasskensoides* "
" sp.

(30) One-third mile south of the highest peak on the peninsula.

Aucella spasskensoides Crickmay
" *canadiana* "
" sp.

(31) West shore of peninsula 3⅓ miles in a straight line from its southern tip.

Aucella acutistriata Crickmay
" *catamorpha* "
" *spasskensoides* "
" *canadiana* "
"Belemnites" sp.

(32) West shore of Harrison lake, 900 yards north of the mouth of Deer creek.

Aucella acutistriata Crickmay
" *spasskensoides* "
" *canadiana* "
Cylindroteuthis baculus Crickmay
Pachyteuthis eocretacicus "

(33) Three hundred and fifty yards west of the shore of the lake and 1,200 yards north of the mouth of Deer creek.

Aucella acutistriata Crickmay
" *catamorpha* "
" *spasskensoides* "
" *cascadensis* "
" *canadiana* "

(34) Three hundred and fifty yards from shore and 1,400 yards north of the mouth of Deer creek.

Aucella acutistriata Crickmay
" *spasskensoides* "
" *cascadensis* "
Entolium aucellarum "
Mclearnia mclearni "
Astarte barbara "
Phylloceras aff. *knoxvillense* Stanton
" sp. indet.
Cylindroteuthis baculus Crickmay
Pachyteuthis eocretacicus Crickmay

(35) One and two-fifths miles northwest of the mouth of Deer creek, at an elevation of 1,000 feet.

Aucella acutistriata Crickmay
" *catamorpha* "
" *canadiana* "
" *spasskensoides* "

(36) Right bank of Mysterious creek at 1,000 feet altitude.

Aucella acutistriata Crickmay
" *spasskensoides* "

(37) North slope of Fossil hill, 250 yards southwest of a point on Mysterious creek of 1,000 feet altitude.

Aucella acutistriata Crickmay
" *spasskensoides* "

(38) Two hundred and fifty yards west of the last locality.

Aucella acutistriata Crickmay
" *spasskensoides* "

(39) Two hundred and thirty-five yards from the shore, on the left bank of a little brook that enters Harrison lake from the west, 1,500 yards north of the mouth of Deer creek.

Aucella kwoiekensis Crickmay
Quoiecchia aliciae "

(40) Lonetree island, off south tip of peninsula.

Aucella crassicollis Keyserling
Aucella solida Lahusen

(41) East shore of peninsula, 200 yards north of Lonetree island.
Aucella crassicollis Keyserling
" *solida* Lahusen
" *harrisonensis* Crickmay
" *gigas* "
Pleuromya harrisonensis "
Homolsomites poecilochotomus Crickmay

(42) East shore of peninsula 400 yards north of Lonetree island.
Aucella crassicollis Keyserling
" *solida* Lahusen
" *harrisonensis* Crickmay
Pleuromya harrisonensis "
Homolsomites poecilochotomus Crickmay

(43) Half a mile southeast of the highest peak on the peninsula.
Pelecypod, unidentifiable

(44) East shore of peninsula, 2½ miles north of Lonetree island.
Aucella crassicollis Keyserling

(45) West shore of Long island 400 yards north of its southern tip.
Aucella crassicollis Keyserling
" *solida* Lahusen

(46) Little islet on south side of south entrance to Roberts bay, west side of Long island.
Aucella crassicollis Keyserling
" *solida* Lahusen

(47) South shore of a little point on the west side of Cascade bay, 1,090 yards south of the north end of that bay; or 4,660 yards north of Lonetree island.
Aucella teutoburgensis Weerth
Yaadia lewisagassizi Crickmay

(48) Forty feet east of the *Yaadia lewisagassizi* locality on south shore of a little point on west side of Cascade bay 1,090 yards due south of the north end of that bay.
Aucella somewhat crushed and not identifiable with certainty, but probably the sharp ribbed species of the *canadiana* zone

(49) Northeast side of the little point on west side of Cascade bay, 1,090 yards due south of the north end of that bay.
Aucella somewhat sheared and so unidentifiable, but probably the sharp ribbed species of the *canadiana* zone

(50) East side of Cascade bay 2⅔ miles from the north end of that bay, also
(51) East side of Cascade bay 3¼ miles from the north end of that bay, also
(52) East side of Cascade bay 4⅙ miles from the north end of that bay.
Aucellae, greatly sheared and so unidentifiable, but probably the sharp ribbed species of the *canadiana* zone

(53) Northwest corner of Roberts bay, west side of Long island.
Aucellae, somewhat crushed and so unidentifiable, but probably the sharp ribbed species of the *canadiana* zone

(54) East side of Roberts bay 650 yards from the north end, also

(55) Islet, 100 yards west of the last locality, also

(56) West shore of Long island, $2\frac{3}{4}$ miles south of the north end of that island, also

(57) East shore of Long island, $3\frac{1}{4}$ miles in a straight line from the north end of that island.

Aucellae, strongly sheared and so unidentifiable, but probably the sharp ribbed species of the *canadiana* zone

(58) West side of Long island, barely 2 miles south of the north end of that island.

Aucellae, considerably crushed and so unidentifiable with certainty, but nevertheless very probably *Aucella crassicollis* Keyserling

(59) North side of Twentymile point, one-quarter mile from the point, also

(60) West shore of Harrison lake, one-half mile south of Rock point.

Pelecypoda, unidentifiable fragments
"Belemnites" sp. indet.

(61) Cut bank on south side of main line of Canadian Pacific railway 838 yards west of the west end of the Harrison River bridge.

Strongylocentrotus drobachiensis Müller
Mytilus edulis Linnæus
Terebratalia transversa Sowerby?
Balanus crenatus Bruguière

(62) Cut bank on south side of main line of Canadian Pacific railway 750 yards west of the west end of the Harrison River bridge.

Saxicava rugosa Linnæus
Other pelecypoda, indeterminable fragments

DESCRIPTION OF FOSSILS

Phylum, **ECHINODERMATA**

Class, *CRINOIDEA*

Order, **Camerata**

Family, MELOCRINIDAE?

Genus, (?)

Fragments of large stalks, 10 to 27 mm. in diameter, the joints of which exhibit the structure and intercolumnal spaces of those of this family. They are imperfectly preserved and do not admit of complete study.

Locality. West side of Bear mountain at 2,000 feet elevation, $1\frac{1}{4}$ miles due east of Harrison Hotsprings hotel. Similar crinoid stalks are common at the type locality of the Chilliwack series on Chilliwack river, also in the Pennsylvanian rocks of Kamloops district, British Columbia.

Family, BATOCRINIDAE?

Fragments of smaller stalks which closely resemble in a superficial way those of this family. The reference is, of course, far from certain. There are probably several forms: the shapes of the small columnals differ somewhat. Diameters from 3 to 8 mm.

Locality. West side of Bear mountain at 2,000 feet, 1¼ miles due east of the Harrison Hotsprings hotel.

Class, *ECHINOIDEA*

Order, **Centrechinoidea**

Family, STRONGYLOCENTROTIDAE

Genus, *Strongylocentrotus* Brandt

Strongylocentrotus drobachiensis Müller

Fragments of corona and spines belonging to this species.

Locality. Main line of Canadian Pacific railway 838 yards west of the west end of Harrison River bridge.

Phylum, **MOLLUSCOIDEA**

Class, *BRACHIOPODA*

Order, **Protremata**

Family, PRODUCTIDAE

Genus, *Productus*

Productus cf. *clarkei* Tschernychew

Specimens comparable with this species from limestone pebbles in conglomerate.

Locality. West shore of Harrison lake 2⅛ miles from Harrison River point.

Order, **Telotremata**

Family, RHYNCHONELLIDAE

Genus, *Rhynchonella*

Rhynchonella sp.

Indeterminable fragments belonging to this genus.

Locality. West shore of Harrison lake 1,820 yards from Harrison River point.

Family, TEREBRATELLIDAE

Genus, *Terebratalia*

Terebratalia transversa Sowerby?

Small, decrepitated fragments that have the structure of this species. Occurs with *Mytilus edulis* and *Strongylocentrotus drobachiensis*.

Locality. On main line of Canadian Pacific railway 838 yards west of the west end of Harrison River bridge.

Phylum, MOLLUSCA

Order, Prionodesmacea

Family, PARALLELODONTIDAE

Genus, *Parallelodon* Meek

Parallelodon cardioceratanum sp. nov.

Plate VIII, figures 1, 2, 3

Surface marked only by excessively delicate, concentric lines.

Dimensions. Holotype, a left valve—length, 22 mm.; height, 14; semidiameter (diameter of one valve, or distance from lateral convexity to median plane), 5.

Locality. Southwest shore of peninsula, on west side of point that bounds the small bay.

Family, PERNIDAE

Genus, *Inoceramus* Sowerby

Indeterminable fragments belonging to this genus.

Locality. West shore of Harrison lake, 600 yards south of Deer creek.

Family, PTERIIDAE

Genus, *Mclearnia* gen. nov.

A giant pteriid without sculpture. Right valve flattish with pectiniform byssal notch. Left valve, somewhat more convex. Ears, subequal, all well developed. Chondrophore, small, central, and vertical.

Mclearnia mclearni sp. nov.

Plate VIII, figure 4; Plate IX, figure 1

Umbo lies at centre of hinge-line, somewhat posterior to centre of disk, giving the shell a peculiar outline. Shell is much thickened in the umbonal region. Surface smooth except for occasional growth-lines. When split the shell shows traces of fine, radial ribbing. Interior smooth except for the single, large, bilobate muscle-scar; and two curved lines of "dimples", one on each side of the umbo. These appear in the figures, as does also the central chondrophore.

Dimensions. Holotype, a right valve seen from interior aspect—length, 115 mm.; height, 112; semidiameter, 11; hinge-line, 71. Paratype, a left valve, cast of interior—height, 118; semidiameter, 25; hinge-line, 78.

Locality. Zone of *aucella canadiana*, west side of Harrison lake 350 yards from shore and 1,400 yards north of Deer creek.

Name. Generic and specific name after F. H. McLearn, palæontologist.

Family, MYALINIDAE

Genus, *Aucella* Keyserling

The species of *Aucella* from Harrison lake form a considerable and an important assemblage belonging to four separate hemeræ. This was obvious at the beginning of this study, but at that time it was thought that the earliest Harrison forms corresponded to the earliest California Cretaceous species—*Aucella piochii*, and, in consequence, some mistaken identifications were made. Subsequently, larger collections and a more exhaustive study have shown that the species of the *A. canadiana* zone are later than *A. piochii*. Moreover, they are not related to that species but rather to the group of *A. bononiensis*. They seem to represent large shelled derivatives of this group evolved during the great expansive evolution of *Aucellae* which occurred at the end of the Jurassic period. They represent one of the earliest Cretaceous hemeræ, probably that of *Craspedites stenomphalus*. The other Harrison *Aucellae*, except *A. kwoiekensis*, belong to the period of restrictive and degenerative evolution of *Polyptychites polyptychus* and later time.

Aucella acutistriata sp. nov.

Plate IX, figure 2

Resembles *A. andersoni* somewhat but differs in its much larger size and greater diameter. The ornament consists of concentric costæ that are as sharp as knife-blades and stand 0·5 to 1 mm. above the general surface. They are spaced 8 or 9 in a cm. of radius. Become obsolete on anterior and posterior ends of shell which are striate concentrically.

Dimensions. Holotype, a left valve—long axis, 78 mm.; short axis, that is the greatest line at right angles to the long axis, 42; semidiameter, 28; apical angle, 69 degrees. Paratype, both valves in contact: left—long axis, 42; short axis, 25; semidiameter, 13; apical angle, 65 degrees; right—long axis, 39; short axis, 25; semidiameter, 11; apical angle, 80 degrees.

Locality. Zone of *Aucella canadiana*, west side of Harrison lake, 350 yards from shore and 1,200 yards north of Deer creek.

Aucella catamorpha sp. nov.

Plate IX, figure 5

Very similar to the last except that the shell is unornamented. It is marked only by growth lines. Also the right valve has a more acute apical angle, and the diameter is slightly less.

Dimensions. Holotype, right valve—long axis, 37 mm.; short axis, 25; semidiameter, 7; apical angle, 60 degrees.

Locality. Zone of *Aucella canadiana*, west side of a small bay on southwest shore of the peninsula.

Aucella spasskensoides

Plate IX, figures 3, 4

Resembles *A. spasskensis* Pavlow, but the diameter is notably greater and the right valve has a greater apical angle. Strong concentric costæ, sharp as in *A. acutistriata*, spaced 4 to 5 in a cm. of radius on the mature shell, though closer in the umbonal region.

Dimensions. Holotype, right valve—long axis, 38 mm.; short axis, 29; semidiameter, . . ; apical angle, 80 degrees; right valve—long axis, 36; short axis, 29; semidiameter, 7; apical angle, 90 degrees. Paratype, left valve—long axis, 55; short axis, 39; semidiameter, 16; apical angle, 67 degrees. The largest specimen found, a left valve, had a long axis measuring 60 mm.

Locality. Zone of *Aucella canadiana*, west side of small bay on southwest shore of peninsula.

Aucella cascadensis sp. nov.

Plate X, figures 1, 2

Having the same general aspect of the *fischeriana* stock which the last species shows. The costation is wider spaced; 3 costæ in a centimetre of radius on the mature shell. Also the costæ are sharp like those of *A. acutistriata.*

Dimensions. Holotype, left valve—long axis, 57 mm.; short axis, 43; semidiameter, 15; apical angle, 80 degrees. Paratype, right valve—long axis, 63; short axis, 54; semidiameter, 15; apical angle, 105 degrees.

Locality. Zone of *A. canadiana*, west side of Harrison lake, 350 yards from shore and 1,200 yards north of Deer creek.

Name. Cascade mountains.

Aucella canadiana sp. nov.

Plate X, figures 3, 4, 5

This form has departed farther from the *fischeriana* ancestry than the preceding species. These costæ are wide spaced: 1·5 to each centimetre of radius, and are sharp like those of *A. acutistriata.*

Dimensions. Holotype, a left valve—long axis, 54 mm.; short axis, 43; semidiameter, 22; apical angle, 75 degrees. Paratype, right valve—long axis, 60; short axis, 49; semidiameter, 12; apical angle, 93 degrees.

Locality. Zone of *Aucella canadiana*, west side of Harrison lake 350 yards from shore and 1,200 yards north of Deer creek.

Name. A Canadian species, and peculiarly so, because it is strikingly different from any of the foreign forms.

Aucella kwoiekensis sp. nov.

Plate X, figures 6, 7

Resembles members of the *inflata* group, but differs markedly from all in proportions and in the fine, closely spaced, concentric striæ. Byssal sinus unusually long.

Although Pavlow suggests a very different history, yet it is quite possible that this form is ancestral to the *crassicollis* group.

Dimensions. Holotype, a right valve—long axis, 42 mm.; short axis, 38; semidiameter, 15; apical angle, 90 degrees.

Locality. Zone of *Quoiecchia aliciae*, 235 yards from shore, on the left bank of a little brook which enters Harrison lake from the west, 1,450 yards north of the mouth of Deer creek.

Name. Kwoiek, Indian geographical name.

Aucella crassicollis Keyserling 1846

1846. Keyserling: Wissenschaftliche. Beobachtungen auf einer Reise in dar Petschoraland.

The left valve is very strongly convex, and the left umbo is strongly incurved. Right valve, less so. The long axis of the left valve is about twice the short axis. The form is rather irregular. The external surface is marked by fine growth lines and concentric varices. The latter appear with maturity, but at slightly different stages in different specimens.

Locality. Zone of *Homolsomites poecilochotomus*, Lonetree island; also on the southeastern shore of the peninsula, etc.

Aucella solida Lahusen

Aucella crassicollis var. *solida* Lahusen 1888: Mem. du Comite géol., St. Petersburg, vol. VIII, No. 1.

This species somewhat resembles the last, but differs in that the long axis is not much greater than the short.

Locality. Occurs associated with the last at all localities.

Aucella harrisonensis sp. nov.

Plate XI, figures 1, 2, 3

Left valve, somewhat convex. Left umbo, slightly incurved. Right valve, flattish. Right umbo, short, obtuse, and almost ecurved. Shell, very thin, and, consequently, there is no ornament except joint growth lines. Concentric varices appear beyond 25 mm. from the umbo in some specimens.

Dimensions. Holotype, a right valve—long axis, 32 mm.; short axis, 30; semidiameter, 8; apical angle, 95 degrees. Paratype, a left valve—long axis, 30 mm.; short axis, 20; semidiameter, 9; apical angle, 73 degrees.

Locality. Zone of *Homolsomites poecilochotomus*, southeast shore of the peninsula, 200 yards from the south end.

Aucella gigas sp. nov.

Plate XI, figures 4, 5, 6

Valves resemble each other strongly in shape. Both are broad, flattish, and rounded ventrally. Umbones, short, obtuse, very slightly incurved. Ornament of obtuse, concentric costæ that have a very characteristic curve. Ornament degenerates beyond 35 mm. from the umbo.

Dimensions. Holotype, left valve—long axis, 100 mm.; short axis, 78; semidiameter, 20; apical angle, 80 degrees; right valve — long axis, 83 mm.; short axis, 72; semidiameter, 16; apical angle, 90 degrees.

Locality. Zone of *Homolsomites poecilochotomus*, southeast shore of the peninsula 200 yards from the south end.

Name. From the fact that it is the largest *Aucella* known.

Aucella teutoburgensis Weerth

Avicula (?) *teutoburgensis* Weerth 1884: Palaeont. abhandl. Bd. II.

Both valves notably convex, left valve somewhat more so than right. Umbones incurved. The outline is characteristic. Ornament, striate.

Locality. Zone of *Yaadia lewisagassizi*, on south shore of a little point on the west side of Cascade bay 1,090 yards south of the north end of that bay.

Family, TRIGONIIDAE

Genus, *Haidaia* Crickmay

Of the Harrison Lake species referred to this genus only one is typical. This form, related to *H. dawsoni* Whiteaves, is unluckily not represented by material good enough for specific description. The other three are new species which are referred to this genus for convenience, as it seems undesirable to make any further division until more forms are known.

Haidaia sp. nov. aff. *H. dawsoni* Whiteaves

Fragments of a new form, similar to *dawsoni* in the main but larger, longer in proportion to height, and having a narrower area.

Locality. Southwest slope of Fossil hill at 1,850 feet; and on Billhook creek at 3,400 feet.

Haidaia billhookensis sp. nov.

Plate XII, figure 1

Costæ, numerous for a member of this genus. Tubercles, numerous, arranged in concentric series, degenerating toward basal margin. Costellæ become irregular at maturity, rather resembling coarse growth lines. Marginal carina at maturity is a line of weak, irregularly spaced bullæ. Median carina, lacking. Inner carina, not seen. Median furrow, shallow.

Dimensions. Length, 77 mm.; height, 70; semidiameter, 25.

Locality. Talus at 3,400 feet on Billhook creek.

Name. After the locality.

Haidaia packardi sp. nov.

Plate XII, figures 2, 3

Radial costæ, strong. Tubercles, strongest on a concentric zone midway between umbo and base; that is, degenerating before maturity—a sign of catamorphism. Tubercles are arranged in concentric series and are joined by weak, concentric costæ. Costellæ, very fine, degenerating with maturity to coarse, irregular striæ resembling rugose growth lines. Inner and marginal carinæ strong, coarsely tuberculate. Median carina, absent. Furrow, weak. Posterior basal margin has three or four crenulations on the inside.

Dimensions. Length, 70 mm.; height, 58; semidiameter, 20.

Locality. Talus at 3,400 feet on Billhook creek.

Name. After E. L. Packard, in recognition of his work on west American Trigoniae.

Haidaia statluensis sp. nov.

Plate XII, figures 4, 5, 6

Costæ weak, though marked by strong, obtuse tubercles that are arranged in concentric series and joined by concentric costæ. Two figures of specially prepared artificial casts are introduced to show this peculiarity, which does not appear very plainly on the holotype. Both costæ and tubercles are small and weak on the umbonal region and anterior end. Area marked by faint, transverse striæ which become with maturity coarse costellæ. Carinæ not specially marked. Furrow, shallow, becoming obsolete with maturity.

Dimensions. Length, 65 mm.; height, 54; semidiameter, 15.

Locality. Billhook creek at 3,600 feet.

Name. Geographical—Statlu creek.

Genus, *Yaadia* gen. nov.

Genotype, *Yaadia lewisagassizi* sp. nov.

This genus is instituted for a branch of the pseudoquadrate Trigoniae that has a discrepant ornament on the anterior end of the disk, and so can not well be included in the true pseudoquadrates, genus *Steinmanella* nov. genotype of which is *S. holubi* Kitchin. The discrepant anterior ornament of Yaadia is not necessarily any indication of relationship with *Scaphitrigon*, because this kind of thing might well be developed independently. *Steinmanella* is an Indo-Pacific genus of the early Cretaceous. *Yaadia* is presumably a north Pacific group of the same time.

Name. From Yaada, Indian legendary name.

Yaadia lewisagassizi sp. nov.

Plate XIII, figures 1, 2

Near the umbo, the two sets of ornament are united into one resembling that of Trigonia s.s. The two sets of ornament on the disk are separated by a perfectly smooth area. Carinæ marked only by rows of coarse

tubercles (bullæ), which are widely spaced and have a peculiar oblique elongation. Area, otherwise smooth. Escutcheon, marked by transverse lines of small tubercles continuous with tubercles of inner carina.

Dimensions. Length, 77 mm.; height, 63; semidiameter, 22. This length and height may be slightly vitiated by diastrophic distortion.

Locality. Zone of *Yaadia lewisagassizi*, on the south shore of a little point on the west side of Cascade bay, 1,090 yards south of the north end of that bay. Occurs with *Aucella teutoburgensis.*

Name. In honour of Captain Lewis N. Agassiz, Royal Welsh Fusiliers, one of the pioneers of British Columbia.

Genus, *Quoiecchia* gen. nov.

Genotype, *Quoiecchia aliciae* sp. nov.

The genus is distinguished by the small-sized shell and the peculiar arrangement of the ornament. It is unlike any other group of Trigoniae, though there is a suggestion of this style of ornament in *Haidaia statluensis.*

Name. From Kwoiek, Indian geographical name.

Quoiecchia aliciae sp. nov.

Plate XIII, figures 3-8

According to the Agassiz classification this species would be referred to "les lisses" (glabrae of Lycett), a group of composite origin, being smooth derivatives of various stocks. The form is probably an aberrant offshoot of the great, protean *Haidaia.* The ornament of the disk is formed by two sets of furrows. One, a radial set, is strong near the umbo but becomes obsolete near the middle of the disk. The other, a concentric set, appears first at 10 mm. from the umbo and becomes increasingly stronger toward the basal margin. The spaces between furrows stand up as low, obtuse costæ; between two intersecting sets of furrows, as low, squarish tubercles. The carinæ are obsolete, the area being ornamented only by the posterior continuation of the concentric furrows. The interior surface of the posterior half of the basal margin is crenulated, forming four or five broad, tooth-like processes which interlock in opposite valves when the shell is closed.

Dimensions. Holotype, a right valve—length, 21 mm.; height, 19; semidiameter, 6. Paratype, a right valve—length, 30; height, 34; semidiameter, 15. This shows that as it grows the shell becomes disproportionately high and robust.

Locality. Zone of *Quoiecchia aliciae,* 235 yards from lake shore, on the left bank of a little brook that enters Harrison lake from the west 1,450 yards north of the mouth of Deer creek.

Name. Geographical—St. Alice' well.

Family, PECTINIDAE

Genus, *Entolium* Meek

Entolium hertleini sp. nov.

Plate XIV, figure 1

Shell, very flat. Ears, small. Upper margins of the ears make a shallow re-entrant. External surface appears smooth, but the X 10 power of magnification shows it to be marked by even, continuous, concentric striæ. These have a characteristic curve which is shown in the plate by a black line. Lateral margin of disk, also ears, are marked by faint, microscopic radial striæ as well. The species is very similar to the wide variety of *Entolium leachii* McLearn, but is separable by its smaller ears, concentric curve.

Dimensions. Holotype—length, 27 mm.; height, 27; semidiameter, 2; base of anterior ear, 5·5; base of posterior ear, 7; upper margins of ears, total 6·5; re-entrant angle, 165 degrees; apical angle, 115 degrees. Paratype—length, 57; height, 56; apical angle, 125 degrees. Both types are right valves.

Locality. Above zone of *Cadoceras brooksi*, at an altitude of 2,100 feet on a small brook which enters Deer creek from the north at 1,700 feet.

Name. After Mr. Leo G. Hertlein.

Entolium vulcanicum sp. nov.

Plate XIV, figure 2

Shell, very flat, large. Ears, small, with a notable re-entrant above. Next below the dorsal margin of the shell, and bounded below by a radial line, there is an area where the shell is thickened. These are plainly visible in the figure. Exterior, smooth or nearly so. Some specimens have an appearance of faint, concentric striæ.

Dimensions. Holotype, a left valve—length, 68 mm.; height, 62; semidiameter, 4; base of anterior ear, 12; base of posterior ear, 17; upper margins of ears, total, 17; re-entrant angle, 140 degrees; apical angle, 128 degrees.

Locality. Associated with *Cylindroteuthis themis*, on the west shore of Harrison lake, 1,820 yards north of Harrison River point.

Name. In allusion to habitat. The species was an inhabitant of the powerfully volcanic British Columbia of Bajocian times.

Entolium aucellarum sp. nov.

Plate XIV, figure 3

Shell, flat, smooth. The ears are larger than those of *E. hertleini* and *E. vulcanicum*, and are of a different shape from those of either, or of *E. leachii* McLearn. As is usual with this genus the apical angle increases with age.

Dimensions. Holotype, a right valve—length, 27 mm.; height, 29; midiameter, 2; base of anterior ear, 7; base of posterior ear, 8; upper

margins of ears, total, 9; re-entrant angle, 160 degrees; apical angle, 113 degrees.

Locality. Zone of *Aucella canadiana*, west side of a small bay on the southwest shore of the peninsula.

Name. The species is a syntopite with the *Aucellae* of the *canadiana* zone.

Family, ANOMIIDAE

Genus, *Anomia* Linné

Anomia columbiana sp. nov.

Plate XIV, figures 4, 5, 6

Differs from *A. albertensis* McLearn in its larger size and in having a much finer ornament of radial striæ. The striæ become slightly stronger as they strike the margin of the shell. The outline of the shell is rather variable. The shell is marked also by concentric irregularities of surface comparable with varices.

Dimensions. Holotype—equidimensional, though somewhat crushed; width, 57 mm. Paratype—width, 55; height, 60.

Locality. Zone of *Lilloettia lilloetensis*, on Billhook creek at 3,100 feet altitude.

Name. After British Columbia.

Family, MYTILIDAE

Genus, *Mytilus* Linnaeus

Mytilus edulis Linnaeus

Fragments of this common living species, very typical as regards form and dimensions.

Locality. Main line of Canadian Pacific railway, 838 yards west of the west end of the Harrison River bridge.

Order, **Anomalodesmacea**

Family, PLEUROMYACIDAE

Genus, *Pleuromya* Agassiz

Pleuromya harrisonensis sp. nov.

Plate XV, figures 1, 2, 3

Shell, pleuromyiform, small, robust, not perceptibly gaping, having a shallow sulcus in the antero-lateral area running radially from umbo to basal margin. Cardinal area obscure. Post-umbonal slope, concave. Posterior dorsal margin, expanded postero-dorsally. No cardinal groove. Maximum diameter is vertically below the umbones. Ornament of concentric wrinkles, which become weak on the posterior end of the shell. They are obscured by matrix on the anterior end of the only specimen.

Dimensions. Holotype—length, 42 mm.; height, 35·5; semidiameter, 13; horizontal distance from anterior extremity to umbo, 15.

Locality. Zone of *Homolsomites poecilochotomus*, on the southeast shore of the peninsula.

Order, **Teleodesmacea**

Family, ASTARTIDAE

Genus, *Astarte* Sowerby

Astarte harrisonensis sp. nov.
Plate XV, figures 4, 5

Lunule and escutcheon, deeply impressed. Ornament of high, concentric costæ, which are somewhat irregular as to size and continuity. On a shell of 21 mm. height there are 8½ costæ in 10 mm. of radius, counted about the centre of the disk. Superimposed upon this ornament are fine growth lines visible only with a magnifier. The whole basal margin from lunule to escutcheon is finely denticulate inside. The species might be confused with *A. dacotensis* Whitfield and Hovey, but it is distinguished by its much less diameter.

Dimensions. Holotype—length, 21 mm.; height, 21; semidiameter, 4·3; apical angle, 108 degrees.

Locality. Talus on small creek one mile east of Billhook creek at 1,500 feet altitude.

Astarte barbara sp. nov.

Plate XV, figure 6

Subquadrate, with the umbo extremely anterior. Ornament of weak, concentric costæ. Basal margin, denticulate. Somewhat resembling *A. californica* Stanton, but differing in the more anterior and less prominent umbo.

Dimensions. Holotype—length, 38 mm.; height, 30; semidiameter, 5·5; apical angle, 116 degrees.

Locality. Zone of *Aucella canadiana*, west side of Harrison lake 350 yards from shore and 1,400 yards north of the mouth of Deer creek.

Name. The word *barbarus* denoted to the Romans that which was not Roman, that is to say, foreign. So this *Astarte*, a lonely foreigner in the great community of *Aucellae* of the *canadiana* zone, may well be called *barbara*.

Family, SAXICAVIDAE

Genus, *Saxicava* Fleurian

Saxicava rugosa Linnaeus

Two well preserved specimens from the clay of the Squawkum formation.

Locality. Main line of Canadian Pacific railway, 750 yards west of the Harrison River bridge.

Class, *CEPHALOPODA*

Order, **Ammonoidea**

Family, CARDIOCERATIDAE

The family name was published first by Hyatt who included *Cardioceras, Cadoceras, Quenstedioceras* (Hyatt[1] always spelled it this way so we can not accept *Quenstedtoceras* as Buckman insists nor *Quenstedticeras* as Reeside demands), and *Neumayria*. H. Douville's supposed publication was not distributed. In 1900 Hyatt attempted to change the name to Cadoceratidae, but this is not valid. Also some later writers have included a lot of utterly unrelated genera, which has caused some confusion. However, excellent summaries of the family have been given by Buckman[2] whose interpretation of the group is clear and connected. Many genera occur in North America as yet unreported. For instance, among the species described by Reeside[3] under *"Quenstedticeras"* and *Cardioceras* there are a dozen or so generic groups; some named, some unnamed. Two known genera and one new genus occur in the Upper Jurassic deposits of the Harrison Lake country. The occurrence of species of *Cadoceras* in the Mysterious Creek formation establishes the general age of that deposit. Also it establishes the exact date of *Paracadoceras* gen. nov. which is associated with *Cadoceras*. Also it establishes the approximate date of *Lilloettia* and *Buckmaniceras*, family Macrocephalitidae, which occur a short distance above *Cadoceras* and associated with cadoceratoid forms close to *Cadoceras*, but not sufficiently fully grown to be generically identified.

Genus, *Paracadoceras* nov.

A cadoceratoid serpenticone. The young is like that of *Cadoceras*, but inflation that supersedes the elevation of the whorl is so moderate that the mature form is only a robust serpenticone. Ribbing notably prorsiradiate. However, the genus differs strongly from *Prorsiceras* Buckman in that the number of secondary ribs is less than double that of the primaries, and in its narrow umbilicus and depressed whorls. Also in the ventral ribbing.

Paracadoceras harveyi sp. nov.

Plate XVI, figures 1, 2; Figure 2

Ornament. In the young that part of the rib within the umbilicus is reclined as in the Canadian and Alaskan *Cadocerata*, but at 27 mm. diameter this part of the rib becomes versiradiate. The extrumbilicate portion of the rib is prorsiradiate at all stages. Ribs cross venter with only a slight forward bend. Venter is almost smooth on last part of last whorl.

Table showing number of ribs in a quadrant at various stages.

Diameter		
18 mm	10 primaries	14 secondaries
34 "	8½ "	14 "
53 "	8 "	15 "

[1]Hyatt: Bull. Geol. Soc. Am., vol. 3, p. 410 (1892).
[2]Type Ammonites, vols. II and III (1913–1921).
[3]Reeside: U.S. Geol. Surv., Prof. Paper 118 (1919).

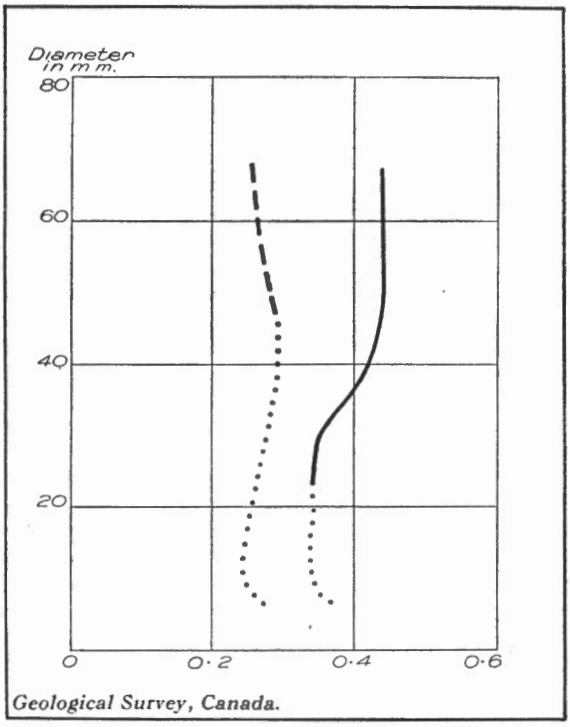


Figure 2. *Paracadoceras harveyi* sp. nov.; width of umbilicus and thickness of whorls expressed as fractions of the diameter. Umbilicus of holotype shown by a broken line; whorls of holotype by a solid line; continuations of curves, based on topotypes, by a dotted line.

Locality. Zone of *Cadoceras brooksi*, on Deer creek one-quarter mile from its mouth, west side of Harrison lake.

Name. After Robert Valentine Harvey.

Genus, *Cadoceras* Fischer 1882

The North American forms of this genus differ somewhat from the European, but not enough to warrant separation. The young are very similar to those of *Paracadoceras* and other genera from North America and the Arctic regions as yet unnamed. It is, therefore, quite unsafe to name a form of less than 45 or 50 mm. diameter unless the development curves of several features show that the specimen is mature. Much revision of the Cadoceratoids is necessary, and it is among Arctic faunas that this can be done. Probably in the Arctic Jurassic is to be found the early history, as yet unknown, of the great Cardioceratid family.

Two Alaskan and one new species of *Cadoceras* were found at Harrison lake.

Cadoceras catostoma Pompeckj 1900

Figure 3

1900. Pompeckj: Verhandl. Kais. Russ. Min. Gesell. St. Petersburg, 2 te Ser., Bd XXXVIII.

Costæ, strong, strongest on venter, bent forward, but not strongly, in crossing venter, strongly reflexed in crossing umbilical border. At 30 mm. diameter there are eight primaries and twelve secondaries in a quadrant. Resembles *C. grewingki* in form and rib-curve, but differs in its more closely crowded ribs. Only immature specimens were found.

Dimensions. *See* graph.

Locality. Zone of *Cadoceras brooksi*, on Deer creek one-quarter mile from its mouth; also other places.

Cadoceras schmidti Pompeckj 1900
Figure 3

1900. Pompeckj: Verhandl. Kais. Russ. Min. Gesell. St. Petersburg, 2 te Ser., Bd. XXXVIII.

Somewhat similar to the last, but having a much narrower umbilicus and costæ bent strongly forward in crossing the venter. At 30 mm. diameter there are eight primaries and fourteen secondaries in a quadrant. This species like the last has the costæ strongly reflexed in crossing the umbilical border.

Dimensions. *See* graph.

Locality. Zone of *Cadoceras brooksi*, on Deer creek, one-quarter mile from the mouth; also other places.

Cadoceras brooksi sp. nov.

Plate XVI, figures 3, 4, 5; Figure 3

Inner whorls rounder in cross-section than is usual in this genus. Cadicone is attained at about 38 mm. diameter, so possibly a large size is never reached. Costæ, obtuse, very slightly bent forward in crossing venter, and slightly reflexed in crossing umbilical border. Table showing number of ribs in a quadrant of whorl at various stages.

Diameter		
30 mm.	8 primaries	13 secondaries
50 "	primaries obsolete, 8 butlæ on umbilical "keel"	13 "

Locality. Zone of *Cadoceras brooksi*, on Deer creek, one-quarter mile from its mouth, west side of Harrison lake.

Name. After Mr. Allan Brooks, in recognition of his inimitable pictorial contributions to natural history.

Genus, *Anacardioceras* Buckman 1923

This stock has not previously been reported from North America, but it seems likely that it is represented by some of the species of *"Cardioceras"* described from Wyoming and Alaska. The form from Harrison lake, described in the sequel, differs from the typical British species in its perfect smoothness, venter of persistently knife-edge sharpness, and

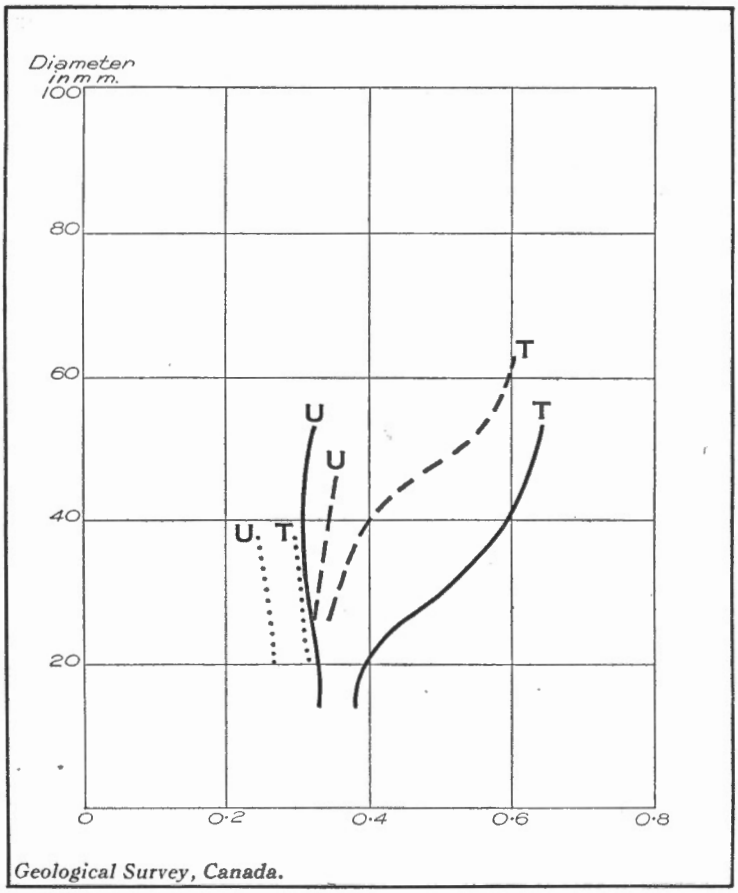


Figure 3. *Cadoceras brooksi* sp. nov.; *C. catostoma;* and *C. schmidti;* widths of umbilicus and thicknesses of whorls expressed as fractions of the diameter. Umbilicus of *C. brooksi*, holotype, shown by a solid line marked U; thickness of *C. brooksi*, holotype, by a solid line marked T; umbilicus of Harrison Lake specimens of *C. catostoma*, by a broken line marked U; thickness of specimens of *C. catostoma* by a broken line marked T; umbilicus of Harrison Lake specimens of *C. schmidti* by a dotted line marked U; thickness of specimens of *C. schmidti* by a dotted line marked T.

slightly ellipticonic periphery. However, these differences are acquired only with late maturity so are not to be taken as a basis for separation. The genus indicates a late Cardioceratan date: most of the European species being in the *excavatum* zone.

Anacardioceras perrini sp. nov.

Plate XVII, figures 1, 2, 3; Plate XXII, figure 1; Figures 4, 5, 6

Living chamber, one-half whorl. Ornament, striate in the young. Becomes heavy enough to be called costate at about 20 mm. diameter.

Ornament reaches acme at 45 mm., then declines. Smooth from 90 mm. on. Table showing number of ribs in a quadrant of whorl at various stages.

Diameter

16 mm.	8 primaries	13 secondaries
30 "	6 "	16 "
62 "	7 "	15 "
		and 17 peripheral knots

Venter rounded up to 5 mm. at which it becomes fastigate. It develops a knotted keel at about 15 mm. Loses its knots about 85 mm. becoming more acute. A true knife-edge from 90 mm. onward. Mouth border

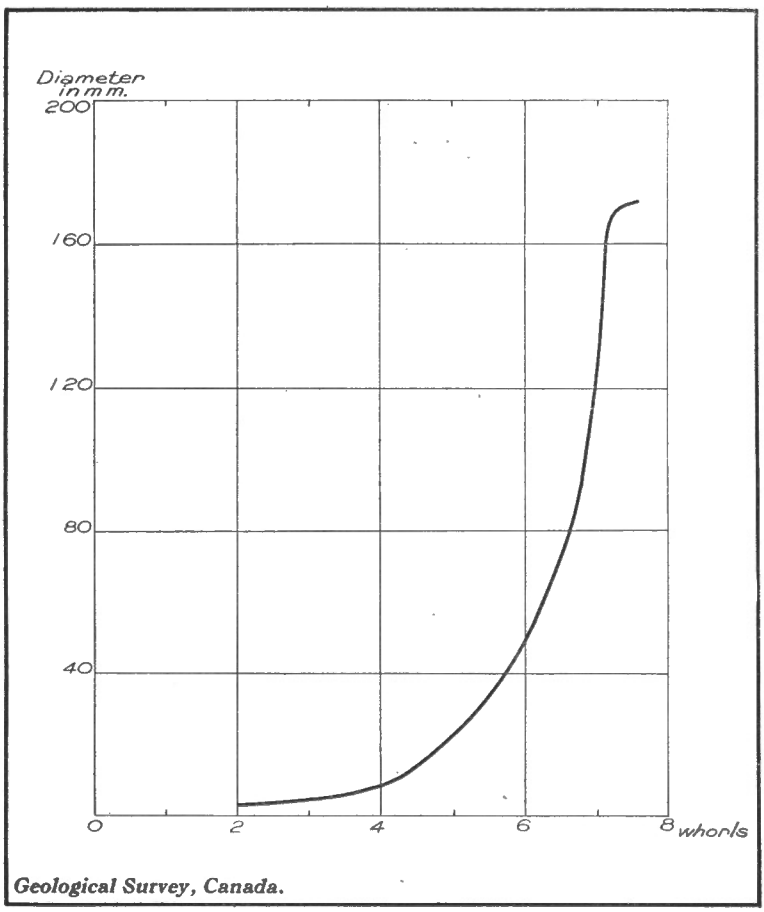


Figure 4. *Anacardioceras perrini* sp. nov.; correlation of diameter and number of whorls.

inclined and rostrate. Conch form, complicated—an oxygastric contracti-ellipti-oxycone. The species differs from the genotype in having the primary rib furcation nearer the umbilicus: about one-third way across the

flank. The ribs are more crowded. Also the persistently acute venter, smoothness, and catagenetic peripheral spiral. The last is not uncommon in various large Cardioceratoids.

$EL = L_2 < L_1$

Locality. On the west side of the point that bounds on the west the small bay on the southwest shore of the peninsula.

Name. After my teacher, Professor James Perrin Smith.

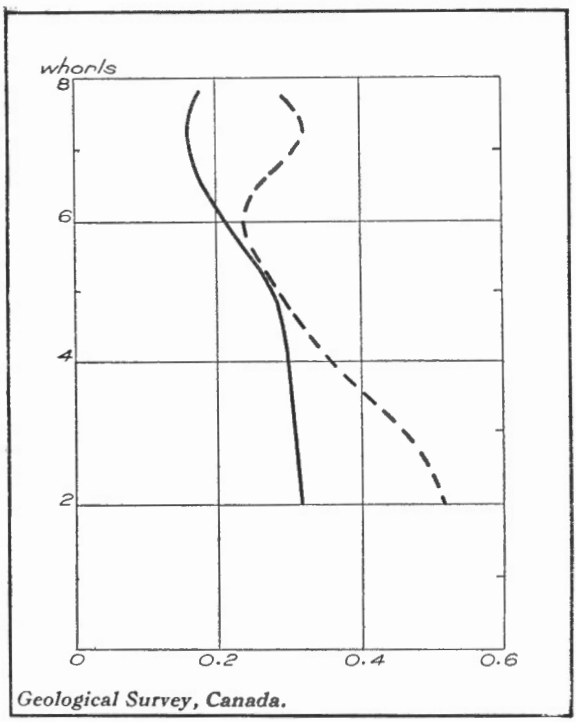


Figure 5. *Anacardioceras perrini* sp. nov.; width of umbilicus (shown by a broken line) and thickness of whorls (by a solid line) of holotype correlated with number of whorls.

Family, MACROCEPHALITIDAE

Genus, *Lilloettia* nov.

The family is represented by two new genera of slightly later date than most of the group and corresponding in age to *Catacephalites*. Both are widespread in deposits of the same age in southern Alaska where they are associated with *Cadoceras* sensu lato.

The young of *Lilloettia* have the ornament and something of the form of *Dolikephalites*, but a smaller umbilicus. The ornament degenerates during late adolescence. Smoothness supervenes first round the umbilicus,

then spreading across the flank it finally extinguishes the ventral ornament. Conch form, a compressed sphaerocone from youth on. Flanks become convergent with maturity. Mouth border, plain, i.e., without lappets, strongly inclined, slightly swollen. A helically twisted umbilical

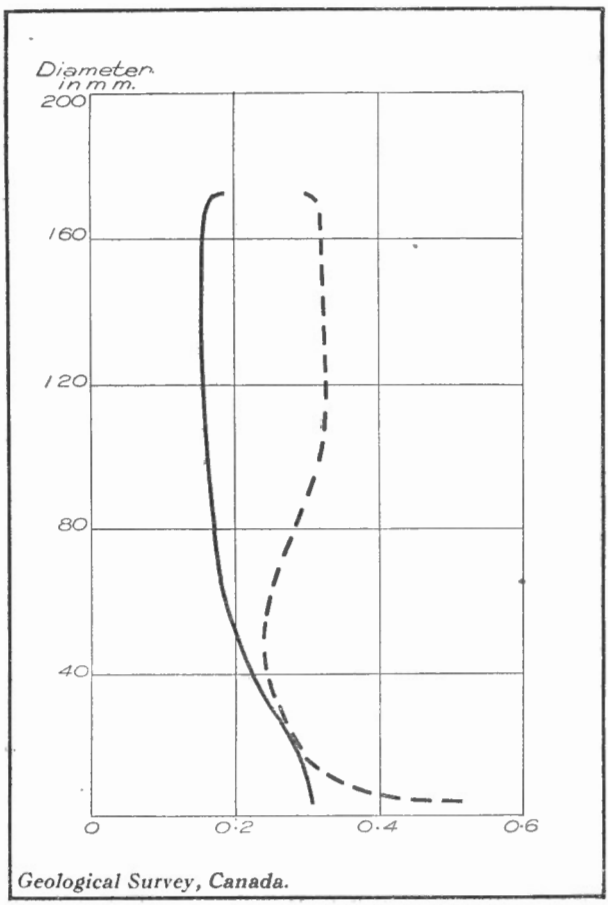


Figure 6. *Anacardioceras perrini* sp. nov.; width of umbilicus (shown by a broken line) and thickness of whorls (by a solid line) of holotype expressed as fractions of the diameter.

columella is present. Differs from other macrocephalitids in its early smoothness and narrow umbilicus. Differs from *Buckmaniceras* in septal line: L1 > EL, L1 has longer though less divergent branches; and in conch form. Septal line rather simple as late as early maturity. Resembles *Buckmaniceras* in its obtuse ornament.

Lilloettia lilloetensis sp. nov.

Plate XVIII, figures 1-4; Figure 7

Body chamber of holotype seven-eighths whorl.
Table showing number of ribs in a quadrant of whorl at various stages.

Diameter

27 mm.	6 primaries	16	secondaries
55 "	primaries obsolete	17	"
70 "		19	"
85 "	complete smoothness		

Dimensions. *See* graph under *Buckmaniceras.*

Locality. Zone of *Lilloettia lilloetensis*, on Billhook creek at 3,100 feet altitude.

Name. Of both genus and species Indian geographical name Lillooet.

Lilloettia mertonyarwoodi sp. nov.

Plate XIX, figures 1, 2; Figure 7

Body chamber of holotype slightly more than two-thirds whorl. Table showing number of ribs in a quadrant of whorl at various stages.

Diameter

55 mm.	8 primaries	25	secondaries
60 "	primaries obsolete	25	"
80 "		33	"
87 "	complete smoothness		

Dimensions. *See* graph under *Buckmaniceras.*

Locality. Zone of *Lilloettia lilloetensis*, on Billhook creek at 3,100 feet altitude.

Name. After my former teacher, Professor Merton Yarwood Williams.

Genus, *Buckmaniceras* nov.

Robust, rounded, sphaerocones with the ornament of *Lilloettia*, from youth on. Differs from *Lilloettia* in a few important respects, such as a total lack of compression and in septal line. EL=L1, L1 branches are short.

Buckmaniceras buckmani sp. nov.

Plate XX, figures 1-4; Figure 7

Table showing number of ribs in a quadrant of whorl at various stages.

Diameter

23 mm.	6 primaries	16	secondaries
55 "	primaries obsolete	17	"
90 "	complete smoothness		

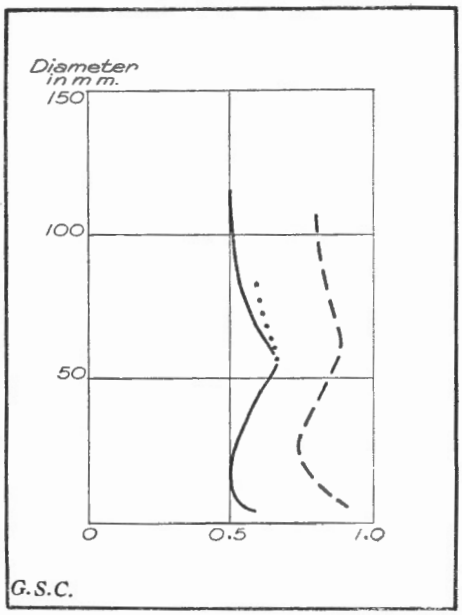


Figure 7. *Lilloettia lilloetensis* sp. nov. shown by a solid line; *L. mertonyarwoodi* sp. nov. by a dotted line; and *Buckmaniceras buckmani* sp. nov. by a broken line; thickness of whorls of holotypes expressed as fractions of the diameter.

Locality. Zone of *Lilloettia lilloetensis*, on Billhook creek at 3,100 feet altitude.

Name. Of genus and species after Mr. S. S. Buckman, the great master of ammonitology.

Family, VIRGATITIDAE

Genus, *Homolsomites* nov.

To be included in this family is the great series of forms of late Jurassic and early Cretaceous showing relationship to the planulates with virgatome ornament typified by *Virgatites*. The genus *Homolsomites* includes platycones with narrow umbilicus and narrow though rounded venter. Costæ, delicate, branching according to various plans, but mostly virgatome, and crossing centre unbroken and with a strong forward bend. In maturity all but the ventral ornament become obsolete. Septum, strongly reclined. Stems of lobes narrower than is usual with this family.

Name. Indian geographical—Homolsom.

Homolsomites poecilochotomus sp. nov.

Plate XXI, figures 1-4

Ornament is striate up to early maturity. It branches according to several plans and combinations thereof, including dichotomous, bidichotomous, and virgatome (3-branch). The plans of branching become more

complex, thereby increasing the number of secondary ribs. After 35 mm. diameter the costæ on the umbilical half of the flank become obsolete, after which the remaining ornamented area narrows so that at 100 mm. only the centre and one-sixth of the flank are costate.

Table showing number of ribs in a quadrant of whorl at various stages.

Diameter		
20 mm.	9 primaries	21 secondaries
35 "	8 "	33 "
90 "	primaries obsolete	25 "

Dimensions. Holotype has a maximum diameter of about 105 mm. Thickness at this diameter is 18 mm. Width of umbilicus, 18 mm.

Name. In allusion to the various plans of branching of the costæ.

Locality. Zone of *Homolsomites poecilochotomus*, on the southeast shore of the peninsula.

Family, PHYLLOCERATIDAE

Genus, *Phylloceras* Suess 1865

Phylloceras columbianum sp. nov.

Plate XXII, figures 1, 2, 3

Shell, quite smooth. Septal line with about seven lobes, exclusive of the external lobe. Mouth-border unknown.

Dimensions. Holotype—maximum diameter, 65 mm.; major radius, 40·5; minor radius, 24·5; thickness, 21·5; thickness at minor radius, 16; umbilicus, 4·5 per cent of diameter.

Locality. On the southwest shore of a small point on the southwest side of the small bay on the southwest shore of the peninsula, where it is associated with *Anacardioceras perrini*.

Name. Geographical from British Columbia.

"Phylloceras" aff. *knoxvillense* Stanton

Stanton: Bull. 133, U.S. Geol. Surv.

Fragments of a very large form highly similar in ornament and septal line to Stanton's species. It may differ in proportions. Not sufficiently complete for naming or special description.

Locality. Zone of *Aucella canadiana*, 350 yards from shore and 1,400 yards north of the mouth of Deer creek.

"Phylloceras" sp. indet.

Fragments of a smooth, latumbilicate *"Phylloceras"*, having a complex septal line. Quite distinct from *Phylloceras* s.s., but not sufficiently complete for further description.

Order, **Belemnoidea**

Family, BELEMNITIDAE

Genus, *Cylindroteuthis* Bayle 1879

Cylindroteuthis themis sp. nov.

Plate XXIII, figures 1, 2

Rostrum, cylindroid, very blunt pointed. Dorsum and flanks, smooth, rounded. Venter, straight, flattish, bearing a broad, shallow canal which is deepest near the apex and becomes so shallow as to disappear 15 mm. from the apex. Taper, very slight, except in the apical region. Axis, slightly eccentric. Phragmacone, very nearly right conical. Septa, alveolus, and proostracum, not preserved.

Dimensions

Vertical diam., at apex of phragmacone	10	mm.
Ventral radius " "	3·5	
Lateral diam. " "	10·5	
Axis, apex of phragmacone to apex of rostrum	40	
Apical angle of phragmacone, lateral	21	degrees

Locality. Associated with *Entolium vulcanicum*, on the west shore of Harrison lake, 1,820 yards north of Harrison River point.

Name. Themis, of Greek mythology.

Cylindroteuthis baculus sp. nov.

Plate XXIII, figures 3, 4

Rostrum, very long, almost perfectly cylindrical through most of its length. Resembling *"Belemnites" tehamaensis* Stanton and certain Russian species of similar date, such as *"Belemnites" obeliscoides* Pavlow and Lamplugh, but differs from some of these in its very gentle taper, from others in its almost perfectly circular cross-section. The holotype has a nearly right conical phragmacone, containing thirty-three chambers and occupying two-fifths of the length of the alveolus. The alveolus is slightly more than one-fifth the entire length of the rostrum.

Dimensions

Vertical diam. at apex of phragmacone	14	mm.
Ventral radius " "	6·5	
Lateral diam. " "	15	
Axis, from apex of phragmacone to apex of rostrum, from a composite specimen	230	
Phragmacone, length	20	
Alveolus, length	50	
Apical angle of phragmacone	15	degrees

Locality. Zone of *Aucella canadiana*, 350 yards from shore and 1,400 yards north of the mouth of Deer creek.

Name. In allusion to external form.

Genus, *Pachyteuthis* Bayle 1879

Pachyteuthis eocretacicus sp. nov.
Plate XXII, figure 4; Plate XXIII, figure 5

Rostrum, very short and thick, resembling the Russian species, "*Belemnites*" *subquadratus* Pavlow and Lamplugh, but differing slightly though distinctly in outlines and cross-section. Surface, perfectly smooth. The type specimens are moulds.

Dimensions

Vertical diam. at apex of phragmacone	31	mm.
Ventral radius " "	15	
Lateral diam. " "	31	
Alveolus, length	65	
Axis, apex of phragmacone to apex of rostrum	59	
Apical angle of phragmacone	21	degrees

Locality. Zone of *Aucella canadiana*, 350 yards from shore and 1,400 yards north of the mouth of Deer creek.

Name. In allusion to the date of existence of the species—the dawn of the Cretaceous.

Phylum, **ARTHROPODA**

Class, *CRUSTACEA*

Order, **Cirripedia**

Family, BALANIDAE

Genus, *Balanus* da Costa

Balanus crenatus Bruguière

Several well-preserved fragments of this species. This may well be the form referred to by Lamplugh as "*Balanus* sp."

Locality. Main line of Canadian Pacific railway 838 yards west of the west end of the Harrison River bridge.

PLATE I

Baculites crickmayi n. sp. (Page 3.)

PLATE I

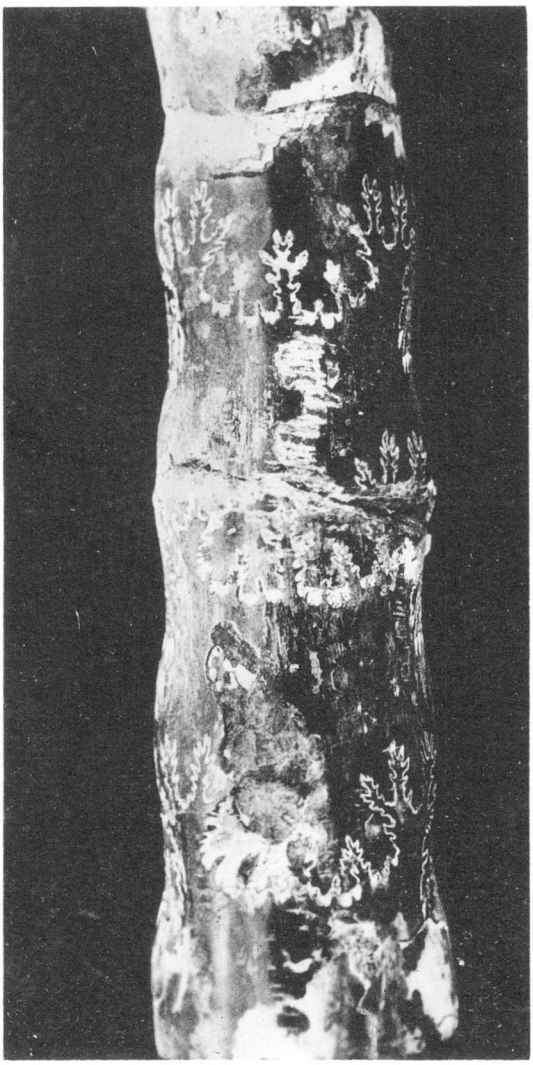
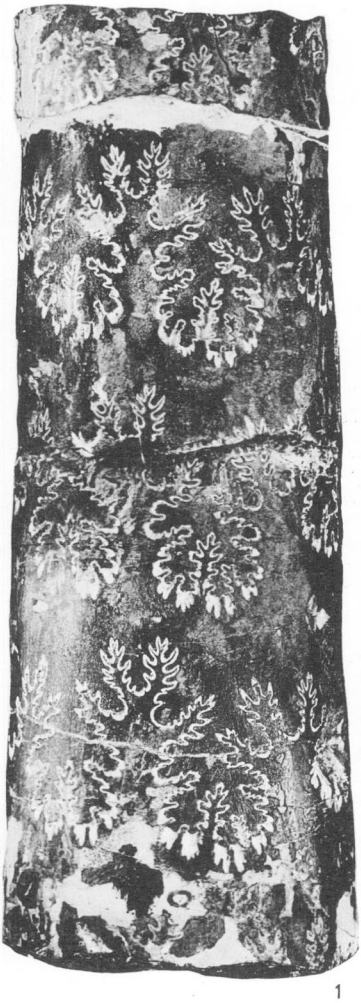


Plate II

Figures 1, 2, 3. *Baculites crickmayi* n. sp. (Page 3.)
Figures 4, 5, 6, 7. *Veniella subtrapeziformis* (Whiteaves) var. *dyeri* var. nov. (Page 1.)



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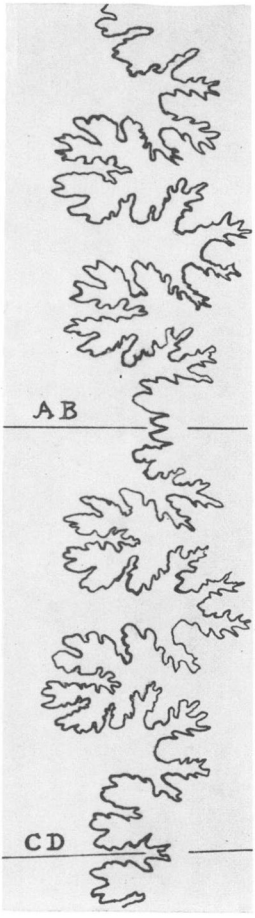

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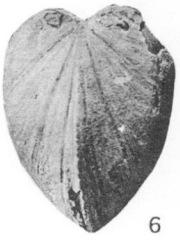

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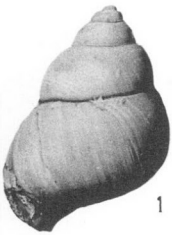
PLATE III

Figure 1. *Viviparus nidaga* sp. nov. (Page 9.)
Figure 2. *Unio subprimaevis* sp. nov. (Page 7.)
Figure 3. *Viviparus crickmayi* sp. nov. (Page 8.)
Figure 4. *Campeloma vetula tenuis* var. nov. (Page 10.)
Figure 5. *Viviparus tasgina* sp. nov. (Page 10.)
Figure 6. *Campeloma praecursa* sp. nov. (Page 11.)
Figure 7. *Campeloma cypressensis* sp. nov. (Page 11.)
Figure 8. *Goniobasis williamsi* sp. nov. (Page 12.)
Figures 9, 10. *Goniobasis subtortuosa* mut. *tenuis* n. mut. (Page 11.)
Figure 11. *Goniobasis whittakeri* sp. nov. (Page 12.)
Figure 12. *Goniobasis judithensis minimus* var. nov. (Page 12.)
Figure 13. *Pupa* sp. indet. (Page 14.)
Figure 14. *Goniobasis webbi* sp. nov. (Page 14.)
Figure 15. *Unio mclearni* sp. nov. (Page 7.)
Figure 16. *Melania whiteavesi nodosa* var. nov. (Page 13.)



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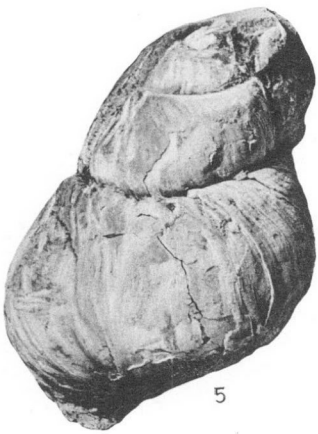

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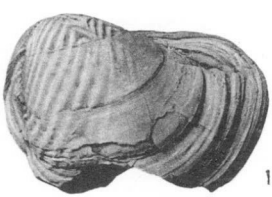

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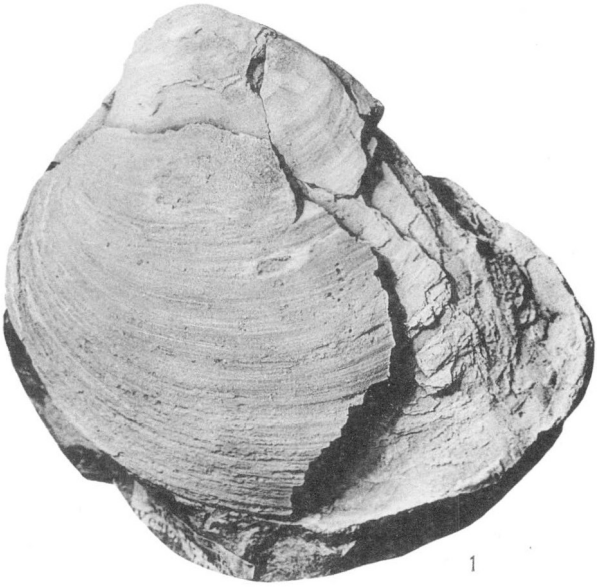
Plate IV

Figure 1. *Unio humei* sp. nov. (Page 8.)
Figures 2, 3. *Velatella rectistriata* sp. nov. (Page 13.)
Figure 4. *Unio humei* sp. nov. (Page 8.)

PLATE IV



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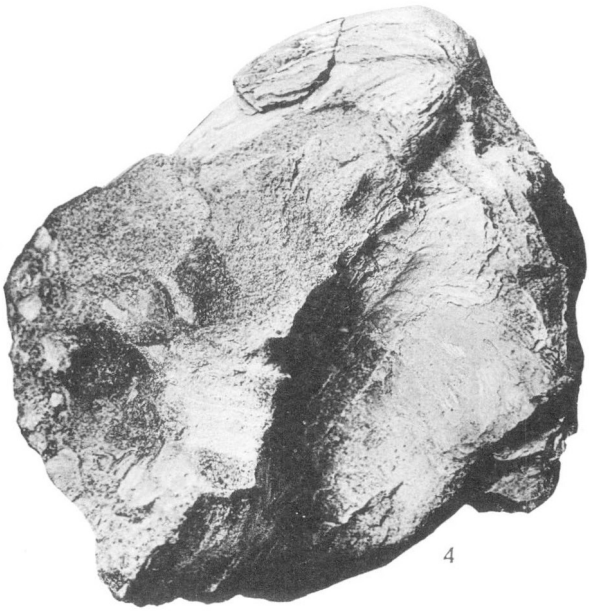

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PLATE V

Figure 1. *Leguminosites williamsi* Berry n. sp. (Page 23.)
Figures 2, 3. *Trochodendroides cuneata* (Newberry). (Page 20.)
Figure 4. *Viburnum finale* Ward. (Page 27.)
Figure 5. *Phyllites aquaticus* Berry n. sp. (Page 28.)
Figure 6. *Cercocarpus ravenscragensis* Berry n. sp. (Page 23.)
Figure 7. *Paliurus* (?) sp. (Page 25.)
Figure 8. *Trochodendroides speciosa* (Ward). (Page 22.)

PLATE V

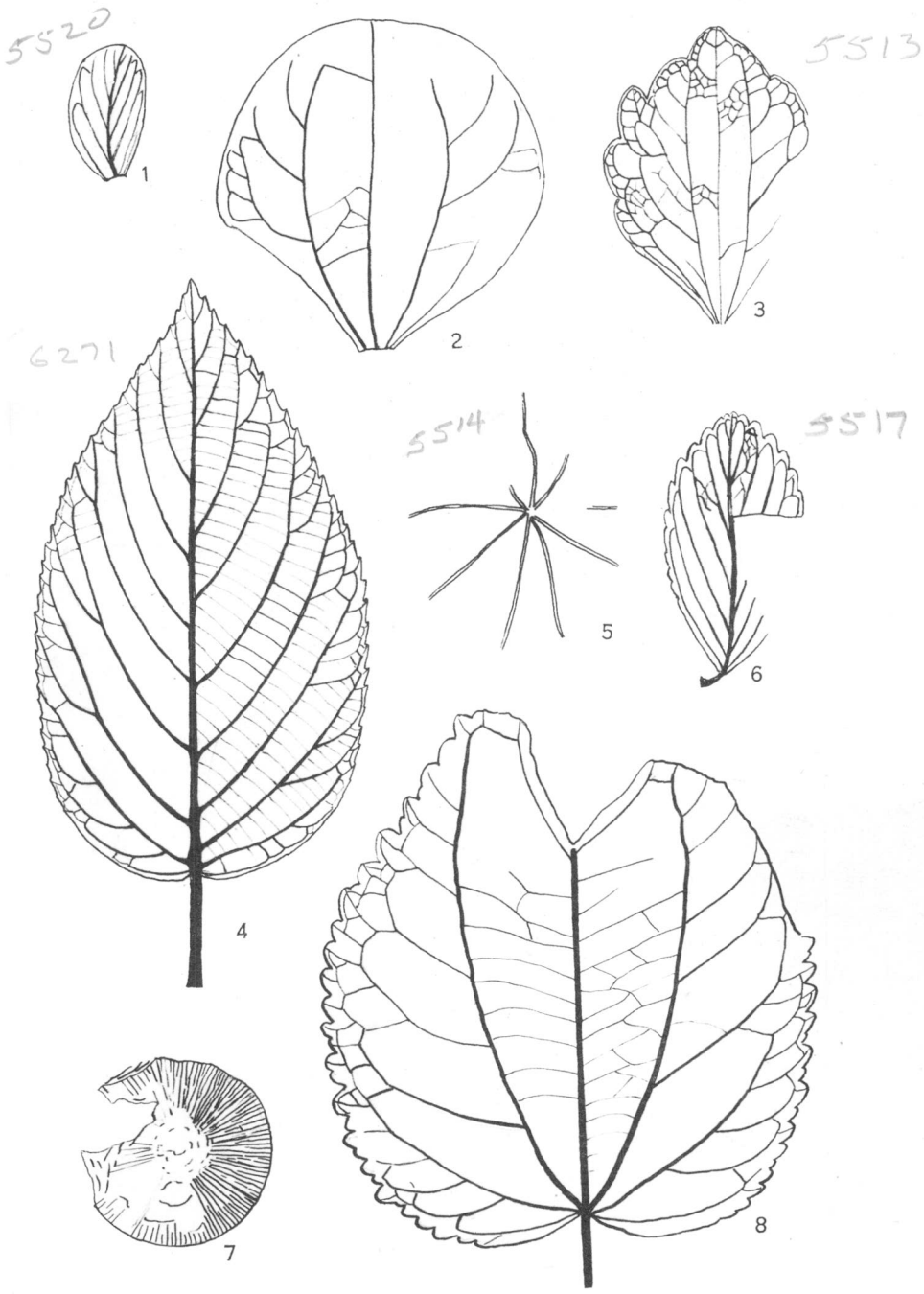

PLATE VI

Figures 1-3. *Aristolochia crassifolia* Cockerell (drawing now ½ natural size). (Page 20.)

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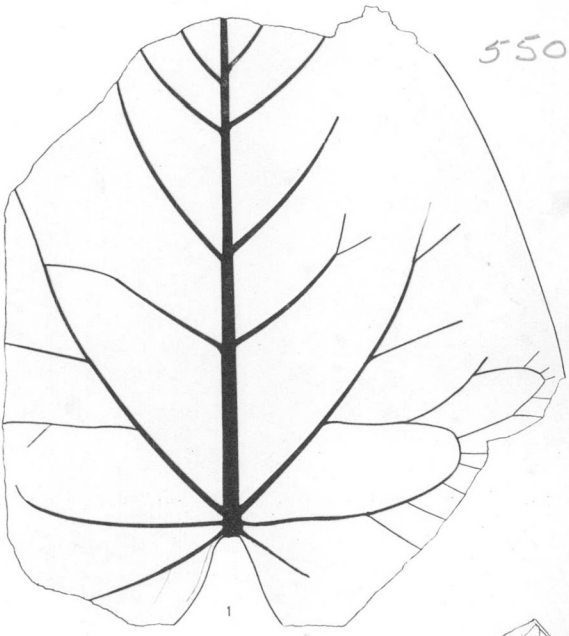

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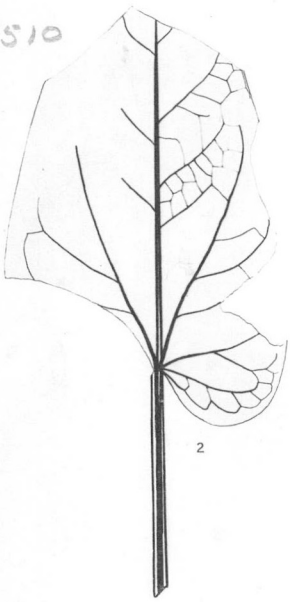

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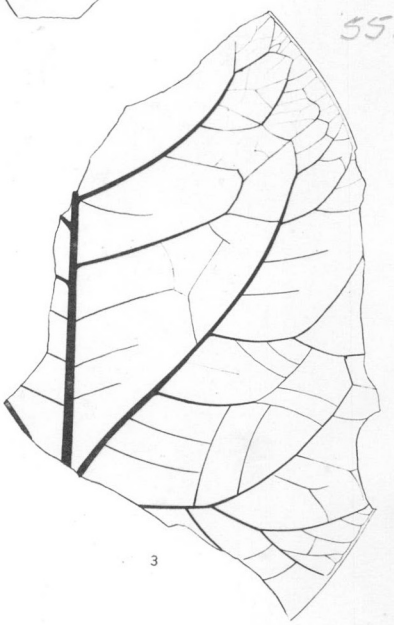

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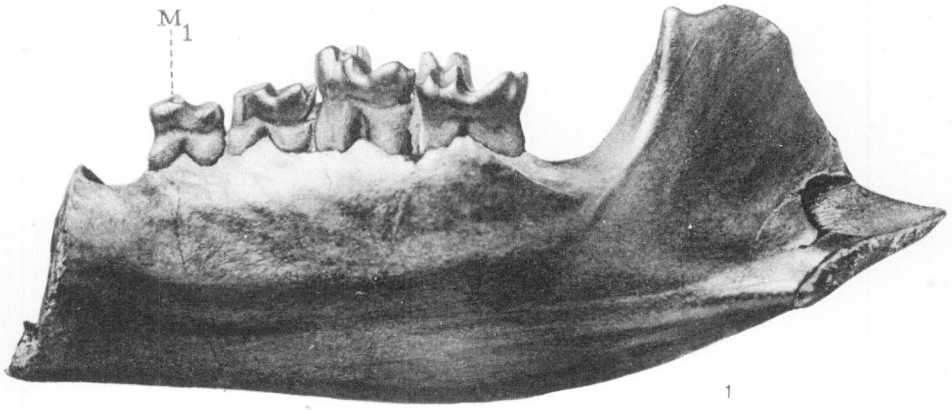
Plate VII

Eodelphis cutleri (Smith Woodward) Cat. 8536, Geol. Surv., Canada. 2·28 times natural size. (Page 30.)
Figure 1. Internal view.
Figure 2. Superior view.
Figure 3. External view.



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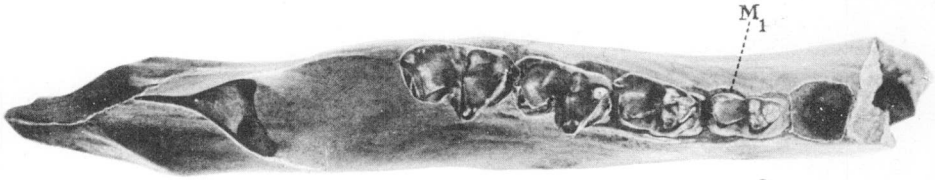

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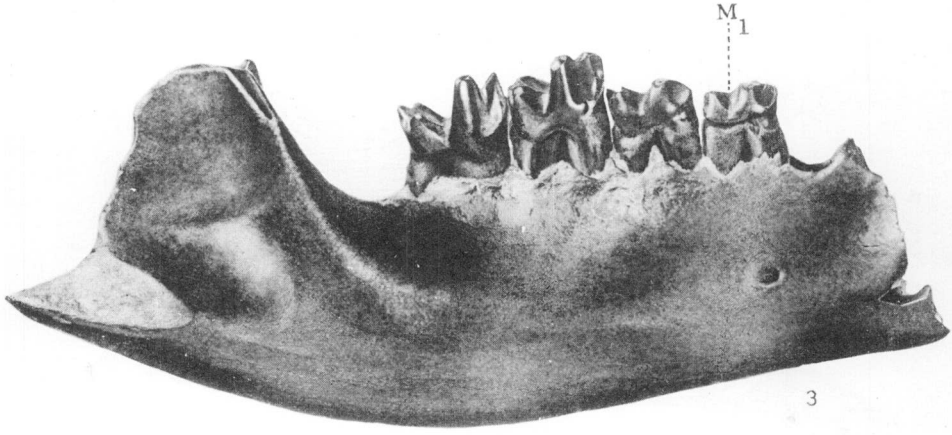

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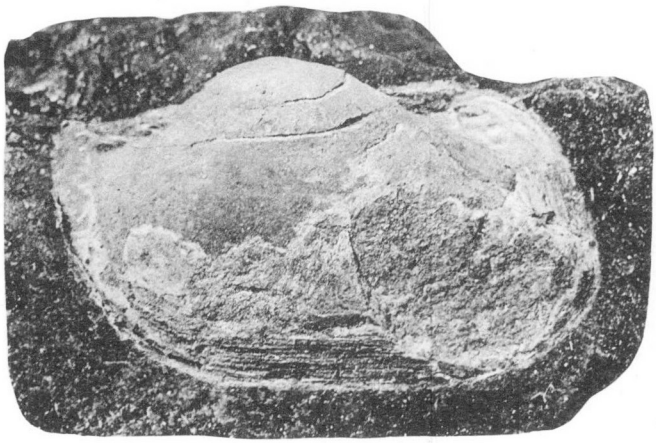
Plate VIII

Figure 1. *Parallelodon cardioceratanum* Crickmay sp. nov., holotype, X 3·28. Locality No. 24, Upper Jurassic. (Page 45.)

Figure 2. *Parallelodon cardioceratanum* Crickmay sp. nov., ink-print of the teeth of the holotype (gelatine process), X 3·6. The black areas correspond to the sockets of the right valve. (Page 45.)

Figure 3. *Parallelodon cardioceratanum* Crickmay sp. nov., holotype about natural size. A left valve. (Page 45.)

Figure 4. *Mclearnia mclearni* Crickmay sp. nov., holotype, about natural size. A right valve showing byssal sinus, small central chondrophore, and single, large muscle-scar. Locality No. 34. Lower Cretaceous. (Page 45.)



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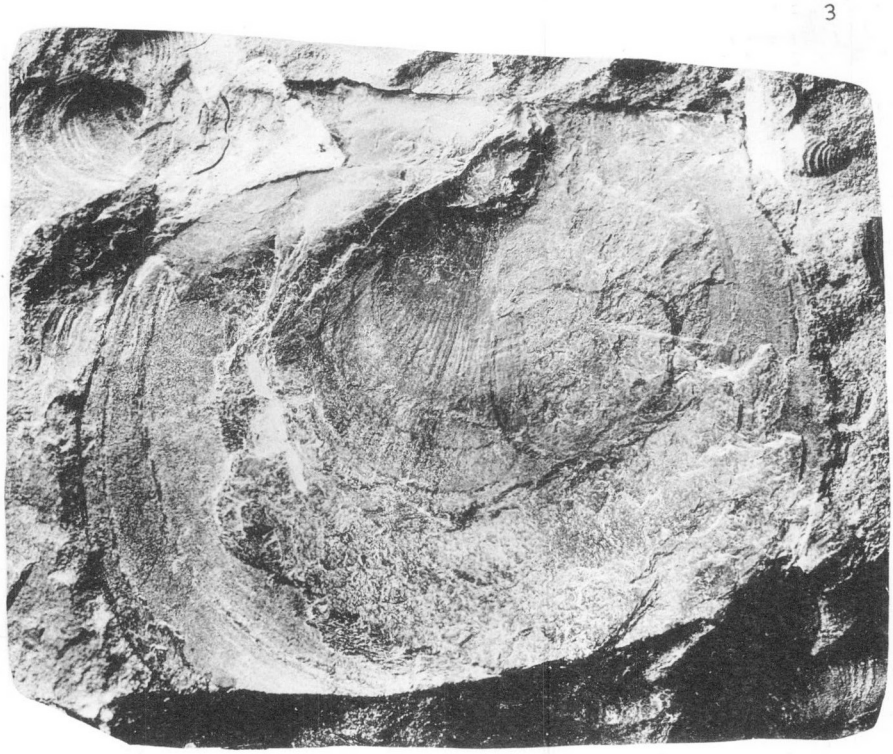

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PLATE IX

Figure 1. *Mclearnia mclearni* Crickmay sp. nov., paratype, about natural size. A left valve, natural cast of interior of shell. Shows a peculiar sinuous series of small muscle scars quite separate and distinct from the large adductor scar. Locality No. 34. Lower Cretaceous. (Page 45.)

Figure 2. *Aucella acutistriata* Crickmay sp. nov., holotype, about natural size. A left valve. Locality No. 33. Lower Cretaceous. (Page 46.)

Figure 3. *Aucella spasskensoides* Crickmay sp. nov., holotype, about natural size. A right valve. Locality No. 28. Lower Cretaceous. (Page 47.)

Figure 4. *Aucella spasskensoides* Crickmay sp. nov., paratype, about natural size. A left valve. Locality No. 28. Lower Cretaceous. (Page 47.)

Figure 5. *Aucella catamorpha* Crickmay sp. nov., holotype, about natural size. A right valve. Locality No. 28. Lower Cretaceous. (Page 46.)

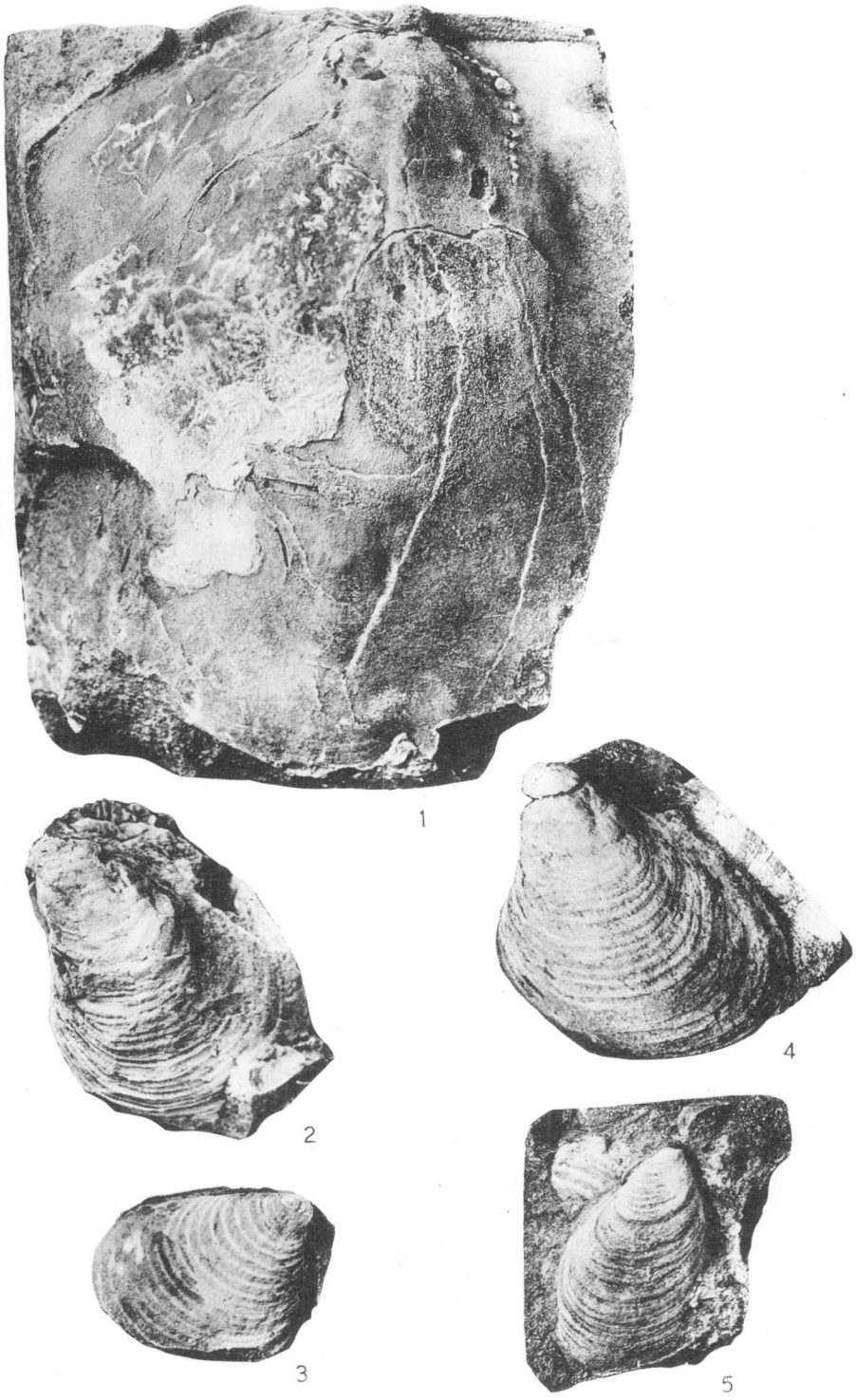


PLATE X

Figure 1. *Aucella cascadensis* Crickmay sp. nov., holotype, about natural size. A left valve. Locality No. 33. Lower Cretaceous. (Page 47.)

Figure 2. *Aucella cascadensis* Crickmay sp. nov., paratype, about natural size. A right valve. Locality No. 33. Lower Cretaceous. (Page 47.)

Figure 3. *Aucella canadiana* Crickmay sp. nov., paratype, about natural size. Two valves in contact. Right aspect. Locality No. 33. Lower Cretaceous. (Page 47.)

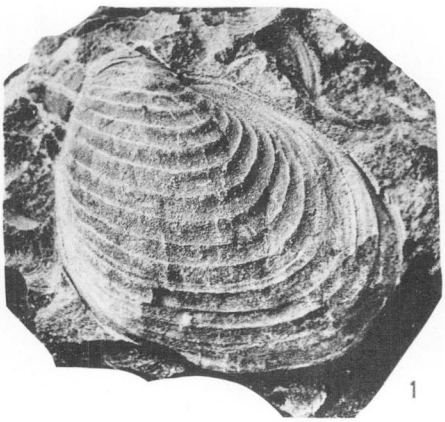
Figure 4. *Aucella canadiana* Crickmay sp. nov., holotype, about natural size. A left valve. Locality No. 33. Lower Cretaceous. (Page 47.)

Figure 5. *Aucella canadiana* Crickmay sp. nov., holotype, anterior aspect. (Page 47.)

Figure 6. *Aucella kwoiekensis* Crickmay sp. nov., wax cast of holotype. (Holotype consists of natural cast of interior of shell, and a small impression of part of the external surface.) A right valve. Locality No. 39. Lower Cretaceous. (Page 48.)

Figure 7. *Aucella kwoiekensis* Crickmay sp. nov. Anterior aspect of the specimen of figure 6. (Page 48.)

PLATE X



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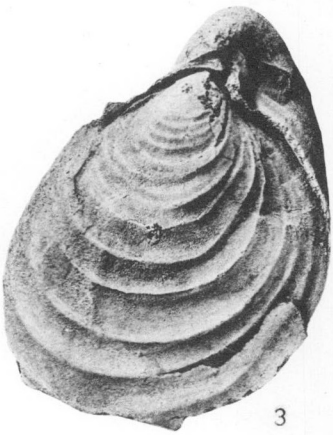

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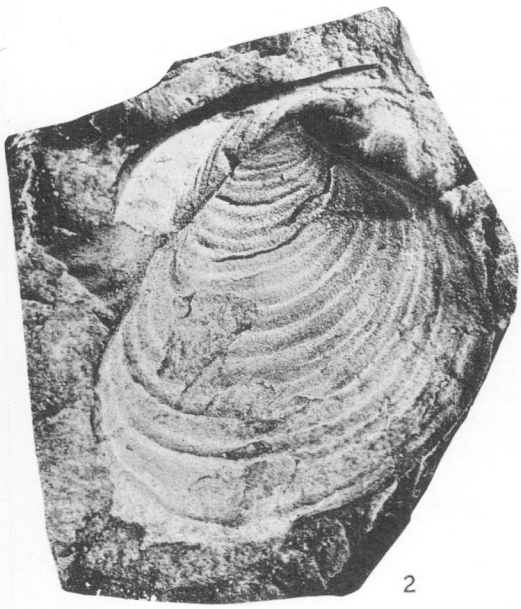

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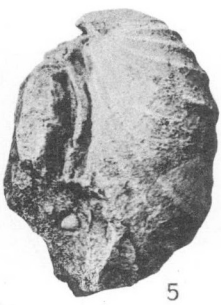

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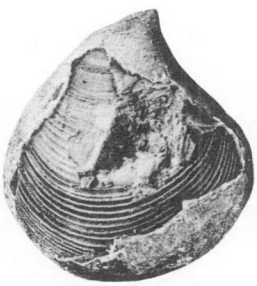

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Plate XI

Figure 1. *Aucella harrisonensis* Crickmay sp. nov., paratype, X 1·8. Anterior aspect of left valve. Locality No. 41. Lower Cretaceous. (Page 48.)

Figure 2. *Aucella harrisonensis* Crickmay sp. nov., paratype, X 1·8. Left valve. Locality No. 41. Lower Cretaceous. (Page 48.)

Figure 3. *Aucella harrisonensis* Crickmay sp. nov., holotype, X 1·5. Right valve, anterior aspect. Locality No. 41. Lower Cretaceous. (Page 48.)

Figure 4. *Aucella gigas* Crickmay sp. nov., holotype, X ·53. Two valves in contact, left aspect. Locality No. 41. Lower Cretaceous. (Page 49.)

Figure 5. *Aucella gigas* Crickmay sp. nov., holotype, X ·53. Right aspect. (Page 49.)

Figure 6. *Aucella gigas* Crickmay sp. nov., holotype, X ·49. Anterior aspect. (Page 49.)

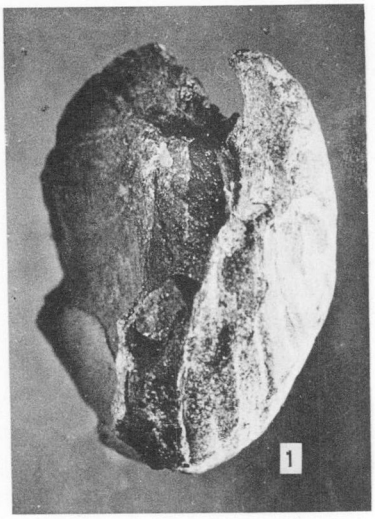


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Plate XII

Figure 1. *Haidaia billhookensis* Crickmay sp. nov., plaster cast of holotype, an external mould of the left valve. Anterior and dorsal outline, partly restored. Locality No. 21. Upper Jurassic. (Page 49.)

Figure 2. *Haidaia packardi* Crickmay sp. nov., plaster cast of holotype, part of which is an external mould of the right valve, ·73 of natural size. Locality No. 21. Upper Jurassic. (Page 50.)

Figure 3. *Haidaia packardi* Crickmay sp. nov., internal natural cast of holotype, with some shell attached, ·73 of natural size. Locality No. 21. Upper Jurassic. (Page 50.)

Figure 4. *Haidaia statluensis* Crickmay sp. nov., plaster cast of holotype, an external mould of two valves in contact, left aspect, ·73 of natural size. Shows outline and conch contour well, but gives poor idea of ornament. Locality No. 22. Upper Jurassic. (Page 50.)

Figure 5. *Haidaia statluensis* Crickmay sp. nov., wax cast of first paratype, ·73 of natural size, to show ornament. Locality No. 22. Upper Jurassic. (Page 50.)

Figure 6. *Haidaia statluensis* Crickmay sp. nov., wax cast of second paratype. (Page 50.)

PLATE XII

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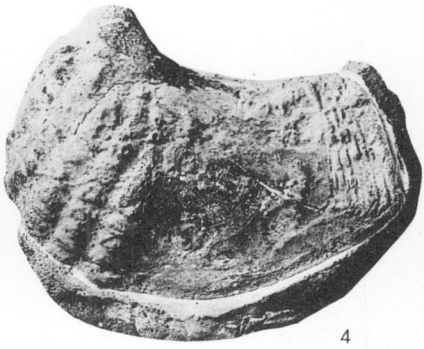

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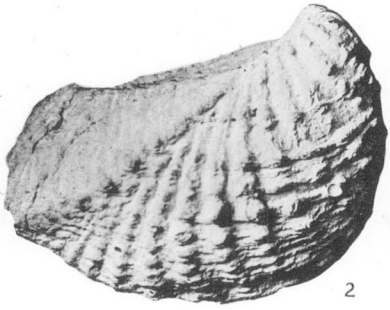

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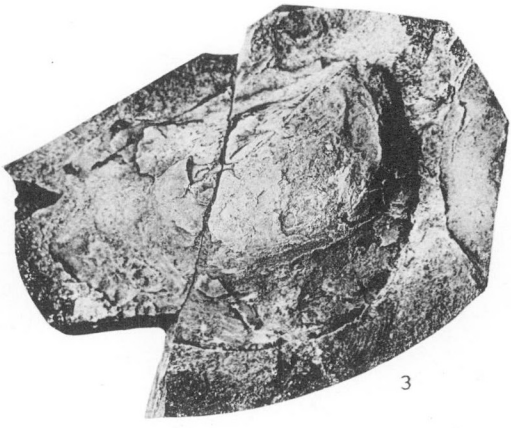

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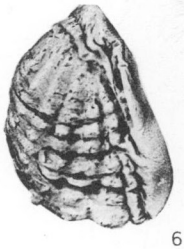

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Plate XIII

Figure 1. *Yaadia lewisagassizi* Crickmay sp. nov., wax cast of holotype, an external mould of left valve, ·87 of natural size. Locality No. 39. Lower Cretaceous. (Page 50.)

Figure 2. *Yaadia lewisagassizi* Crickmay sp. nov., wax cast of holotype, ·87 of natural size, postero-dorsal aspect. Shows ornament of area and escutcheon. (Page 50.)

Figure 3. *Quoiecchia aliciae* Crickmay sp. nov., holotype, ·87 of natural size, posterior aspect. Locality No. 39. Lower Cretaceous. (Page 51.)

Figure 4. *Quoiecchia aliciae* Crickmay sp. nov., holotype, a right valve, ·87 of natural size. (Page 51.)

Figure 5. *Quoiecchia aliciae* Crickmay sp. nov., holotype, anterior aspect. (Page 51.)

Figure 6. *Quoiecchia aliciae* Crickmay sp. nov., paratype. Juvenile, right valve. Locality No. 39. Lower Cretaceous. (Page 51.)

Figure 7. *Quoiecchia aliciae* Crickmay sp. nov., paratype, same specimen as figure 6, dorsal aspect, ·87 of natural size. (Page 51.)

Figure 8. *Quoiecchia aliciae* Crickmay sp. nov., paratype, internal mould of right valve, X 1·9. Shows crenulation of ventral margin. Locality No. 39. Lower Cretaceous. (Page 51.)

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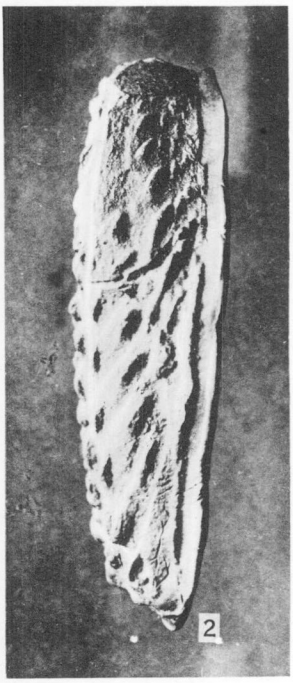

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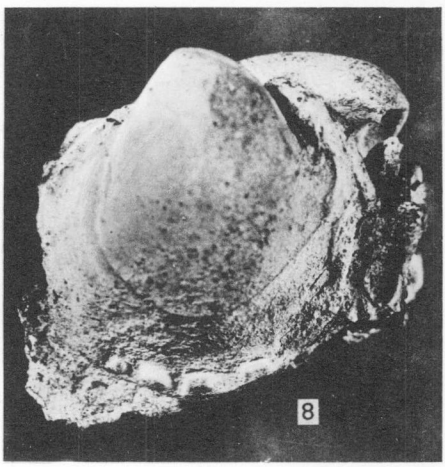

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Plate XIV

Figure 1. *Entolium hertleini* Crickmay sp. nov., holotype, a right valve, external aspect, X 3·19. Shows the microscopic ornament. Dark line shows curve of concentric striæ. Locality No. 13. Upper Jurassic. (Page 52.)

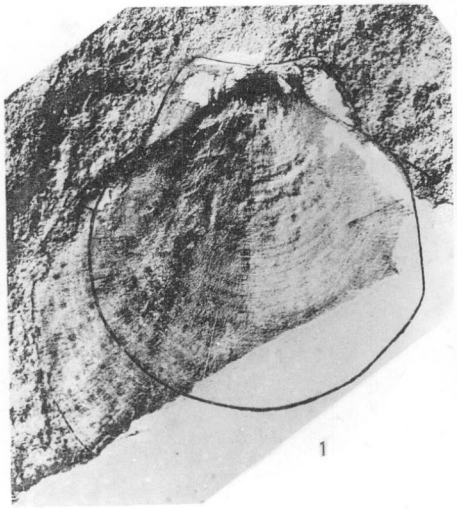
Figure 2. *Entolium vulcanicum* Crickmay sp. nov., holotype, an internal mould of left valve, X ·66. Locality No. 3. Middle Jurassic. (Page 52.)

Figure 3. *Entolium aucellarum* Crickmay sp. nov., holotype, an external mould of right valve, $\frac{8}{10}$ natural size. Locality No. 28. Lower Cretaceous. (Page 52.)

Figure 4. *Anomia columbiana* Crickmay sp. nov., holotype, external aspect, $\frac{8}{10}$ natural size. Locality No. 15. Upper Jurassic. (Page 53.)

Figure 5. *Anomia columbiana* Crickmay sp. nov., holotype, X 1·9. (Page 53.)

Figure 6. *Anomia columbiana* Crickmay sp. nov., paratype, external mould with some shell attached. Locality No. 15. Upper Jurassic. (Page 53.)



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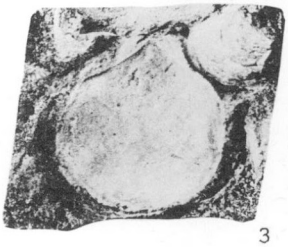

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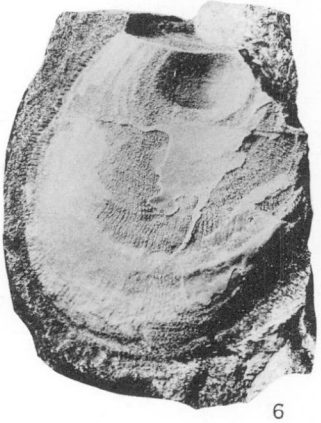

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Plate XV

Figure 1. *Pleuromya harrisonensis* Crickmay sp. nov., holotype, two valves together, right aspect, X 1·3. Locality No. 41. Lower Cretaceous. (Page 53.)

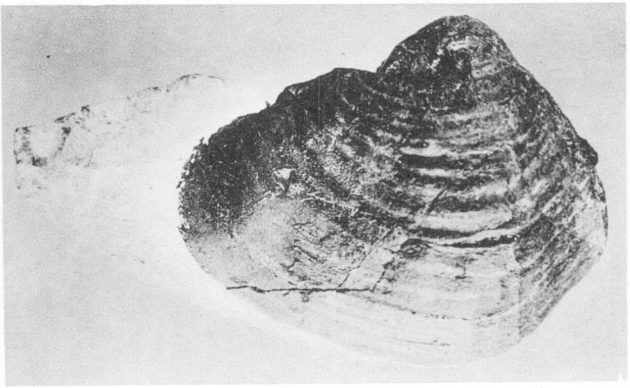
Figure 2. *Pleuromya harrisonensis* Crickmay sp. nov., holotype, dorsal aspect, X 1·18. (Page 53.)

Figure 3. *Pleuromya harrisonensis* Crickmay sp. nov., holotype, anterior aspect, $\frac{74}{100}$ natural size. (Page 53.)

Figure 4. *Astarte harrisonensis* Crickmay sp. nov., artificial cast in clay of part of holotype, mould of two valves in contact, X 1·5. Left aspect, showing ornament. Locality No. 19. Upper Jurassic. (Page 54.)

Figure 5. *Astarte harrisonensis* Crickmay sp. nov., artificial cast of holotype, X 1·5. Left aspect, showing outline, etc. (Page 54.)

Figure 6. *Astarte barbara* Crickmay sp. nov., holotype, a left valve with shell mostly decorticated, $\frac{74}{100}$ natural size. Locality No. 34. Lower Cretaceous. (Page 54.)



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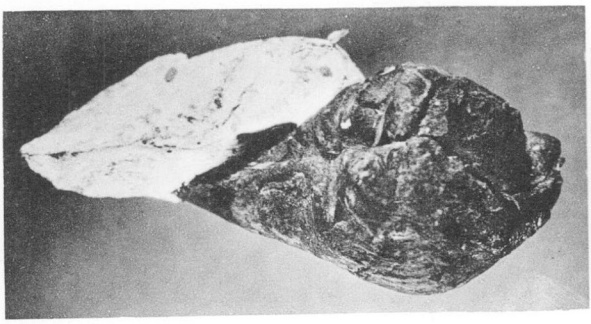

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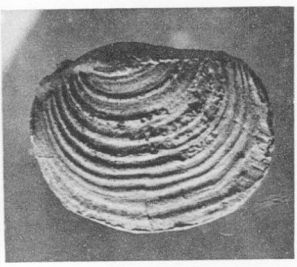

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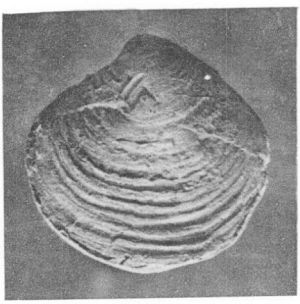

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PLATE XVI

Figure 1. *Paracadoceras harveyi* Crickmay sp. nov., holotype, about natural size. Anterior aspect, showing mouth-border, which is somewhat distorted, and ventral portion of septal lines. Locality No. 12. Upper Jurassic. (Page 55.)

Figure 2. *Paracadoceras harveyi* Crickmay sp. nov., holotype. Lateral aspect. Shows living chamber, ¾ whorl. (Page 55.)

Figure 3. *Cadoceras brooksi* Crickmay sp. nov., holotype, about natural size. Ventro-lateral aspect. Locality No. 12. Upper Jurassic. (Page 57.)

Figure 4. *Cadoceras brooksi* Crickmay sp. nov., holotype, about natural size. Lateral aspect. (Page 57.)

Figure 5. *Cadoceras brooksi* Crickmay sp. nov., holotype, with some of the missing parts restored in clay, X 1·6. (Page 57.)

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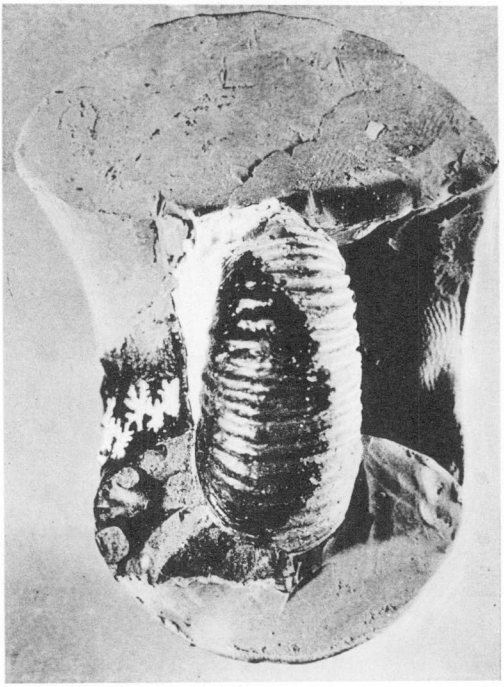

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Plate XVII

Figure 1. *Anacardioceras perrini* Crickmay sp. nov., cross-sectional outlines of holotype, taken at 90 degrees behind the mouth border, $\frac{5}{16}$ natural size. From external mould of holotype. (Page 58.)

Figure 2. *Anacardioceras perrini* Crickmay sp. nov., holotype, lateral aspect, $\frac{5}{16}$ natural size. The reconstructed peripheral curve and mouth-border were obtained from part of the holotype not included in the photograph, namely an external mould of the full-grown shell. At 5 and 5½ whorls the ribbing and venter are well shown. At 6⅛ whorls a small fragment shows the ornament of the umbilical border. The entire specimen consists of 7¼ whorls. Locality No. 24. Upper Jurassic. (Page 58.)

Figure 3. *Anacardioceras perrini* Crickmay sp. nov., paratype, X 5·2 cross-sectional outlines at 3¾ whorls. Protoconch is marked by a line of dashes which represents the central axis of the shell. Shows elevation of whorl between 2¾ and 3¾ whorls, and appearance of fastigate venter between 3¼ and 3¾. Locality No. 24. Upper Jurassic. (Page 58.)

PLATE XVII

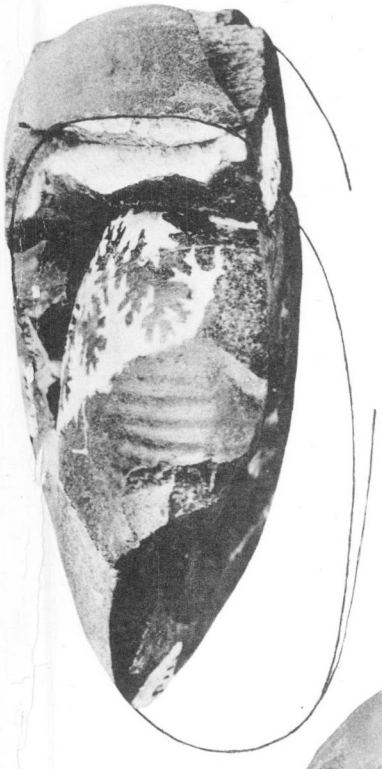
PLATE XVIII

Figure 1. *Lilloettia lilloetensis* Crickmay sp. nov., holotype, genotype, apertural aspect, about natural size. Last whorl slightly distorted by diastrophic forces. Mouth border outlined in black. Lost parts of shell partly restored in outline from measurements of the rest of the shell. Locality No. 15. Upper Jurassic. (Page 62.)

Figure 2. *Lilloettia lilloetensis* Crickmay sp. nov., holotype, genotype, lateral aspect, about natural size. Mouth border outlined in black. Periphery partly restored in outline by proportional method *(vide* Crickmay: Am. Jour. Sci., 5th ser., XIII, 1927). (Page 62.)

Figure 3. *Lilloettia lilloetensis* Crickmay sp. nov., holotype, about natural size, lateral aspect. Shows ornament of fifth whorl. (Page 62.)

Figure 4. *Lilloettia lilloetensis* Crickmay sp. nov., holotype, peripheral aspect, about natural size. Same specimen as shown in figure 3—the internal whorls of the holotype. (Page 62.)



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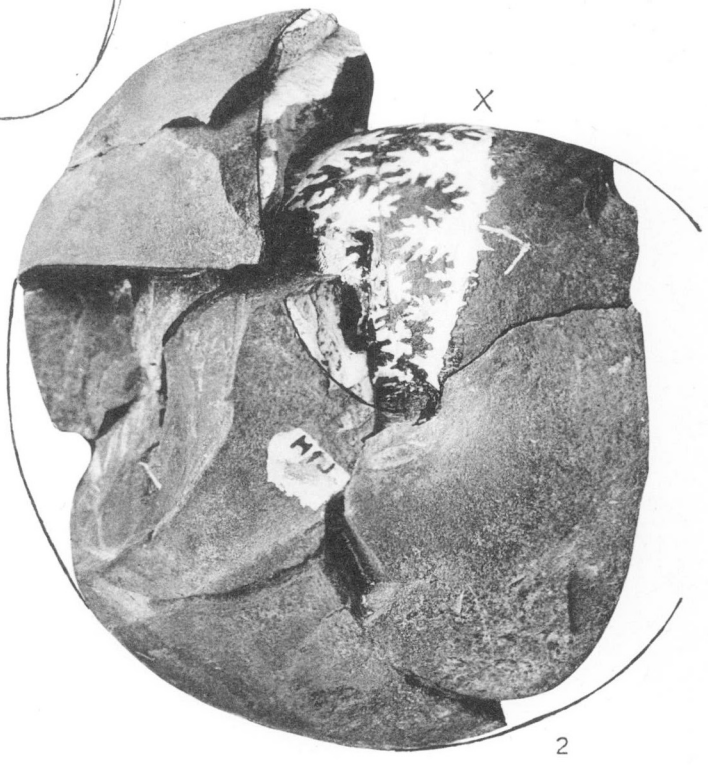

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PLATE XIX

Figure 1. *Lilloettia mertonyarwoodi* Crickmay sp. nov., holotype, lateral aspect, ½ natural size. Mouth border restored in outline from about one-third of it preserved and by the analogy of the other species of this genus. Periphery restored purely on basis of proportional method. This is unreliable when used for extrapolation, especially on the ultimate whorl of ammonites. So this outline is intended only to complete the picture and so elucidate the interpretation of the specimen. Ornament is seen 1 and 1½ whorls behind mouth border. Locality No. 15. Upper Jurassic. (Page 62.)

Figure 2. *Lilloettia mertonyarwoodi* Crickmay sp. nov., holotype, peripheral aspect, ½ natural size. (Page 62.)

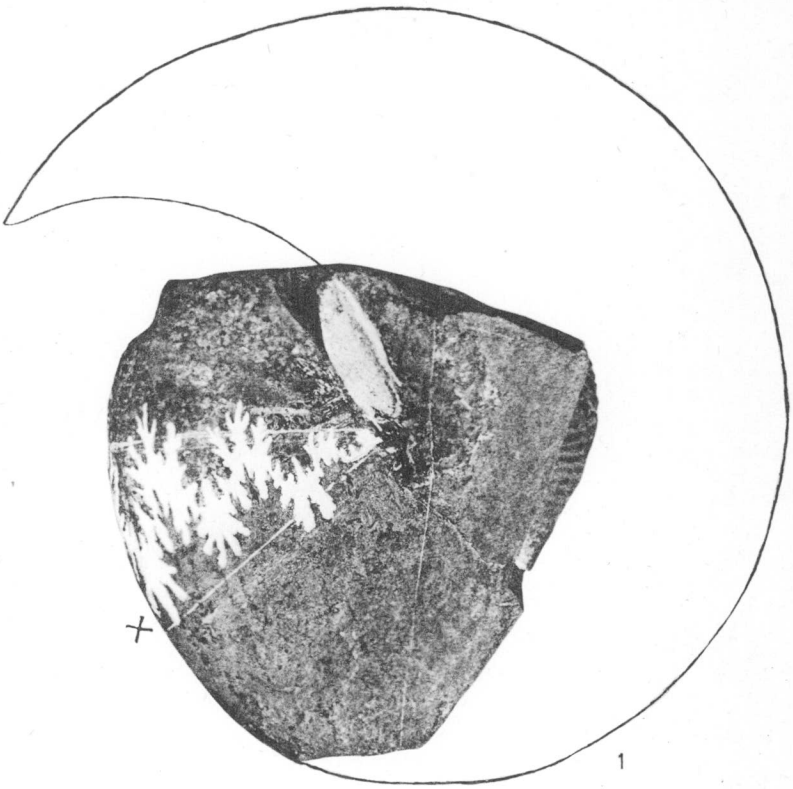

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PLATE XX

Figure 1. *Buckmaniceras buckmani* Crickmay sp. nov., holotype, lateral aspect, about natural size. Small black line shows position of emergence of penultimate whorl. Mouth border not preserved. Dotted lines show the great thickness of shell substance around the umbilicus. Locality No. 15. Upper Jurassic. (Page 62.)

Figure 2. *Buckmaniceras buckmani* Crickmay sp. nov., holotype, peripheral aspect, about natural size. This, as well as figure 1, shows the disappearance of ornament on the last whorl. (Page 62.)

Figure 3. *Buckmaniceras buckmani* Crickmay sp. nov., holotype, last quadrant of penultimate whorl, lateral aspect, about natural size. (Page 62.)

Figure 4. *Buckmaniceras buckmani* Crickmay sp. nov., holotype, last quadrant of penultimate whorl, ventro-lateral aspect, about natural size. (Page 62.)

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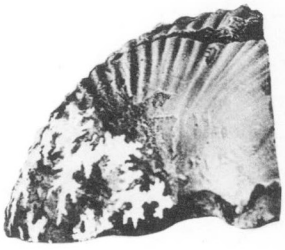

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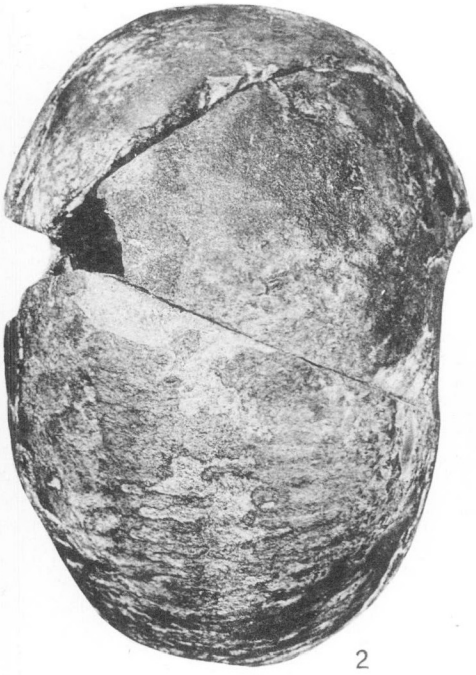

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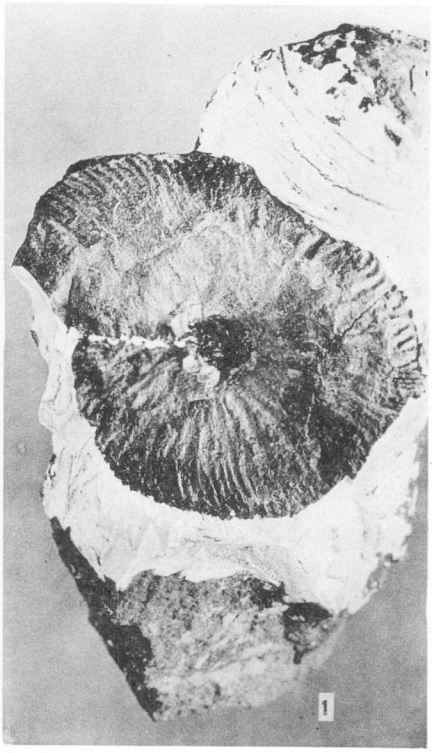
PLATE XXI

Figure 1. *Homolsomites poecilochotomus* Crickmay sp. nov., paratype, X 1·5. Locality No. 41. Lower Cretaceous. (Page 63.)

Figure 2. *Homolsomites poecilochotomus* Crickmay sp. nov., holotype, ·77 of natural size. Restoration of spiral by proportion. Locality No. 41. Lower Cretaceous. (Page 63.)

Figure 3. *Homolsomites poecilochotomus* Crickmay sp. nov., paratype, ·77 of natural size. Locality No. 41. Lower Cretaceous. (Page 63.)

Figure 4. *Homolsomites poecilochotomus* Crickmay sp. nov., paratype, X 3·08. Two primary ribs are outlined with their secondaries. They show two styles of furcation common with this species, the bidichotomous and the virgatome. Locality No. 41. Lower Cretaceous. (Page 63.)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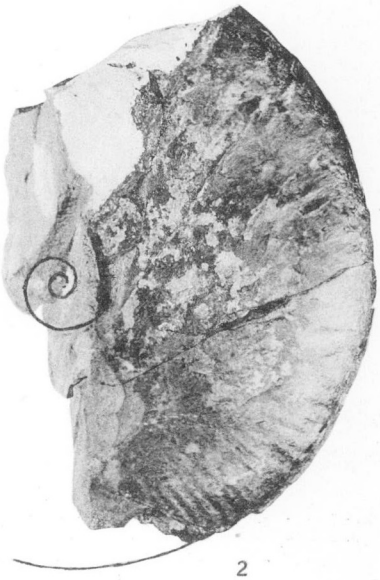
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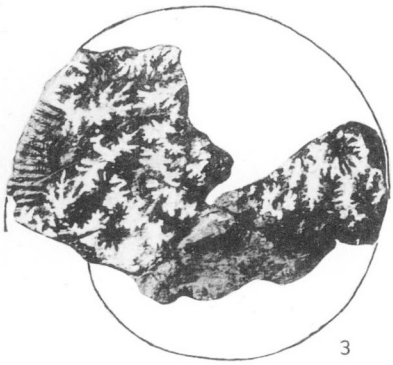
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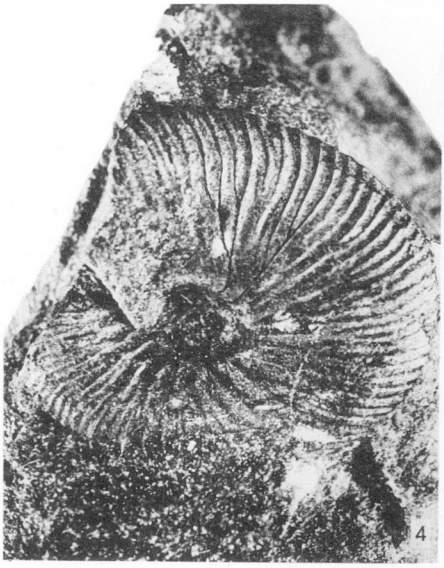
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PLATE XXII

Figure 1. *Phylloceras columbianum* Crickmay sp. nov., holotype, natural size. A young specimen, and several impressions of *Anacardioceras perrini* are to be seen on this specimen. Locality No. 24. Upper Jurassic. (Pages 58, 64.)
Figure 2. *Phylloceras columbianum* Crickmay sp. nov., holotype. (Page 64.)
Figure 3. *Phylloceras columbianum* Crickmay sp. nov., holotype. (Page 64.)
Figure 4. *Pachyteuthis eocretacicus* Crickmay sp. nov., cross-sectional outline of paratype, natural size. Locality No. 34. Lower Cretaceous. (Page 66.)

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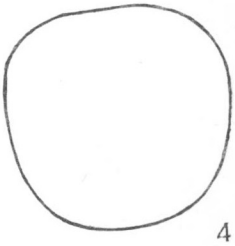

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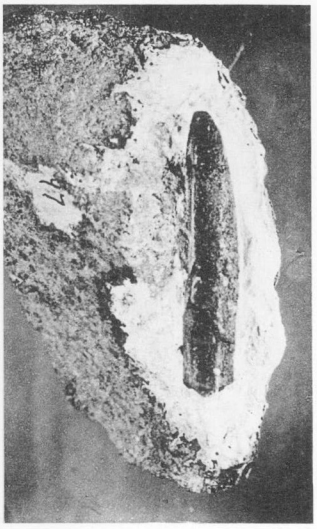
Plate XXIII

Figure 1. *Cylindroteuthis themis* Crickmay sp. nov., holotype, lateral aspect, ·66 of natural size. Locality No. 3. Middle Jurassic. (Page 65.)
Figure 2. *Cylindroteuthis themis* Crickmay sp. nov., holotype, ventral aspect, ·66 of natural size. (Page 65.)
Figure 3. *Cylindroteuthis baculus* Crickmay sp. nov., holotype, lateral aspect, ·66 of natural size. Locality No. 34. Lower Cretaceous. (Page 65.)
Figure 4. *Cylindroteuthis baculus* Crickmay sp. nov., outlines restored from the holotype and several paratypes, ·66 of natural size. (Page 65.)
Figure 5. *Pachyteuthis eocretacicus* Crickmay sp. nov., holotype, an external mould, lateral view, X ·44 . Locality No. 34. Lower Cretaceous. (Page 66.)



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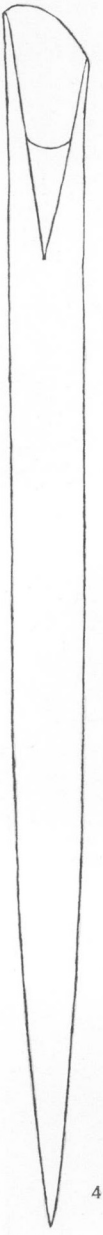

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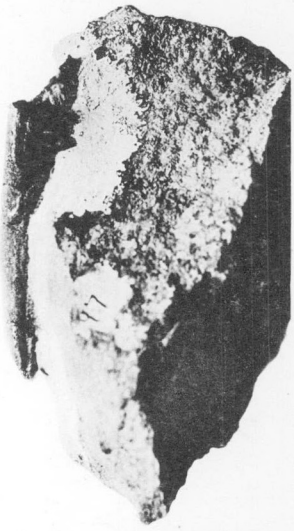

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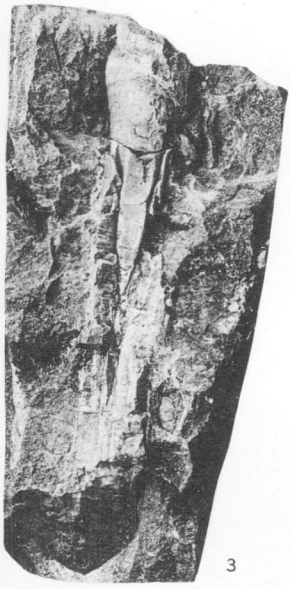

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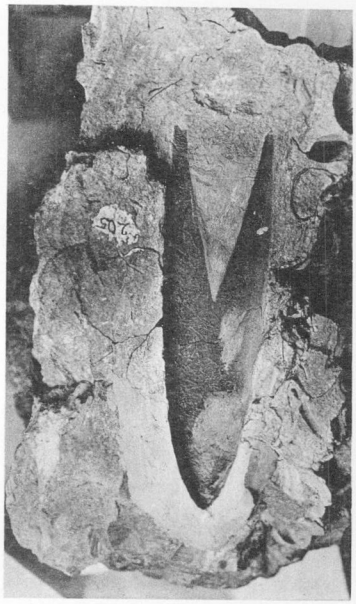

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