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NATIONAL MUSEUM OF CANADA
W. H. COLLINS, ACTING DIRECTOR

**BULLETIN No. 54**

GEOLOGICAL SERIES, No. 49

# Contributions to Canadian Palæontology

CONTENTS



OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1929

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# CONTRIBUTIONS TO THE STRATIGRAPHY AND PALÆONTOLOGY OF SKIDEGATE INLET, QUEEN CHARLOTTE ISLANDS, B.C.

*By F. H. McLearn, Geological Survey, Canada*

CONTENTS



## INTRODUCTION

Skidegate inlet is important in the study of Canadian Mesozoic stratigraphy, for it is possible there to establish the order of succession of several Jurassic and Cretaceous faunas. At most localities in western British Columbia and on the Pacific coast, where Mesozoic rocks are exposed, it is not possible to do this satisfactorily, because only one or two faunas occur at each place, or the faunas are meagre.

The Mesozoic strata of Skidegate inlet have for a long time claimed the interest of Canadian geologists and the results of their work have been summarized by J. D. MacKenzie.[1] In spite of all they had done, however, from Richardson to MacKenzie, the stratigraphic relations of the faunas were by no means completely solved; e.g. it was not known whether many of the species described by Whiteaves came from the Jurassic or Cretaceous formations and it did not appear that all the faunas had been recognized and their order of succession determined. These problems might have been to some extent solved without recourse to further field work had all of MacKenzie's collections reached the office; unfortunately most of them were lost in a shipwreck. It, therefore, became necessary to make new collections and to obtain additional stratigraphic data. This was done in the summer of 1921, by the writer, with the able assistance of C. H. Crickmay and R. H. B. Jones. Large collections of fossils were made, the strata were carefully measured, the stratal position of each fauna was obtained, and the structure and areal distribution were worked out in greater detail than by previous students.

Thereafter, in the office, and in time available, progress has been made in the study of the fossils and it is now possible to present a first section of an account of the Jurassic Ammonoidea. This will be followed by other sections on the Jurassic Ammonoidea, on other groups of Jurassic and Cretaceous Invertebrata, on the plants, on correlation, stratigraphy, etc. They will all appear under the general title, "Contributions to the Stratigraphy and Palæontology of Skidegate Inlet, B.C."

Grateful acknowledgment is made to Mr. S. S. Buckman, F.G.S., for most helpful advice in the study of the Jurassic Ammonoidea, which has saved the writer from many a serious pitfall. Because of his guidance and

[1] Geol. Surv., Canada, Mem. 88, pp. 7-13 (1916).

corrections, the comparisons with foreign species, the generic assignments, and the correlations, may claim an accuracy, and carry a weight which they would not otherwise have. Mr. Buckman, however, must not be held personally responsible for any errors that may appear.

The ammonoids described in the following first section on Jurassic Ammonoidea, are all from the Yakoun formation. They are listed in a general paper on the Jurassic faunas of western Canada,[1] where their stratigraphic position and correlation are given and their use in dating times of volcanic activity and other geological phenomena is demonstrated.

The *Seymourites* fauna, in the upper part of the Yakoun formation, must have had a fairly wide distribution in northwestern North America, for it is present not only at Skidegate inlet, but also on Kananaskis river (south of Banff in the Rocky mountains), where it is represented in the Fernie formation by *Seymourites mcevoyi*,[2] and also, possibly, in the Chinitna shale of the east shore of Iniskin bay, Cook inlet, Alaska, where *Kepplerites* ? cf. *K. loganianus* (Whiteaves) has been recorded.[3] The distribution indicates a sea, or several connected seaways, extending, from Alaska probably, down the western margin of the continent at least as far south as Skidegate inlet and eastward at least as far as Kananaskis river in the Rocky mountains. The ends of fern and cycad fronds occur with the marine fossils and must have drifted in from a nearby land area. As the genera *Seymourites* and *Yakounoceras* are not known outside of these localities, it is not safe to infer further extensions or connexions of this sea, although *Toricelliceras*, a member of the fauna, is in the European Jurassic. The affinities of this fauna are with those of late Macrocephalitan and of Proplanulitan age in the British Jurassic, and, therefore, it is of early Upper Jurassic time. The dating is based on the following resemblances:

| Skidegate Inlet | England and Europe |
|---|---|
| *Seymourites* | *Galilaeanus* etc. Proplanulitan age |
| *Yakounoceras* | *Gowericeras* etc. Proplanulitan age |
| *Galilaeites* ? | *Galilaeites*. Proplanulitan age |
| *Toricelliceras* | *Toricelliceras*. Late Macrocephalitan age |

The *Defonticeras* fauna, in the lower part of the Yakoun formation, has not yet been found in the Fernie formation of the Rocky mountains, but possibly may be present in the Tuxedni formation of Cook inlet, Alaska, where *Sphaeroceras oblatum* and *Sphaeroceras* have been recorded[4]. The writer, however, has not examined any specimens from Alaska and cannot determine if the genus *Defonticeras* is present there. There is some resemblance to a South American fauna (*See* under *D. oblatum*), but, as far as known, the genus *Defonticeras* is not present in it. It is difficult, therefore, to determine the distribution of this fauna and to infer the extensions of the sea in which it lived. The nearest affinities of *Defonticeras* in the British Jurassic are with forms of late Sonninian or middle Bajocian age. The time, therefore, is early Middle Jurassic.

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[1] McLearn, F. H.: "Some Canadian Jurassic Faunas"; Trans. Roy. Soc. Canada, 3rd ser., vol. 21, sec. IV, pp. 61-73, fig. 1, Plate I (1927).

[2] McLearn, F. H.: "New Jurassic Ammonoidea from the Fernie Formation, Alberta"; Geol. Surv., Canada, Bull. 49, Pl. IV, figs. 1, 2 (1928). The generic name *Seymourites* takes precedence over *Yakounites*.

[3] Martin, G. C.: U. S. Geol. Surv., Bull. 776, p. 165 (1926).

[4] Martin, G. C.: U. S. Geol. Surv., Bull. 776, p. 142 (1926).

The *Zemistephanus* fauna is also in the lower part of the Yakoun formation. It includes the ammonoid genera, *Zemistephanus* and *Kanastephanus*. The fauna is not known in the Fernie formation of the Rocky mountains or, at least, is not represented by these ammonoid genera in any fauna known from there. It is probably represented in the Tuxedni formation of Cook inlet, Alaska, where *Stephanoceras richardsoni* has been recorded;[1] the writer, however, has not examined specimens from Cook inlet. There is some resemblance to certain Pacific faunas, e.g. a Jurassic fauna of New Guinea which includes a species resembling a *Zemistephanus* (*See* under *Zemistephanus*). The import of these resemblances will be better known as studies progress. The *Zemistephanus* fauna is another fauna of early Middle Jurassic age and probably close in time to the *Defonticeras* fauna.

From the *Itinsaites* fauna only the ammonoid *Itinsaites* is described in the following first section of the account of the Jurassic Ammonoidea. The fauna occurs in the Yakoun formation on the southernmost of the Channel islands and includes other ammonoids, pelecypods, etc. Of considerable interest is the presence of the seeds of cycads which must have drifted in from a nearby land area. The fauna is probably close, if not identical, in age with the *Zemistephanus* and *Defonticeras* faunas.

As the study of the Canadian Jurassic faunas proceeds it is evident that they are many in number, although they are for the most part fragmentary and scattered geographically. They record the presence of seas on the western part of the continent from fairly early Jurassic to well on in the Upper Jurassic. The seas, from at least earliest Middle Jurassic to middle Upper Jurassic time, spread eastward to the site of the Canadian Rocky mountains and even farther eastward, but it is not known: (1) whether at any one time the Jurassic sea was essentially one body of water or a number of distinct yet connected bodies; (2) whether the sea or seaways were or were not comparatively persistent; (3) whether seas of successive stages occupied essentially the same or different sites.[2] The Canadian strata contain some genera and even species of European faunas, but also contain many genera not known outside of western North America, and this is also true of most of the species. It remains to be determined whether this very local appearance of the faunas will become less marked as progress is made in the study of the Pacific and other faunas. It is noted, in passing, that to date no ammonoids of the subfamily *Sonnininae* have been found associated with those of the families *Stepheoceratidae* and *Sphaeroceratidae* in Canadian Middle Inferior Oolite faunas.

The thick accumulations of massive tuff and agglomerate in the Yakoun formation are of Middle Jurassic age. Some of this material must have accumulated quite rapidly and some, due to the filling in of the sea, may have been laid down subaerially, but it is not all of one date, for there is evidence of at least one decided halt in the deposition. By early Upper Jurassic time, the deposition of volcanic products had ceased, at least locally. It is not known whether volcanic accumulations were resumed in later Upper Jurassic time, for whatever later Jurassic deposits may have been present were removed by erosion before Albian or late Lower Cretaceous time. Certain analogies with the Jurassic deposits

[1] Martin, G. C.: U. S. Geol. Surv., Bull. 776, p. 142 (1926).
[2] Trans. Roy. Soc., Canada, 3rd ser., vol. 21, pp. 70-71 (1927).

of Hazelton district have been pointed out by both Hanson[1] and the writer.[2] There, too, in the Hazelton series, the fossiliferous basal Middle Jurassic rocks are followed by massive accumulations of tuff, agglomerate, etc., probably also of Middle Jurassic age, and pointing as at Skidegate inlet, to intense volcanic activity. The uppermost part of the Hazelton series, the upper sedimentary division of Hanson, is without volcanic material, but as these rocks are unfossiliferous the date of the cessation of volcanic activity in this area cannot be determined, although it may also be Upper Jurassic. Extension of studies of this kind should result in the dating of times of volcanic activity and in the locating of the sites of volcanic activity and deposition, and thus form an important contribution to the study of the igneous geology of the Canadian Cordillera. Other applications of the fossils are the dating of igneous intrusions, etc. Thus the study of the Mesozoic fossils of western Canada becomes, not an end in itself, but a means to an end, the solution of the history of the Canadian Cordillera.

In the succeeding account, measurements of the ammonoids are given as follows, and in the following order: diameter of specimen in millimetres and height of whorl, thickness of whorl, and width of umbilicus in percentages of the diameter. Although no graphs of shell proportions are figured they have been prepared and are made use of in descriptions of genera and species. The following symbols are used: ES for external saddle, S1 for first lateral saddle, S2 for second lateral saddle, EL for external lobe, L1 for first lateral lobe, L2 for second lateral lobe, aux. for auxiliary lobe, etc. Lower, Middle, and Upper Jurassic are used as provisionally defined in a previous paper.[3] Except where otherwise stated all illustrations are natural size. Ammonoid specimens are not abundant, so that variation and intergradation cannot be studied.

## JURASSIC AMMONOIDEA

### Phylum, **MOLLUSCA**

### Class, *CEPHALOPODA*

### Order, **Ammonoidea**

### Family, GOWERICERATIDAE S. Buckman

### Genus, *Seymourites* Kilian and Reboul

1909. *Seymourites* Kilian and Reboul, Wissenschaftliche Ergebnisse der Schwedischen Sud-polar Exped. Band 3, Lief 6, p. 26.

1927. *Yakounites* McLearn[4], Trans. Roy. Soc., Canada, 3rd ser., vol. 21, sec. IV, p. 71.

At the stage of growth of the anterior part of the penultimate and the posterior part of the ultimate whorl the shell is subangustumbilicate, and about sphaeroconic, with somewhat convergent sides, but broad venter. On the ultimate whorl there is umbilical enlargement and eccentrumbilication; whorl contraction in anterior part of ultimate whorl. Inner whorls

[1] Geol. Surv., Canada, Sum. Rept. 1925, pt. A, p. 107 (1926).
[2] Trans. Roy. Soc., Canada, 3rd ser., vol. 21, p. 65 (1927).
[3] Trans. Roy. Soc., Canada, 3rd ser., vol. 21, sec. IV, p. 62 (1927).
[4] The generic name *Seymourites* was at first overlooked because of its publication in a work on Cretaceous ammonites. No adequate description of *Seymourites* was given by Kilian and Reboul and its true systematic position was unknown to them. They considered it a subgenus of *Kossmaticeras*. It is unlikely that the Snowhill specimen figured by Kilian and Reboul can be referred to Whiteaves' species or to the family Gowericeratidae.

are probably as in *Yakounoceras* McLearn. Runcinate venter not observed and if present must be suppressed before the stage of growth of the penultimate whorl. The ribs are numerous, narrow, and elevated. There is a single row of small, lateral tubercles. The suture line is florid; L1 is narrow, has a long terminal lobule, and is longer than EL; L2 is shorter than L1 and more leaf-like; ES is unequally divided by a very long accessory lobe, situated on its inner side so that the inner branch is the smaller. The genotype is *Ammonites loganianus* Whiteaves.

In the tuberculate genera *Galilaeanus* S. Buckman[1], *Gowericeras* S. Buckman[2], and *Galilaeiceras* S. Buckman[3], EL is longer[4], not shorter, than L1. These genera also have not so florid a suture line and have not a long prominent accessory lobe on the inner part of ES. *Galilaeanus* is probably the most closely related, having similar shallow saddles. *Kepplerites* Neumayr and Uhlig[5] does not retain the tubercles and has not so deeply cut a suture line. The tubercles also are not retained in *Ammonites macrocephalus evolutus* Quenstedt[6] and its suture line is not so deeply cut, has not a long accessory lobe in ES, and has a wider and shorter L1 as compared with EL.

*Seymourites plenus* (McLearn)

(*plenus*, full)

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

1927. *Yakounites plenus* McLearn, Trans. Roy. Soc., Canada, 3rd ser., vol. 21, sec. IV, p. 71, Pl. 1, fig. 1.

| | | |
|---|---|---|
| Diameter | 154·0 | 117·0 |
| Height, whorl | 40·5 | 50·0 |
| Thickness, whorl | 40·5 | 57·4 |
| Width, umbilicus | 24·8 | 18·5 |

The first measurement is made near the anterior end of the ultimate whorl and the second at the point of umbilical enlargement. The posterior part of the ultimate whorl is involute, being subangustumbilicate, has somewhat convergent sides outside the tubercles, is broad and rounded on the venter, is stout, being both thick and high, and a little thicker than high. Umbilical enlargement begins at a diameter of about 117 mm. or at about the beginning of the anterior half of the ultimate whorl, where the whorl suture passes from inside the tubercles to outside them. The proportional height and thickness both decrease on the anterior part of the ultimate whorl and are about equal near the aperture. There is a little more than half a whorl of living chamber. The primary ribs are angular, reclined a little on the inner margin, inclined a little on the inner area, and end in small tubercles. There are about 4 secondary ribs to each primary; all 4 branch from the primary or 3 branch from it and 1 is intercalated. All secondary ribs are narrow and elevated, i.e. plate-like, are inclined on the sides, are straight across the venter, are septate on the anterior half of

[1] Type Ammonites, IV, pt. 32, Pl. 293 (1922). *See also* VI, pp. 16-23 (1926).
[2] Type Ammonites, III, pt. 29, Pl. 254 (1921).
[3] Type Ammonites, IV, pt. 32, Pl. 290 (1922).
[4] Buckman, S. S.: personal communication.
[5] *See* Buckman, S. S.: Type Ammonites, IV, pt. 32, Pl. 289A (1922). The writer has not access to the original description of this genus.
[6] Ammon. Schwäb. Jura, p. 655, Pl. 77, figs. 1-5 (1887).

the ultimate whorl, and are separated by flat interspaces wider than the ribs. The total number of primary ribs on the ultimate whorl is 33, and that of the secondary ribs 135.

The suture line is deeply cut and florid. ES is very little deeper than wide and is unequally divided by a long lobule, which is longer than half the depth of ES, and is situated on the inner side, so that the inner branch is the smaller. S1 is smaller than ES, is hardly as deep as wide, and is divided by a long lobule. S2 is much smaller than S1, is wider than deep, and is about equally divided by a relatively long lobule and has its inner branch on the umbilical margin. EL is longer than wide. L1 is longer than EL, is narrower, and has a long, median lobule. L2 is short and relatively wider than L1. All the saddles are much wider than the lobes. The tubercle is on the inner border of S1.

This species at the same stage of growth is somewhat larger and has relatively stouter whorls and somewhat smaller umbilicus than *Seymourites loganianus* (Whiteaves). The ornament is similar in both species. What is known of the suture line of *S. loganianus* is similar to that of *S. plenus*. However, *S. loganianus* is based on an imperfect and distorted specimen with which exact comparison cannot be made.

*Horizon and Locality.* In a sandstone bed in the upper part of the Yakoun formation on the northeast shore of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9000.

*Seymourites loganianus* (Whiteaves)

1876. *Ammonites loganianus* Whiteaves (part), Geol. Surv., Canada, Mes. Foss., I, pt. 1, p. 27, Pl. 8, fig. 2 only.

1884. *Olcostephanus loganianus* Whiteaves (part), Geol. Surv., Canada, Mes. Foss., I, pt. 3, p. 211, not Pl. 23, figs. 1, 1a.

1900. *Olcostephanus loganianus* Whiteaves (part), Geol. Surv., Canada, Mes. Foss., I, pt. 4, p. 276.

| | |
|---|---|
| Diameter | 136·0 |
| Height, whorl | 40·8 |
| Thickness, whorl | 40·4 |
| Width, umbilicus | 26·5 |

The holotype of this species is too imperfect and distorted to admit of exact measurement. The above measurements are only approximate and have been made about midway between the point of umbilical enlargement and the anterior end of the specimen, at the only place where direct measurement of the diameter is possible. The anterior part of the penultimate whorl has a small umbilicus. There is marked umbilical enlargement on the anterior part of the ultimate whorl. The whorls are fairly stout and have somewhat convergent sides ventral to the tubercles, but are broad and rounded on the venter. The primary ribs are angular, straight, and inclined on the sides, outside the inner margin, and end in tubercles. From each tubercle there branch 3 or 4 secondary ribs and there are some intercalated secondary ribs. The secondary ribs are narrow, elevated, and inclined a little on the sides, but are straight across the venter. A part of the ES has been prepared with some difficulty; it is deeply cut and has a long accessory lobe on its inner side.

As already noted, *S. plenus* (McLearn) is similar in ornament, but has stouter whorls and a somewhat smaller umbilicus.

*Horizon and Locality.* Collected at Alliford bay by G. M. Dawson in 1878, presumably from a sandstone near the top of the Yakoun formation at that locality.

*Type.* National Museum of Canada; holotype, Cat. No. 5012.

*Seymourites multus* n. sp.

(*multus*, many)

Plate III, figure 2

| | |
|---|---|
| Diameter | 145 |
| Height, whorl | 37 |
| Thickness, whorl | 42 |
| Width, umbilicus | 36 |

The above measurements are approximate, for the specimen is distorted, particularly in the umbilicus. They have been made at the anterior end of the specimen, the only place where direct measurement of the diameter is possible. The ribs, both primary and secondary, are numerous; there are about 5 secondaries to each primary on the ultimate whorl, 5 branching from the small tubercle at the end of each primary or 4 branching and one intercalated. The primary ribs are angular and outside the inner margin are a little inclined. The secondary ribs are a little inclined on the sides, but are straight across the venter; they also are narrow and elevated. Only a part of the suture line can be prepared. It is deeply cut. ES is only partly preserved and the total length of the accessory lobe cannot be obtained, although it is evidently fairly long. S1 has a long accessory lobe and is about as deep as it is wide. Only a part of L1 is preserved and the total length of the median lobule cannot be determined. L2 is somewhat as in *S. plenus* (McLearn). The tubercle is on the inner side of S1.

The proportions and size are much as in *S. plenus*, but the relative height of whorl is less and the umbilicus is greater. The ribs, both primary and secondary, are more numerous than in either *S. plenus* or *S. loganianus* (Whiteaves). The suture line is sufficiently like that of *S. plenus* to admit of its assignment to the same genus.

*Horizon and Locality.* In a sandstone bed near the top of the Yakoun formation, on the northeast shore of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9001.

Genus, *Yakounoceras* McLearn

1927. *Yakounoceras* McLearn, Trans. Roy. Soc., Canada, 3rd ser., vol. 21, sec. IV, p. 71.

This genus agrees in shape and ornament with *Seymourites* and the description of these features under *Seymourites* applies also to *Yakounoceras*. Although the preservation is poor, there appears to be evidence (*See Yr. abruptum*) of less involution of the inner whorls and of some umbilical contraction up to the stage of growth of the anterior end of the penultimate whorl and the posterior part of the ultimate whorl; at any rate at this stage the cone shape is near sphaeroconic, and angustumbilicate to subangustumbilicate. On about the anterior half of the ultimate whorl there is umbilical expansion and eccentrumbilication and some whorl

contraction. The cone development, therefore, appears to be stout-whorled serpenticone to about sphaerocone to part ellipticone and part contracticone. *Yakounoceras* differs from *Seymourites* in having a simpler and less deeply cut suture line, a shorter, yet distinct, accessory lobe on the inner side of ES, L1 equal in length to EL, not longer than, and, on the whole, deeper saddles and narrower and longer lobes. The genotype is *Yakounoceras gitinsi* McLearn.

It differs from the tuberculate genera *Gowericeras* S. Buckman;[1] *Galilaeanus* S. Buckman,[2] and *Galilaeiceras* S. Buckman[3] in having L1 equal to, not shorter than, EL. The well-defined, although short, accessory lobe in ES is also a distinction as compared with these genera. The somewhat narrow long lobes recall *Gowericeras*, but those of *Yakounoceras* are even longer and are more developed; the accessory lobe is well defined, whereas in *Gowericeras* it is scarcely perceptible;[4] moreover, *Gowericeras* has not the abrupt umbilical enlargement on the ultimate whorl. *Kepplerites* Neumayr and Uhlig[5] and *Ammonites macrocephalus evolutus* Quenstedt[6] differ in not retaining the tubercles. The latter has also a very different suture line with shallower saddles and lobes much shorter and wider.

*Yakounoceras gitinsi* McLearn

(*Gitins*, Indian name of the Eagle clan)

Plate III, figure 1; Plate IV, figure 1; Plate VIII, figure 5

1927. *Yakounoceras gitinsi* McLearn, Trans. Roy. Soc., Canada, 3rd ser., vol. 21, sec. IV, p. 72, Pl. 1, fig. 2.

| | | |
|---|---|---|
| Diameter | 138·0 | 105·0 |
| Height, whorl | 36·5 | 44·7 |
| Thickness, whorl | 33·0 | 46·5 |
| Width, umbilicus | 32·0 | 23·5 |

The second measurement is taken just a little beyond the point of umbilical enlargement and the first about one-fourth whorl back from the anterior end of the ultimate whorl. The former corresponds in position to the anterior measurement given for *Seymourites plenus* McLearn, and to the measurement given for *S. multus*, i.e. at the maximum diameter. In *S. gitinsi* the outer whorl extends beyond this stage and bends back, so that the diameter at the aperture, 133 mm., is less than the maximum diameter of this ellipticonic shell. The umbilical enlargement and eccentrumbilication begin at a diameter of about 100 mm. There is about three-fourths of a whorl of living chamber, the anterior part of which is contracted. The primary angular ribs end in small tubercles, from each of which branch 3 narrow, elevated, secondary ribs, inclined a little on the sides, but straight across the venter. In addition there are single intercalated ribs. There are 33 primary and about 130 secondary ribs on the ultimate whorl, or about the same number as in *S. plenus*. ES is deep and unequally divided by a narrow lobule on its inner side. EL and L1 are long and narrow and about equal in length.

[1] Type Ammonites, III, pt. 29, Pl. 254 (1921).
[2] Type Ammonites, IV, pt. 32, Pl. 293 (1922).
[3] Type Ammonites, IV, pt. 32, Pl. 290 (1922).
[4] Buckman, S. S.: personal communication.
[5] *See* Buckman, S. S.: Type Ammonites, IV, pt. 32, Pl. 289A (1922).
[6] Amm in. Schwäb. Jura, p. 655, Pl. 77, figs. 1-5 (1887).

This species has thinner whorls than *Seymourites plenus*, *S. loganianus*, or *S. multus*, and lower whorls than *S. plenus* or *S. loganianus*. The umbilicus is larger than that of *S. plenus* or *S. loganianus*.

*Horizon and Locality.* In a sandstone bed near the top of the Yakoun formation on the northeast shore of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9002.

*Yakounoceras abruptum* n. sp.

(*abruptus*, sudden)

Plate V, figure 1; Plate VI, figures 1, 2

| | | |
|---|---|---|
| Diameter | 121·0 | 96·0 |
| Height, whorl | 34·7 | 46·6 |
| Thickness, whorl | 44·2 | 56·6 |
| Width, umbilicus | 31·5 | 14·6 |

The second measurement is taken at the point of umbilical enlargement and the first at about the anterior end of the ultimate whorl preserved.

In size this species is between *Yakounoceras gitinsi* and *Yr. ingrahami* and smaller than the three species of *Seymourites* described above. It has relatively thicker whorls than *Yakounoceras gitinsi*. The umbilicus of the anterior part of the penultimate and posterior part of the outer or ultimate whorl is smaller than that of any of the above species, but the umbilical enlargement on the anterior part of the ultimate whorl is more marked and abrupt. There is about one-half whorl of living chamber preserved. There is some whorl contraction on the anterior part of the ultimate whorl. Three secondary ribs branch from the small tubercle at the end of each primary and there are in addition intercalated secondary ribs. The primaries number about 35 and the secondaries 120 on the ultimate whorl.

The inner whorls are much distorted, but dissection of the interior, at some cost to the specimen, reveals a runcinate venter at a diameter of 15 mm. There appears to be less involution and some umbilical contraction in the inner whorls up to the stage of the anterior part of the penultimate whorl, with change in cone shape from approximate stout whorled serpenticone to about sphaerocone.

ES is very deep and as in other species of the genus is somewhat unequally divided by an accessory lobe on the inner side. EL is about equal in length to L1.

*Horizon and Locality.* In a sandstone bed near the top of the Yakoun formation on the northeast shore of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9003.

*Yakounoceras ingrahami* n. sp.

Plate VII, figures 1, 2

| | | |
|---|---|---|
| Diameter | 105·0 | 78·3 |
| Height, whorl | 35·0 | 46·0 |
| Thickness, whorl | 44·6 | 57·3 |
| Width, umbilicus | 33·0 | .... |

The second measurement is from near the point of umbilical enlargement, and is approximate, the first is from near the anterior end of the ultimate whorl. The specimen is incomplete on the posterior part of the ultimate whorl and obscure on the inner part of the umbilicus. The whorl proportions are similar to those of *Yakounoceras abruptum*, but the size is much less. As little of the umbilicus is known, no comparison can be made of the rate of umbilical expansion. There are about 29 primary ribs on the ultimate whorl, less than in *Yr. abruptum*, and 115 to 120 (estimated) secondary ribs. The saddles are not relatively so deep nor the lobes so long as those of *Yr. abruptum*.

The species name is given for the explorer Ingraham.

*Horizon and Locality.* Collected at Alliford bay by G. M. Dawson in 1878, presumably from the sandstone bed near the top of the Yakoun formation.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 5012b.

*Yakounoceras torrensi* n. sp.

Plate VIII, figures 3, 4

| | | | | |
|---|---|---|---|---|
| Diameter | 47·0 | 40·6 | 27·7 | 24·7 |
| Height, whorl | 40·4 | 41·8 | 39·7 | 38·8 |
| Thickness, whorl | 56·3 | ..... | ..... | 54·7 |
| Width, umbilicus | 33·0 | 33·2 | 36·1 | 37·6 |

The first measurement is taken at the anterior and the last at about the posterior end of the ultimate whorl. The cone shape is that of a stout, thick-whorled serpenticone, latumbilicate to sublatumbilicate, the umbilicus contracting with growth. The whorl suture is on the outer edge of the lateral tubercles. The whorls are much thicker than high; the sides are narrow, somewhat flattened and divergent inside the tubercles, and wide, moderately convex, and convergent outside the tubercles; the venter is tabulate on the posterior part of the ultimate whorl (preserved) and rounded on the anterior part. There is about one-fourth whorl of living chamber preserved. The primary ribs are short and a little inclined. They increase in number with growth and each ends in a tubercle from which there proceed three narrow secondary ribs, inclined a little on the sides, but straight across the venter; there are also a few, single, intercalated secondary ribs. The ribs are thickened and raised at the borders of the tabulate venter, but these modifications are lost on the anterior part of the last whorl preserved. There are 88 secondary ribs on the ultimate whorl.

EL is long and narrow. ES is very deep and a little wider than EL and has a short accessory lobe on its inner side. L1 is as long as EL, is narrow and has a long median lobule. S1 is deep and narrow, but not so deep as ES. L2, shorter than L1, is very narrow with a long terminal lobule. The tubercle is on the inner border of S1.

This is probably not a full grown specimen. The shape of ES with its accessory lobule, and of L1 and the equal lengths of EL and L1 recall *Yakounoceras*. L2, however, is much narrower than that of any of the known species of *Yakounoceras* or *Seymourites*. The deep ES and long, narrow L1 are as in *Yakounoceras abruptum*, but the inner whorls of that

species have more numerous primary ribs at the same stage of growth. The umbilicus is wide for *Yakounoceras*, but it is contracting with growth,[1] the specimen is not fully grown, and in *Yakounoceras*, e.g. in *Y. abruptum*, there appears to be umbilical contraction before enlargement.

The species name is given for Capt. Torrens.

*Horizon and Locality.* In a sandstone bed in the upper part of the Yakoun formation on the northeast shore of Maude island, Skidegate inlet, Queen Charlotte islands.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9004.

Genus, *Galilaeites* S. Buckman

*Galilaeites ? penderi* n. sp.

Plate VIII, figures 1, 2

| | | | | |
|---|---|---|---|---|
| Diameter | 37·5 | 35·0 | 31·5 | 24·0 |
| Height, whorl | 36·5 | 38·5 | 38·5 | 35·0 |
| Thickness, whorl | 43·7 | 40·0 | 43·0 | 43·6 |
| Width, umbilicus | 40·0 | 41·0 | ..... | 44·9 |

The first measurement is taken near the anterior and the last about one-eighth whorl in front of the posterior end of the ultimate whorl. The cone shape is that of a serpenticone with subtrigonal whorls thicker than high, broad, flattened, convergent sides outside the line of lateral tubercles, and narrow, somewhat flattened, divergent sides inside the tubercles. The venter is tabulate. Perlatumbilicate to latumbilicate, the umbilicus contracting with growth. The inner margin is narrow and its edge abruptly rounded. There are about 22 inclined, narrow, elevated, primary ribs, each ending in a tubercle, and about 70 elevated, narrower, secondary ribs, arising by trifurcation at the tubercle and also by occasional intercalation. They are inclined slightly on the sides, bent back in some places, straight across the tabulate venter, and thickened transversely and elevated on the margins of the tabulate area. There is less than half a whorl of living chamber. The suture line is rather simple. The EL is longer than wide. L1 is as long as EL, is rather narrow, has a long median lobule and two small drooping lobules on either side. L2 is also narrow, but much shorter than L1. ES is nearly as wide as deep and is unequally divided by a narrow lobule on its inner side. S1 is about as deep as ES, but much narrower. The tubercle is on the inner side of S1.

As this may not be a mature specimen and as only one specimen is known it does not seem advisable to make a new genus. It resembles *Galilaeites* S. Buckman[2] in the shape of the whorls and in the suture line, but has a relatively longer L1, which is not leaf shaped. Compared with *Gowericeras* S. Buckman[3], the sides ventral to the tubercles are flatter and the rib curve is different. The suture line of *Galilaeiceras* S. Buckman[4] is very different.

The species name is given for D. Pender, R.N.

[1] In *Yakounoceras abruptum*, however, the probable umbilical contraction to the approximate sphaerocone stage appears to be accompanied by a passing of the whorl suture inside the line of lateral tubercles.
[2] Type Ammonites, IV, pt. 32, Pl. 294 (1922).
[3] Type Ammonites, III, pt. 29, Pl. 254 (1921).
[4] Type Ammonites, IV, pt. 32, Pl. 290 (1922).

*Horizon and Locality.* In a sandstone bed near the top of the Yakoun formation, on the northeast shore of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9005.

Genus, *Toricelliceras* S. Buckman

*Toricelliceras newcombii* (Whiteaves)

Plate V, figures 2, 3, 4

1900. *Hoplites newcombii* Whiteaves, Geol. Surv., Canada, Mes. Foss., I, pt. 4, p. 281, Pl. 37, figs. 1, 1a.

| | | | | |
|---|---|---|---|---|
| Diameter | 35·6 | 30·5 | 27·0 | 20·0 |
| Height, whorl | 38·5 | 39·0 | 38·9 | 37·5 |
| Thickness, whorl | 48·0? | 46·7 | 50·0 | 51·5 |
| Width, umbilicus | 34·3 | 36·6 | 37·0 | 39·5 |
| Primary ribs | 25 | ..... | ..... | ..... |
| Secondary ribs | 60 | ..... | ..... | ..... |

The first measurement is taken near the anterior and the last about one-tenth whorl in front of the posterior end of the ultimate whorl. The whorl shape is that of a stout-whorled serpenticone, latumbilicate, the umbilicus contracting with growth. The whorl suture is on the outer edge of the lateral tubercles. The whorls are thicker than high. The area inside the tubercles is narrow, somewhat flattened and divergent; the area outside the tubercles is wide, gently convex, and convergent; the venter is tabulate, but is becoming rounded on the anterior part of the ultimate whorl. The inner margin is narrow, and its edge abruptly rounded; the very angular edge on one side of the specimen is caused by distortion. The living chamber preserved is about seven-eighths of a whorl, but the aperture is not known. The narrow, elevated, primary ribs are straight and inclined on the sides, increase in number with growth, and end in narrow, elevated, sharp transverse tubercles. From each tubercle arise two secondary ribs and there are some single intercalated secondary ribs. The secondary ribs are narrow, elevated, inclined on the sides, but bend back ventrally and proceed straight across the tabulate area. The ribs are raised and slightly thickened on the borders of the tabulate area; on the anterior part of the ultimate whorl the tabulate venter is beginning to lose the feeble bordering of incipient tubercles and is becoming rounded.

The suture line is fairly simple and little lobate. ES is very deep. L1 is long and narrow, is about as long as EL, has a long, narrow terminal lobule and two short, drooping lobules on either side. S1 is smaller than, and not as deep as, ES. The tubercle is on its inner edge.

In proportional thickness of whorl this species resembles *Toricelliceras torricelli* (Oppel)[1], but in proportional height is less and in umbilication is somewhat greater. The suture line is very close to that of *T. subsulcatum* S. Buckman[2], particularly in the shape of L1. The whorls of *T. newcombii*, however, are proportionally thicker, the venter is not subsulcate, the tubercles on the borders of the tabulate area are not so well defined, and the secondary ribs are more numerous, narrower, and more elevated.

[1]Buckman, S. S.: Type Ammonites, pt. 32, Pl. 292 (1922).
[2]Type Ammonites, pt. 33, Pl. 310 (1922).

*T. runcinatum* S. Buckman[1] has a much smaller umbilicus. *T. subrotundum* S. Buckman[2] among other differences is increasing in thickness of whorl on the outer whorl and has more ribs.

*Horizon and Locality.* Collected by Dr. C. F. Newcombe in 1895 on the south side of Alliford bay, probably from the sandstone bed near the top of the Yakoun formation.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 5990.

Family, SPHAEROCERATIDAE S. Buckman

Genus, *Defonticeras* McLearn

1927. *Defonticeras* McLearn, Trans. Roy. Soc., Canada, 3rd ser., vol. 21, sec. IV, p. 72.

Inner whorls and posterior part of ultimate whorl sphaeroconic, with very small umbilicus, followed by marked and abrupt umbilical enlargement on the anterior half of the ultimate whorl. Mouth border rather simple, having behind the lip a well-defined sulcus and in some species a ridge of low relief. Living chamber is about three-fourths of a whorl or less. Primary ribs are fairly stout and slightly inclined, but not sloping well forwards at the anterior end of the ultimate whorl. The secondary ribs are straight across the ventral area. No tubercles. The suture line is complex with a wide L2 and very small S2 and auxiliaries. The point of furcation of the ribs is on the outer part of L2.

The genotype is *Defonticeras defontii* McLearn.

*Chondroceras* Mascke[3] has a three-ridged mouth, a somewhat regular umbilicus, and fine ribs sloping well forward near the anterior end of the ultimate whorl.[4] The stout ribs recall *Emileia* S. Buckman, but the suture line is simpler and there are other differences.

*Defonticeras defontii* McLearn

Plate XII, figures 1-3

1927. *Defonticeras defontii* McLearn, Trans. Roy. Soc., Canada, 3rd ser., vol. 21, sec. IV, p. 72, Pl. 1, fig. 3.

| — | (a) | (b) | (c) |
|---|---|---|---|
| Diameter | 62·4 | 58·5 | 45·1 |
| Height, whorl | 40·0 | 46·8 | 52·5 |
| Thickness, whorl | 62·3 | ..... | 78·0 |
| Width, umbilicus | 22·4 | 15·3 | ..... |

(*a*) is taken about one-sixth of a whorl back from the anterior end of the ultimate whorl, (*b*) is taken one-third of a whorl back, and (*c*) is taken at the beginning of the ultimate whorl. This species has very stout whorls, both thick and high. The sides are somewhat flattened and the venter is broad and arched. There is nearly five-eighths of a whorl of living chamber. The ventral part of the aperture is broken off. The umbilical enlargement is abrupt and comes at the beginning of the last half of the ultimate whorl. There is also whorl contraction. The whorls are ornamented on the sides with slightly inclined primary ribs which rapidly increase in size and spacing

[1] Type Ammonites, pt. 34, Pl. 318 (1922).
[2] Type Ammonites, pt. 34, Pl. 319 (1922).
[3] Die Stephanoceras—Verwandten in den Coronatenschichten von Norddeutschland, Gottingen, 1907.
[4] Buckman, S. S.: personal communication.

on the anterior half of the ultimate whorl, where they are fairly stout. These primary ribs divide into finer secondary ribs, which are small and very closely spaced on the posterior part of the ultimate whorl, but are coarser, more widely spaced, and have fewer secondary per primary ribs on the anterior part of the ultimate whorl. Secondary ribs have only moderate relief.

The suture line is complex. The ES and S1 are of about the same size and are a little deeper than wide. S2 is very small. L1 is about as wide and as long as EL, is rather narrow stemmed, much longer than wide, and nearly symmetrical. L2 is broad and the point of furcation is on the outer part of it.

The species name is given for the Spanish explorer de Fonte.

*Horizon and Locality.* From talus on ledges of the lower Yakoun at Richardson bay, on the south side of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9009.

*Defonticeras maudense* n. sp.

Plate XIII, figure 1; Plate XIV, figures 2, 3

| | |
|---|---|
| Diameter | 74·0 |
| Height, whorl | 48·3 |
| Thickness, whorl | 70·0 |
| Width, umbilicus | 17·9 |

The specimen is much distorted, so that the above measurements are approximate. It has stout whorls, much thicker than high, and a highly arched ventral area. There is a fairly narrow sulcus back of the lip and no ridge or second depression posterior to this sulcus. The living chamber is almost three-fourths of a whorl. The umbilicus of the inner whorls is very small and there is abrupt umbilical enlargement on the anterior half of the ultimate whorl. The primary ribs of the ultimate whorl are fairly stout and the secondary ribs are small, of low relief, decrease in number per primary ribs and increase in width and spacing with the growth of the ultimate whorl. The suture line is complex. S1 is almost as large as ES and like it is somewhat deeper than wide; S2 is small; L1 is narrow-stemmed, is almost symmetrical, and is about as long as EL; L2 is wider and shorter than L1.

This is the largest of the species of this genus in the Yakoun formation. It is larger and has a more highly arched ventral area than *D. defontii* McLearn.

*Horizon and Locality.* From talus on ledges of the lower part of the Yakoun formation at Richardson bay, on the south side of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9010.

*Defonticeras marchandi* n. sp.

Plate XII, figures 4, 5

| | |
|---|---|
| Diameter | 50·5 |
| Height, whorl | 43·3 |
| Thickness, whorl | 56·9 |
| Width, umbilicus | .... |

The above measurements were taken about one-tenth whorl back from the lip. The posterior part of the ultimate whorl is not preserved and the

umbilicus is obscure. It is a much smaller species than either *D. defontii* or *D. maudense* and has more slender whorls than either, both proportional height and thickness being less. The sides of the whorl are somewhat flattened, but the ventral area is well rounded. The sulcus behind the lip is fairly wide and the ridge posterior to that is broad, but has little relief. Behind this is a very shallow, hardly perceptible, depression. The primary ribs are of moderate stoutness and relief on the core, and anteriorly increase evenly in size and width of spacing. The secondary ribs are numerous, particularly on the posterior half of the ultimate whorl; they are more numerous on the anterior half of the ultimate whorl than in *D. defontii*.

The suture line is fairly complex; ES is about as deep as broad; S1 is similarly proportioned, but a little smaller; L1 is nearly as wide as EL, and about as long; L2 is broader and more shallow than L1; the point of furcation of the ribs is in the outer part of L2.

The species name is given for Captain Etienne Marchand, an early explorer of the islands.

*Horizon and Locality.* From talus on ledges of the lower part of the Yakoun formation at Richardson bay, on the south side of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9011.

*Defonticeras colnetti* n. sp.

Plate XIII, figures 4, 5

| | | |
|---|---|---|
| Diameter | 53·8 | 40·0 |
| Height, whorl | 49·2 | 50·0 |
| Thickness, whorl | 63·5 | 68·5 |
| Width, umbilicus | | |

The first measurement is taken about one-eighth whorl behind the lip and the second at the beginning of the ultimate whorl. The specimen is somewhat distorted. The preservation of the umbilicus is poor, but it appears to be very small in the inner whorls and the umbilical expansion on the ultimate whorl is marked and abrupt. It is a smaller species than *D. defontii*, has thinner whorls, and the decrease in proportional thickness and height on the ultimate whorl is not so great. It is larger than *D. marchandi* and has stouter whorls; otherwise the whorl shape recalls that species, for the sides are similarly somewhat flattened, although not so much so, the sulcus behind the lip is not well preserved, but is apparently not so wide as in *D. marchandi* and is deeper on the sides. The ribbing is similar to that of *D. marchandi*, there being about 3 secondaries to each primary on the anterior part of the ultimate whorl and the increase in size and width of spacing are proportionately much the same. Of course the ribs are actually larger in this species, being comparable with its greater size. The saddles are proportionately deeper and the lobes longer than in *D. marchandi*. S1 is about as large as ES; L1 is as long, but not as wide as EL; L2 is wider than L1. The point of furcation of the ribs is on the border between S1 and L2.

*Sphaeroceras* cf. *submicrostoma* Gottsche, as identified by Boehm[1], has a somewhat similar form and ribbing, but the umbilicus of its inner

[1] Boehm, G.: Nova Guinea, Resultats L'expédition scientifique Ne'erlandaise à la Nouvelle-Guinée en 1903, vol. 6, Géologie, Abschnitt I, p. 11, Pl. 2, figs. 3a-c not 4 (1912).

whorls appears to be larger, the primary ribs appear to be fewer and somewhat stouter, and it has more secondary ribs per each primary.

The species name is given for Captain Colnett.

*Horizon and Locality.* In the lower part of the Yakoun formation at Richardson bay, south side of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9012.

*Defonticeras ellsi* n. sp.

Plate XIII, figures 2, 3; Plate XIV, figure 1

| | | | |
|---|---|---|---|
| Diameter | 61·7 | 52·1 | 42·8 |
| Height, whorl | 38·9[1] | 45·8 | 51·0 |
| Thickness, whorl | 57·0[1] | 60·5[1] | 70·0[1] |
| Width, umbilicus | 23·1 | 13·8 | 9·5 |

One side of the specimen is crushed, the other side is well preserved, but only the inner part of the apertural margin is complete. This species has moderately stout whorls with somewhat flattened sides and well-arched venter. Because of the difficulty of preparing the suture line, the length of the living chamber is not known; it is a whorl or less. Judging from the remnant of the apertural margin, the sulcus behind the lip is very narrow. The umbilicus of the inner whorls is very small. There is fairly abrupt umbilical enlargement on the last half of the ultimate whorl. Primary ribs are broad, particularly so on the last half of the ultimate whorl, have considerable relief, and are a little inclined. The secondary ribs are smaller, are of fair relief, and are straight across the venter. The suture line is complex; S1 is a little smaller than ES; both are deeper than wide; L2 is fairly wide and the furcation of the ribs takes place about on the border between S1 and L2.

*D. defontii* has thicker and somewhat higher whorls, somewhat flatter sides, wider and less arched venter, and saddles not so relatively deep. *D. maudense* is much larger, and has much stouter whorls. *D. marchandi* is smaller and has relatively shallower saddles and shorter lobes. *D. colnetti* has a less proportional decrease in thickness and height on the ultimate whorl, a more broadly arched ventral area, and a somewhat less delicate suture line.

The name is given for R. W. Ells.

*Horizon and Locality.* In the lower part of the Yakoun formation at Richardson bay, on the south side of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9013.

*Defonticeras oblatum* (Whiteaves)

Plate XV, figure 1

1876. *Ammonites loganianus* Whiteaves, Form A, Geol. Surv., Canada, Mes. Foss., I, pt. 1, p. 29, Pl. 4, figs. 2, 2a.

1884. *Stephanoceras oblatum* Whiteaves, Geol. Surv., Canada, Mes. Foss., I, pt. 3, p. 209.

| | (a) | (b) | (c) |
|---|---|---|---|
| Diameter | 58·0 | 49·0 | 37·5 |
| Height, whorl | 37·5 | 43·8 | 53·8 |
| Thickness, whorl | 55·5 | 62·8 | 74·5 |
| Width, umbilicus | 25·0 | 15·7 | ..... |

[1] Approximate.

(*a*) is taken about one-fourth whorl back from the aperture, (*b*) about one-half whorl back, and (*c*) at about the beginning of the ultimate whorl. This species has moderately stout whorls which are rounded and convergent on the sides and arched on the venter. The sulcus behind the lip is wide and behind this is a low ridge, and behind it a broad, very shallow depression. There is nearly three-fourths of a whorl of living chamber. The umbilicus of the inner whorls is very small. On the last half of the ultimate whorl there is marked and abrupt umbilical enlargement. On the posterior part of the ultimate whorl there are 19 rather closely set, slightly inclined primary ribs of considerable relief; each divides into 2 closely approximated, rather stout secondary ribs; there are in addition some intercalated secondary ribs; there are about 5 secondary ribs per 10 mm. in this part of the ultimate whorl. On the anterior part of the ultimate whorl the primary ribs are wider, more rounded, of proportionately less relief, and are more widely spaced, being about 5·5 mm. apart or spaced less than 2 per 10 mm.; they are, moreover, inclined a little and divide into 2 secondary ribs of smaller size and of low relief; there are in addition some intercalated ribs in this anterior part; the secondary ribs are spaced about 3 per 10 mm. The suture line is not complex and the saddles are relatively shallow. ES is deeper than S1, which is about as wide as deep; L1 is wide stemmed and L2 is wider and shorter than L1.

This species differs from all the above in its simpler suture line, its shallower saddles, and its different ribbing. It may belong to a different stock and is only provisionally placed in the genus *Defonticeras*. *Stephanoceras submicrostoma* Gottsche[1] resembles this species somewhat, but has fewer and more widely spaced primary ribs on the posterior part of the ultimate whorl, and narrower primary ribs of greater relief on the anterior part of the ultimate whorl; the mouth border also is different. The sulcus behind the lip is narrower than in *D. oblatum* and there is no ridge and shallow depression behind it; the umbilical enlargement also is more regular.

*Horizon and Locality.* Probably from the lower part of the Yakoun formation at Richardson bay, south side of Maude island. Collected by J. Richardson in 1872 and labelled "Skidegate channel".

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 4964.

*Defonticeras* ? sp.

Plate XI, figure 3

The specimen so designated consists of part of an inner whorl, probably the penultimate whorl. The umbilicus is very small and the ribbing is as in *Defonticeras*. The suture line, however, has much deeper saddles than those of typical *Defonticeras*. With it, but not attached, is a fragment of an ultimate whorl, the ribbing and mouth border of which are similar to that of *Defonticeras*.

Other specimens collected from the lower Yakoun at Richardson bay are too fragmental or too badly crushed for description and illustration.

[1] Gottsche, C.: Beitr. Geol. Pal. Argent. Rep. II, Pal. Theil, p. 15, Pl. 3, figs. 2a, b. Cassel (1878).

One has a suture line with very deep saddles like *Defonticeras* ? sp., but it is larger and has thicker whorls.

*Horizon and Locality.* In the lower Yakoun at Richardson bay, south side of Maude island.

*Type.* National Museum of Canada, Ottawa; Cat. No. 9014.

*Frogdenites* ? cf. *profectus* S. Buckman

Plate XII, figure 6

Cf. 1923. *Frogdenites profectus* S. Buckman, Type Ammonites, V, pt. 42, Pl. 430.

Mr. Buckman advises the above designation of one of the specimens in the *Defonticeras* fauna, noting in comparison with *D. marchandi*, the flatter periphery and sharper fall of the sides into the umbilical area. It differs from *F. profectus* chiefly in the anterior ribs which do not become widely spaced. As only a part of the ultimate whorl and none of the inner whorls are preserved, the exact affinites of this form cannot be determined.

*Horizon and Locality.* In the lower Yakoun formation at Richardson bay, south side of Maude island.

*Type.* National Museum of Canada, Ottawa; Cat. No. 9015.

Family, STEPHEOCERATIDAE S. Buckman

Genus, *Zemistephanus* McLearn

1927. *Zemistephanus* McLearn, Trans. Roy. Soc., Canada, 3rd ser., vol. 21, sec. IV, p. 72.

The inner whorls are cadiconic and latumbilicate. On ultimate whorl becoming serpenticonic, there being umbilical enlargement and whorl contraction, particularly in the proportional thickness of whorl. The primary ribs end in tubercles and are becoming less prominent on the ultimate whorl, but persist to the end. The suture line is moderately complex; ES is large and deeply divided, S1 is smaller than ES, and S2 is shallower than, and as broad as, S1; L1 is somewhat longer than EL, L2 is much smaller than L1, is simple and cruciform, has a long, median lobule and is a little inclined; the auxiliary lobes are inclined. The tubercle is about on the border between L2 and S2. The genotype is *Ammonites richardsoni* Whiteaves.

The cone shape recalls *Emileia* (of Sonninian age) in the cadicone stage, i.e., *E. crater* S. Buckman[1]; there are tubercles at the ends of the primary ribs, however, and the suture line is not so complex as in typical *Emileia* S. Buckman. The cone shape also recalls *Tulites* S. Buckman, but the ornament is stronger and the suture is somewhat more complex and differs in detail, L2 being simple, not double, and cruciform. There is some resemblance in shape, ribbing, and suture line to *Teloceras*, e.g., *T. banksii* (J. Sowerby),[2] but the tubercle is more dorsal in position with respect to L2 of the suture line and there is the falling off to serpenticone, which does not occur in *Teloceras*. *Stephanoceras* ? *humphriesi crassicostata* Quenstedt, as identified by Boehm[3] from New Guinea has a similar cone

[1] Type Ammonites, III, pt. 22, Pl. 164 (1920). Yorkshire Type Ammonites, II, p. IX (1913).

[2] Type Ammonites, VI, pt. 59, Pl. 660B (1926).

[3] Boehm, G.: Unteres Callovien und Coronatenschichten zwischen MacCluer-Golf und Geelvink bai, Nova Guinea. Resultats L'expédition scientifique Ne'erlandaise à la Nouvelle-Guinée en 1903, vol. 6, Geologie, Abschnitt 1, Pl. 3, fig. 2.

shape and ribbing, and, possibly, suture line; compared with all the known Skidegate species of *Zemistephanus*, however, it has much thinner whorls.

*Zemistephanus richardsoni* (Whiteaves)

1876. *Ammonites richardsoni* Whiteaves, Geol. Surv., Canada, Mes. Foss., I, pt. 1, p. 32, Pl. 5, figs. 1, 2.

HOLOTYPE

| | | | | |
|---|---|---|---|---|
| Diameter | 104·0 | 86·5 | 73·0 | 62·5 |
| Height, whorl | 29·8 | 33·8 | 39·1 | 39·3 |
| Thickness, whorl | 53·0 | 58·0 | 75·0 | 73·0 |
| Width, umbilicus | 43·6 | ..... | 40·4 | 40·3 |
| Tubercles per whorl | 13–14 | ..... | ..... | ..... |

As only one side of the specimen is preserved, the measurements for thickness are only approximate. The inner whorls are cadaconic and latumbilicate and the walls of the umbilicus are very steeply inclined. The ventral area is broad and arched. The umbilical enlargement begins at a diameter of about 80 mm., and near the last septum, where the whorl suture passes outside the tubercles. About three-fourths of a whorl of living chamber preserved, but marks on the specimen show that it extended nearly an entire whorl at least. Anterior end of ultimate whorl contracted both in height and thickness. The primary ribs end in large conical tubercles. The primary ribs are of less relief on the ultimate whorl, but persist to the end. The ventral area of the ultimate whorl is covered with small costulæ which are arched forward a little.

PLESIOTYPE

Plate IX, figures 1, 2; Plate X, figure 2

| | | | | | | |
|---|---|---|---|---|---|---|
| Diameter | 119·5 | 113·0 | 91·0 | 77·5 | 71·5 | 58·0 |
| Height, whorl | 24·7 | 28·0 | 32·0 | 32·8 | 33·3 | 34·0 |
| Thickness, whorl | ..... | ..... | ..... | ..... | 72·4 | 72·5 |
| Width, umbilicus | 46·2 | 43·5 | 38·0 | 37·3 | 39·5 | 39·0 |
| Tubercles per whorl | 16 | ..... | ..... | ..... | ..... | ..... |

The first measurement is taken at the anterior end of the ultimate whorl preserved and the last a little more than 1½ whorls back.

The number of tubercles per whorl increases with growth. This specimen is larger than the holotype and the umbilical enlargement takes place at a somewhat later stage of growth, at a diameter of about 90 mm. near the last septum and not far from the beginning of the ultimate whorl. There is about three-fourths of a whorl of living chamber preserved, but marks on the specimen indicate that it was at least nearly a whorl. It is possible to follow the ventral ornament back farther in this specimen than in the holotype; on the posterior part of the penultimate whorl there are small secondary ribs or costæ, arched forward a little and numbering about 7 per each tubercle. On the anterior part of this whorl they are similar, but are obscured over most of the surface by imprint of the ornament of the dorsal surface of the ultimate whorl, which leaves an impress of closely approximate irregular costulæ. On the ultimate whorl the ventral ornament is not well preserved; the core appears to be smooth, but may not be so; there are some coarse undulations on the anterior part.

The suture line of one side of this specimen has been prepared. It is moderately complex. The ES is broad, deeper than broad, and deeply divided by a long, narrow lobule; S1 is much smaller, but is of about the same proportions as ES; S2 is broad, but very shallow; L1 is somewhat longer than EL, has a long, slender, median lobule, and long, slender lobules on each side; L2 is short, narrow, simple, and cruciform, a little inclined, and has a long, narrow, median lobule; auxiliaries are narrow and aslant. The tubercle is about on the border between L2 and S2.

*Horizon and Locality.* The holotype was collected by J. Richardson in 1872 from Skidegate channel and is probably from the lower Yakoun formation at Mackenzie bay. The plesiotype is from the lowest and fossiliferous beds of the Yakoun formation on the northeast shore of Mackenzie bay, northwest shore of Maude island.

*Types.* National Museum of Canada, Ottawa; holotype, Cat. No. 5013; plesiotype, Cat. No. 9006.

*Zemistephanus funteri* n. sp.

Plate X, figure 1

| | | | | |
|---|---|---|---|---|
| Diameter | 102·0 | 95·5 | 78·0 | 65·0 |
| Height, whorl | 23·1 | 26·2 | 32·4 | 36·0 |
| Thickness, whorl | ..... | ..... | ..... | ..... |
| Width, umbilicus | 52·8 | 43·5 | 41·0 | 39·4 |
| Tubercles per whorl | 16 | ..... | ..... | ..... |

As only one part of one side is preserved, the above measurements are only approximate. The shell form, proportions, and size, as far as they can be determined, are somewhat similar to those of *Zemistephanus richardsoni* (Whiteaves). The umbilical expansion begins at about the same stage of growth as that of the holotype of that species, i.e., at a diameter of about 80 mm. The umbilical expansion, however, is more abrupt than in *Z. richardsoni*. Nearly three-fourths of a whorl of living chamber is preserved. The primary ribs have low relief and end in large conical tubercles. The secondary ribs on the penultimate whorl are small and about 8 in number between tubercles. On the ultimate whorl they are fewer and larger. The suture line is much as in *Z. richardsoni;* L1 is long and cruciform with a long, narrow, median lobule and a fairly long lobule on either side; it is slightly asymmetric, the median lobule being a little towards the inner side; L2 is small, similar to that of *Z. richardsoni*, but a little shorter; the auxiliaries are small and inclined; S1 is smaller than ES, and S2 is broad and shallow. The tubercle is about on the border between L2 and S2.

The species name is given for Robert Funter.

*Horizon and Locality.* From the lower Yakoun on the northeast side of Mackenzie bay, northwest shore of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9007.

*Zemistephanus vancouveri* n. sp.

Plate XI, figures 1, 2

| | |
|---|---|
| Diameter | 101·6 |
| Height, whorl | 42·3 |
| Thickness, whorl | 70·0 |
| Width, umbilicus | 40·0 |

As less than one-half of a side of the specimen is preserved, the above measurements are very approximate. The entire specimen is septate and no living chamber is preserved. The complete specimen must have been larger than any of the other species referred to *Zemistephanus*. Cadiconic. There is no whorl contraction or umbilical enlargement. It is placed in *Zemistephanus* because of its similarity in ornament and its similarity in cone shape to the inner whorls of the other species of this genus. The walls of the umbilicus are steep and the ventral area is highly arched. The primary ribs, of rather low relief, end in large conical tubercles. The secondary ribs are rather small, of moderate relief, and are arched forward; about three of them branch from each tubercle and in addition there are two intercalated secondary ribs per tubercle. The preparation of the suture line is not satisfactory.

Compared with *Z. richardsoni* and *Z. funteri*, this species is larger, has more highly arched whorls, somewhat fewer tubercles per whorl, and the secondary ribs are more strongly arched forward on the ventral area.

Compared with *Teloceras banksii* (J. Sowerby)[1], the whorls are not so thick, are more highly arched on the venter, and the size is probably smaller.

The species name is given for Captain Vancouver.

*Horizon and Locality.* From the lower Yakoun beds on the northeast side of Mackenzie bay, northwest shore of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9008.

## Genus, *Kanastephanus* McLearn

(*Kana*, Skidegate channel)

1927. *Kanastephanus* McLearn, Trans. Roy. Soc., Canada, 3rd ser., vol. 21, sec. IV, p. 73.

At stage of growth of inner whorls, cadiconic. At stage of penultimate whorl, cadiconic, with slightly contracting umbilicus, but whorl becoming relatively a little higher and, therefore, somewhat less depressed, as in *K. altus*. At stage of ultimate whorl there is umbilical enlargement and rounding and contracting of whorl, chiefly in thickness, i.e., a falling off to serpenticone. At all stages, however, whorls are thicker than high. The living chamber is nearly three-fourths of a whorl. There are lateral lappets. With the falling off to serpenticone at the stage of the ultimate whorl, there is also some simplification in ribbing. The primary ribs, however, increase in number, not only on the inner whorls, but also on the ultimate whorl where there is the greatest number per whorl. The simplification on the ultimate whorl is the decrease in number of secondary ribs, due to decrease in number of secondaries per each primary, and is carried to the stage of two per each primary, arising by bifurcation. The ribs are of considerable relief and in some species are slightly inclined on the sides, particularly near the anterior end, but in all are straight across the venter. There is a single row of lateral tubercles. Suture line fairly simple. L1 is rather broad stemmed, tripartite, with moderately long median lobule, and is about as long as EL. The small L2 is both narrow and short. The small aux.1 is inclined and the miniute aux.2 is a little inclined. ES is much broader and deeper than S1 and is unequally

[1] *See* Buckman, S. S.: Type Ammonites, VI, pt. 59, Pls. 660 A, B (1926).

divided by a short lobule, the inner branch being the smaller. The S1 is smaller, but is similarly divided. S2 is smaller than S1 and divided by a short lobule. There are two minute auxiliary saddles. The position of the tubercle is about on the boundary between S1 and L2. The genotype is *Kanastephanus crickmayi* McLearn.

The suture line is very similar to that of *Epalxites* Mascke,[1] but the lappet, and also the tubercle with respect to the suture line, are more dorsal in position than in *Epalxites*. The lateral position of the lappets recalls *Otoites* Mascke[2] of Sonninian age, but L2 is smaller and narrower and the position of the tubercle with respect to the suture line is more ventral than in *Otoites*, being about on the border between S1 and L2 and not on the outer part of S2. In a like manner this genus both resembles, and differs from, *Otoites* in the Jurassic of western Australia[3]; the suture line, moreover, of these Australian species, and of *O. depressus* in particular, is simpler and has shallower saddles and larger auxiliary saddles than the suture line of *Kanastephanus*. As no diagnosis of *Germanites* Mascke[4] has been given and the genotype has been neither figured nor described no comparison with it can be made.

Other differences, of less generic significance than the foregoing, are also worthy of note. The umbilicus is larger in all the known species of *Kanastephanus* than in the typical species of *Otoites* like *O. sauzei* d'Orbigny[5], *O. delicatus* S. Buckman[6], and *O. contractus* J. de C. Sowerby[7]. The Australian *Otoites* are variable; *O. depressus* Whitehouse[8] has an even larger umbilicus than any of the species of *Kanastephanus*, but has much more depressed whorls; *O. semiornatus* (Crick.)[9] has an umbilicus somewhat similar to that of the known species of *Kanastephanus*, but has much more compressed whorls.

*Kanastephanus crickmayi* McLearn

Plate XVI, figures 7, 8

1927. *Kanastephanus crickmayi* McLearn, Trans. Roy. Soc., Canada, 3rd ser., vol. 21, sec. IV, p. 73, Pl. 1, figs. 5, 6.

| | | | | | |
|---|---|---|---|---|---|
| Diameter | 52·0 | 47·0 | 43·8 | 39·3 | 36·2 |
| Height, whorl | 30·0 | 28·8 | 28·6 | 28·6 | 29·0 |
| Thickness, whorl | 40·9 | 44·1 | 46·1 | ..... | ..... |
| Width, umbilicus | 48·2 | 49·2 | 48·1 | 44·6 | 42·8 |
| Primary ribs | 19 | ..... | ..... | ..... | ..... |
| Secondary ribs | 50 | ..... | ..... | ..... | ..... |

The first measurement is from the anterior and the last is from the posterior end of the ultimate whorl. The ultimate whorl is perlatumbilicate, the umbilicus increasing with growth on the ultimate whorl.

[1] Die Stephanoceras-Verwandten in den Coronaten-schichten von Norddeutschland, Gottingen 1907; Buckman, S. S.: Type Ammonites, III, Pls. 151, 159 (1920).
[2] Die Stephanoceras-Verwandten in den Coronaten-schichten von Norddeutschland, Gottingen 1907; Buckman, S. S.: Type Ammonites, III, Pl. 141 (1919), Pl. 158 (1920).
[3] *O. depressus*, Whitehouse, *O.* sp. and *O. semiornatus* (Crick.). *See* Whitehouse, F. W.: Jour. Roy. Soc., Western Australia, XI, pp. 6-8 (1924); Crick., G. C.: Geol. Mag., Lon., Dec. 4, I, pp. 391, 433-436 (1894).
[4] Die Stephanoceras-Verwandten in den Coronaten-schichten von Norddeutschland, Gottingen, 1907; Buckman, S. S.: Ann. Mag. Nat. Hist., I, 8th ser., p. 147 (1908).
[5] Pal. Française, Ter. Jurass. I, p. 407, Pl. 139 (1849).
[6] Type Ammonites, III, Pl. 151 (1919).
[7] Type Ammonites, III, Pl. 158 (1920).
[8] Jour. Roy. Soc. Western Australia, XI, p. 6, Pl. 1, figs. 4, 5, 6, text fig. 4 (1924).
[9] Geol. Mag., London, n. ser., Dec. 4, vol. I, p. 434, Pl. 13, figs. 1a, b (1894).

The whorl suture begins to advance outside the line of lateral tubercles at about the beginning of the living chamber. Whorl section thicker than high; the proportional thickness decreases rapidly on ultimate whorl, but the proportional height remains about the same. On ultimate whorl the sides are rounded and the venter arched. The living chamber is about eleven-sixteenths of the ultimate whorl; the last septum is at a diameter of 35 mm. The primary ribs increase with growth, 15 to 19 per whorl; the secondary ribs decrease on the ultimate whorl. On the anterior part of the penultimate whorl three secondary ribs arise by trifurcation of each primary rib and, in addition, there is one intercalated secondary per each primary rib. In the posterior part of the ultimate whorl there are three secondary ribs per each primary, arising by trifurcation or by bifurcation and intercalation. This is followed by a stage in which there are two secondaries by furcation plus one intercalated rib, which passes into a stage, near the aperture of the shell, of two secondaries, arising by bifurcation, to each primary. The ribs are inclined very slightly forward on the sides; on the posterior part of the outer whorl they are straight across the venter, but on the anterior part are bowed forward; this, however, appears to have been caused by distortion or abnormal growth, for the curves are not symmetrical. The ribs have considerable relief, are narrow and fairly sharp, except on the anterior part of the ultimate whorl where they are somewhat broader and more rounded.

The suture line is fairly simple. The ES is deeper than wide, is nearly twice as wide as EL, and is unequally divided by a short lobule into two branches, the inner one of which is the smaller. L1 is about as long as EL, is tripartite, and is lightly asymmetric; the median lobule is fairly long and narrow, and almost in a median position. S1 is smaller than ES, but is similarly unequally divided, the inner branch being the smaller. L2 is small. S2 is smaller than S1 and about equally divided by a small lobule. Aux.1 is about as long as L2, but is narrower and is inclined at a high angle. Aux.2 is very small and there are two minute, poorly defined, auxiliary saddles. The tubercle is on the border between S1 and L2.

The name is given for C. H. Crickmay.

*Horizon and Locality.* In the lower Yakoun formation at Mackenzie bay, on the north side of Maude island, and in a collection taken from 10 to 22 feet above the base of the section exposed there.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9016.

*Kanastephanus mackenzii* n. sp.

Plate XVI, figures 1-3

| | | | | | | |
|---|---|---|---|---|---|---|
| Diameter | 51·0 | 48·0 | 47·0 | 45·0 | 41·2 | 32·0 |
| Height, whorl | 28·1 | 30·4 | 29·6 | 29·2 | 30·7 | 32·0 |
| Thickness, whorl | 41·3 | 42·7 | 44·2 | 46·4 | 50·0 | 57·0 |
| Width, umbilicus | 47·0 | 48·3 | 47·6 | 45·7 | 43·0 | 42·0 |
| Primary ribs | 24 | ..... | ..... | ..... | ..... | ..... |
| Secondary ribs | 49 | ..... | ..... | ..... | ..... | ..... |

The first measurement is from near the anterior and the last from near the beginning of the ultimate whorl.

The cone shape is a cadicone becoming serpenticone. Perlatumbilicate, the umbilicus increasing with size, but not uniformly. On inner whorls, the whorl suture is just on the outer edge of the tubercles, but in living chamber part and on last three-fourths of ultimate whorl, the whorl suture leaves the line of tubercles and migrates outward. The whorl section is depressed, being much thicker than high. On the ultimate whorl the proportional thickness decreases, whereas the proportional height changes very little, but the section remains thicker than high; the section also becomes more rounded. The living chamber is nearly three-fourths of the ultimate whorl. The lappet is relatively short and lateral in position. The primary ribs are fairly numerous, are very little inclined, and each ends in a tubercle. On the ultimate whorl there are two bifurcated secondary ribs to each primary and there are very rare single intercalated ribs. On inner whorls the number of secondary per primary ribs is greater. All ribs have considerable relief, are narrow and fairly sharp. A good preparation of the suture line could not be obtained. There is a large ES, deeper than wide.

This species agrees with *Kanastephanus crickmayi* n. sp. in general proportions and in number of secondary ribs, but it has many more primary ribs and sharper and more pronounced ribs on the anterior part of the ultimate whorl. *Stephanoceras* sp. of Boehm[1] has about the same number of primary ribs and a few more secondary ribs per whorl, but has not the rapid change from cadicone to serpenticone. The lappet and suture line of Boehm's species are not illustrated, so that comparison of these features cannot be made.

*Horizon and Locality.* In the lower part of the Yakoun formation at Mackenzie bay, on the north side of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9017.

*Kanastephanus altus* n. sp.

(*altus*, high)

Plate XVI, figures 4-6

| | | | | | | |
|---|---|---|---|---|---|---|
| Diameter | 47·0[2] | 33·1 | 32·0 | 28·8 | 25·0 | 22·3 |
| Height, whorl | 32·4[2] | 35·2 | 36·0 | 35·7 | 33·7 | 33·6 |
| Thickness, whorl | 47·4[2] | 59·5 | 60·0 | 60·8 | 62·3 | 61·7 |
| Width, umbilicus | 46·6[2] | 40·9 | 40·2 | 41·3 | 43·2 | 43·0 |
| Primary ribs | ..... | ..... | 18½ | ..... | ..... | ..... |

The inner whorls and the anterior and posterior parts of the ultimate whorl are preserved. Latumbilicate to perlatumbilicate, the umbilicus decreasing a little on the penultimate and increasing on the ultimate whorl. The whorl suture on the inner whorls is on the outer edge of the tubercles, but on the ultimate whorl is considerably outside the tubercles. The inner whorls are depressed, are much thicker than high, and somewhat flattened or broadly arched on the venter. The penultimate whorl is increasing in height, but varying little in thickness. Ultimate whorl decreases in thickness, less so in height, becomes less depressed, although

[1] Boehm, G.: Nova Guinea Resultats L'Expedition scientifique Ne'erlandaise à la Nouvelle Guinée en 1903, vol. 6, Geologie, Abschnitt I, p. 10, Pl. 5, fig. 4 (1912).
[2] Approximate.

thicker than high, and more rounded. Lappet, partly preserved, is lateral in position. The number of primary ribs per whorl slowly increases on the inner whorls, the number on the ultimate whorl is not known. On the inner whorls there are about three secondaries to each primary consisting chiefly of two bifurcated and one intercalated or rarely three trifurcated secondary ribs. On the anterior part of the ultimate whorl there are two secondary ribs to each primary, arising by furcation. The ribs have considerable relief. The suture line is similar to that of *K. crickmayi* n. sp. L1 is about symmetrical; the median lobule is fairly long and narrow. The proportional whorl height is somewhat greater than in *K. crickmayi*, *K. mackenzii*, and *K. canadensis*. The umbilicus is a little smaller than that of *K. crickmayi* or of *K. mackenzii*. The primary ribs per whorl are intermediate in number between those of *K. crickmayi* and *K. mackenzii*. The whorl proportions are somewhat as in *Otoites delicatus* S. Buckman[1], but the umbilicus is larger and the ribs per whorl fewer.

*Horizon and Locality.* In the lower part of the Yakoun formation at Mackenzie bay, on the north side of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9018.

*Kanastephanus canadensis* n. sp.

Plate XV, figures 4, 5

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Diameter | 57·5 | 57·0 | 55·2 | 52·0 | 50·0 | 48·0 | 45·0 |
| Height, whorl | ..... | ..... | 29·2 | 29·2 | 27·0 | 26·3 | 27·1 |
| Thickness, whorl | 39·2 | 39·0 | 41·2 | 44·2 | 47·8 | 49·0 | 51·4 |
| Width, umbilicus | ..... | ..... | 48·6 | 47·5 | 45·2 | 45·4 | 44·3 |
| Primary ribs | 23 | ..... | ..... | ..... | ..... | ..... | ..... |
| Secondary ribs | 49 | ..... | ..... | ..... | ..... | ..... | ..... |

Perlatumbilicate, the umbilicus increasing with growth of ultimate whorl. Whorl suture on inner whorls is at outer edge of tubercles, but near beginning of living chamber it moves outward, enlarging the umbilicus. Whorl section depressed on inner whorls, but less so on ultimate whorl, where the proportional thickness decreases and the venter becomes more arched. The living chamber is nearly three-fourths of a whorl; the last septum is at a diameter of 44·5 mm. The ribs have considerable relief, and are straight across the venter. On the anterior part of the penultimate whorl there are about 3 secondary ribs to each primary, arising chiefly by bifurcation and intercalation; on the first quarter of the ultimate whorl there are two bifurcated secondary ribs to each primary and one intercalated for every second primary rib; on the anterior three-fourths of the ultimate whorl there are on the average two bifurcated secondary ribs to each primary, plus an additional rare intercalated secondary rib. The same ribs are not joined together on opposite sides. The suture line is not well prepared but is similar to that of *K. crickmayi* and *K. altus*. L1 is tripartite and is nearly symmetrical. L2 is small and the tubercle is on it.

This is the largest of the species of *Kanastephanus* in the Yakoun formation and has proportionately the thickest ultimate whorl. In number of both primary and secondary ribs it resembles whorls of *K. crickmayi*

[1]Type Ammonites, III, pt. 20, Pl. 151 (1919).

of the same diameter, but differs in the greater size, greater proportional thickness of whorl, and in the greater number of primary ribs at full size. The whorls are not so depressed, nor the umbilicus so large as in *Otoites depressus* Whitehouse[1] and the suture line is different.

*Horizon and Locality.* In the lower part of the Yakoun formation at Mackenzie bay, on the north side of Maude island.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9019.

### *Itinsaites* McLearn

(*It-in-sa*, name of an Indian chief)

1927. *Itinsaites* McLearn, Trans. Roy. Soc., Canada, 3rd ser., vol. 21, sec. IV, p. 73.

The genus has a more complex suture line and on the ultimate whorl, more secondary ribs than *Kanastephanus*. In all other characters, however, it is very close. It differs from *Epalxites* Mascke[2] in the more dorsal position of lappet and tubercle. In *Itinsaites* the tubercle is on the inner edge of S1; in *Epalxites* it is on the outer part of S1. The position of the lappet is similar to that in *Otoites*. The umbilication is greater than in typical, but not in all, *Otoites*, and about as in *Kanastephanus*. The genotype is *Itinsaites itinsae* McLearn.

### *Itinsaites itinsae* McLearn

Plate XV, figures 2, 3

1927. *Itinsaites itinsae* McLearn, Trans. Roy. Soc., Canada, 3rd ser., vol. 21, sec. IV, p. 73, Pl. 1, fig. 7.

| | | | | | | |
|---|---|---|---|---|---|---|
| Diameter | 51·0 | 48·4 | 45·0 | 43·4 | 35·2 | 33·8 |
| Height, whorl | 27·6 | 28·2 | 28·8 | 28·4 | 29·7 | 30·1 |
| Thickness, whorl | 38·9 | 44·0 | 47·9 | 48·8 | 57·6 | 57·5 |
| Width, umbilicus | 49·6 | 48·6 | 46·4 | 46·0 | 45·0 | 43·4 |
| Primary ribs | 23 | ..... | ..... | ..... | ..... | ..... |
| Secondary ribs | 71 | ..... | ..... | ..... | ..... | ..... |

The umbilicus increases on the ultimate whorl; perlatumbilicate. Whorl suture begins to move outside of line of tubercles somewhat posterior to the last septum, which is at a diameter of 36·5 mm. The inner whorls are depressed, much thicker than high. On ultimate whorl the proportional thickness decreases and the venter becomes well rounded. The lappets are long and lateral in position. The living chamber is about nine-sixteenths of the ultimate whorl. There are 23 primary and 71 secondary ribs on the ultimate whorl. The stage of reduction to two secondary ribs per each primary, attained, or nearly attained, in all species of *Kanastephanus*, is not reached in *I. itinsae:* in the first three-quarters of the ultimate whorl there are three and a fraction secondary ribs to each primary, arising by trifurcation or bifurcation and intercalation.

[1] Jour. Roy. Soc. Western Australia, XI, p. 6, text fig. 4, Pl. 1, figs. 4, 5, 6 (1924).
[2] *See* Buckman, S. S.: Type Ammonites, III, Pls. 151, 159 (1920).

On the last and anterior quadrant of the ultimate whorl there are two bifurcated secondaries plus one intercalated secondary per each primary rib. The ribs are narrow, rather sharp, and of considerable relief. The primary ribs are very slightly inclined forward. The secondary ribs are inclined a little on the sides, and most so near the anterior end; they are straight across the venter except close to the anterior end, where they incline forward a little. The suture line is fairly complex. ES is deeper than broad and unequally divided by a small lobule, the inner branch is the smaller. S1 is smaller and about equally divided into two branches. S2 is smaller than S1 and divided into three branches. The auxiliary saddle is small and inclined. L1 is a little longer than EL, rather broad stemmed, tripartite, about symmetrical, and with a long and narrow median lobule. L2 is narrow and short. Aux.1 is inclined and is shorter and much more narrow than L2. Very small aux. 2. The tubercle is on the inner branch of S1.

In number of secondary ribs this species resembles *Epalxites formosus* S. Buckman[1], but it has fewer primary ribs, is smaller, has thinner and lower whorls, a larger umbilicus, the lappet and tubercle are more dorsal in position, and there are differences in the suture line.

Compared with *Otoites braikinridgii* (Sowerby)[2] it has fewer primary ribs, sharper ribs, more gently arched whorls, and a larger umbilicus. The general shell proportions are similar to those of *Kanastephanus crickmayi* and *K. mackenzii*. In number of primary ribs it is intermediate between *K. crickmayi* and *K. mackenzii* and nearest to *K. altus*. It differs from all the known species of *Kanastephanus* in the greater number of secondary ribs on the ultimate whorl. *Stephanoceras* sp. of Boehm[3] is somewhat similar, but has fewer secondary ribs and lacks the umbilical enlargement.

*Horizon and Locality.* In the Yakoun formation on the southernmost of Channel islands, Skidegate inlet.

*Type.* National Museum of Canada, Ottawa; holotype, Cat. No. 9020.

[1] Type Ammonites, III, pt. 21, Pl. 151 (1920).
[2] Yorkshire Type Ammonites, p. 81b.
[3] Boehm, G.: Nova Guinea, Resultats L'Expedition scientifique Ne'erlandaise à la Nouvelle Guinée en 1903, vol. 6, Geologie, Abschnitt I, p. 101, Pl. 5, fig. 4 (1912).

# A TOOTHLESS ARMOURED DINOSAUR FROM THE UPPER CRETACEOUS OF ALBERTA

*By C. M. Sternberg, Geological Survey, Canada*

**Illustrations**



The Geological Survey's collection of vertebrate fossils contains a specimen of armoured dinosaur which reveals certain characters hitherto unknown among the *Stegosauria*. The specimen consists of skull, left mandibular ramus, one caudal vertebra with co-ossified chevron, one phalanx, and many dermal scutes. It was collected by G. F. Sternberg in 1916, from the Edmonton formation, 90 feet above Red Deer river, in sec. 3, tp. 21, range 31, W. 4th prin. mer. This locality is about 8 miles southwest of Morrin, Alberta, and the horizon is near the middle of the Edmonton beds. The specimen was preserved in a tenacious fine-grained sandstone which does not free well from some of the softer bones, particularly the under side of the skull and the roof of the mouth, thus making the preparation of this portion difficult.

The most unusual features of the specimen are the total absence of teeth and the development of bony plates to take their place on both the maxillæ and dentaries; the reduction of the mandible; the great depression of the skull; and the thinness of the dermal scutes. This is the first toothless member of the *Stegosauria* to be recorded and the name *Anodontosaurus lambei* is proposed for its reception. The specific name is given in honour of the late L. M. Lambe, who was the first to describe armoured dinosaurs from the Cretaceous of Alberta.

Future studies of the genus may show that it differs sufficiently from described forms to warrant placing it in a new subfamily, but for the present the differences are regarded as only of generic distinction.

*Anodontosaurus lambei* gen. et. sp. nov.

Type of species, No. 8530, Geological Survey, Canada.

*Generic and Specific Characters.* Skull very much depressed; completely covered with moderate-sized, irregular, dermal ossifications; broadly rounded in front; small overhanging occipital crest; external nares transversely elongate and terminally placed; orbit roughly lenticular in outline, placed moderately far back and facing outward; teeth absent, and broad, flat, bony plates for masticating food developed on maxillæ and dentaries; pterygoids small and meeting on midline; palatines not fused on midline; mandible greatly reduced and without coronoid process; dermal scutes thin and concave inferiorly, to correspond to the superior convexity.

SKULL

When viewed from above the skull (Plate XVII, figure 1) resembles that of *Euoplocephalus tutus* as figured by Gilmore[1] and, as in that genus, is broader than long, has a broad muzzle, and a slightly overhanging occipital crest. Posteriorly it is nearly flat, but the anterior half is slightly arched longitudinally and transversely. The whole surface is covered with thick, moderate-sized scutes which are thoroughly co-ossified with each other and the skull and surrounded by rather deep circumscribing grooves. Unlike *Euoplocephalus* there is no large central plate covering the nose, but just behind the raised rugose plates which form the superior border of the external nares is a pair of moderate-sized plates which meet on the midline. Behind these is a single plate on the midline, but it is not conspicuously larger than the others. All of the plates on the anterior portion of the skull have a flat or concave superior surface. Above the orbit and continuing back to the supero-posterior angle of the skull is a series of sub-triangular plates with the apexes directed upward. These give the side of the skull, from the orbit backward, an almost vertical aspect. On the postero-inferior angle of the skull is a large sub-triangular plate with the apex pointing outward and downward. The apexes of these scutes form the widest part of the skull. These resemble the homologous plates of *Euoplocephalus*[2] and *Ankylosaurus*[3] and extend well below the distal ends of the quadrates.

When viewed from the side (Plate XVII, figure 2) the head is more depressed than in any other plated dinosaur known to the writer. Its greatest height, including the mandible, is only slightly more than one-third of the length.

The limits of the bones of the top and sides of the skull are, in most cases, not discernible because of the covering of dermal plates.

The *external nares* are long, narrow, transverse slits, placed on either side of the midline of the broad muzzle and separated by the premaxillæ. They face almost directly forward and are surrounded by a high ridge of dermal bone. The greatest vertical diameter is 20 mm. and the transverse diameter is 75 mm.

The *orbit* is moderately far back, broadly lenticular in outline, and faces outward. It is surrounded by thin dermal plates which at the anterior extremity stand out from the inferior border of the rim, thus giving certain protection to the eye from the front.

The *lateral temporal fossa* is completely hid from the external view by a covering of small, thick, irregular-shaped dermal scutes. This mass of thoroughly fused ossicles completely fills the space behind the orbit, between the sub-triangular plates on the supero-external angle of the skull and the large plate on the postero-inferior angle.

The *supratemporal fossæ* are also completely covered by the dermal scutes.

The *foramen magnum* is small, subcircular in outline, and is overhung by the short occipital crest.

[1] Gilmore, C. W.: The Canadian Field-Naturalist, vol. XXXVII, No. 3, Pl. 11 (1923).
[2] Loc. cit.
[3] *Ankylosaurus magniventris* Brown, Dinosaurs by W. D. Matthew, A. M. A. H. Handbook No. 5, Fig. 35.

When viewed from below the skull (Plate XVIII, figure 1) is broadly rounded in front and the anterior half is about the same breadth as the muzzle. From a point just below the anterior edge of the orbit, which is about the midlength, the skull broadens very rapidly. This broadening is due to the flaring out of the large plates which cover the lateral temporal fossæ and quadrates.

The palate is flat or slightly arched upward, thus differing from *Edmontonia longiceps* in which the pterygoids and palatines unite to form a sharp ridge which extends well down into the mouth cavity.[1] A portion of the right premaxilla was eroded away and the specimen is somewhat crushed, but all the elements are preserved on one side or the other. The limits of some of the bones cannot be positively determined owing to co-ossification or poor preservation of the bones. The fact that very little has been done in the way of description or illustration of the palate of the plated dinosaurs makes it difficult to compare *Anodontosaurus* with other forms. There are several fenestra in the roof of the mouth, made by the union of branches of the premaxillæ, maxillæ, and palatines with each other and the vomer. In this respect it is very unlike *Edmontonia longiceps* in which there is only one pair of openings in the roof of the mouth, viz., the anterior palatine vacuities.

The *internal nares* seem to have been wholly within the premaxillæ. This is an unusual position for the internal nares and it is possible that the respiratory canal may have been separated from the mouth cavity in this region by a membrane only and that the outlet was through one of the fenestra farther back, though this is not considered probable.

The *premaxillæ* (Plate XVIII, figure 1, Pmx.) make up the whole of the inferior portion of the broad muzzle, but are not developed into a flat roof as in *Edmontonia*. The inferior edges of the premaxillæ are notched and pitted and were covered, in life, with a horn beak, but were not curved strongly downward to form a sharp cutting edge as in *Ankylosaurus*, *Euoplocephalus*, and *Edmontonia*. The premaxillæ are fused anteriorly, but farther back the medium separation is well shown. Within the premaxillæ, on either side of the midline of the skull, are the large, sub-oval, internal nares. The premaxillæ are developed backward, on the midline, as a thin process, to meet the long, slender vomer. This union is concealed in the specimen by the internal flanges of the palatines, which meet on the midline of the skull, but there is little question as to the premaxillæ joining the vomer.

The *maxillæ* (Plate XVIII, figure 1, Mx.) are greatly reduced and completely edentulous. The anterior portion of the maxilla is very slender, but posteriorly it is expanded into a subcircular, rugose plate about 35 mm. in diameter. This evidently served as a grinding or crushing plate. At about the middle of the maxilla a slender process, which seems to be a branch of the maxilla, runs forward and inward to meet the premaxilla, thus forming a fenestra between these two bones. The dermal plates, which cover the skull, run straight back from the external borders of the premaxillæ and flank the posterior portion of the maxillæ, but the anterior ends of the maxillæ are well removed, inward, from these borders. On the

[1] Sternberg, C. M.: "A New Armoured Dinosaur From the Edmonton Formation of Alberta"; Trans. Roy. Soc., Canada, vol. 22 (in press).

left side of the skull a portion of this dermal border is crushed over against the anterior half of the maxilla, but on the right side the relative position is well shown (Plate XVIII, figure 1).

The *vomer* is a long, thin, vertically placed bone which is united with the pterygoids behind, flanked by the palatines anteriorly, and united, in front, with a backwardly developed process of the premaxillæ.

The *palatine* (Plate XVIII, figure 1, Pal.) is roughly boot-shaped, with the leg of the boot very slender and the top flared out antero-posteriorly into a flange which unites with its fellow on the midline of the palate and covers the anterior end of the vomer. The foot of the boot is relatively large and the broad toe unites with the posterior half of the maxilla and the base of the maxillary process which is given off for union with the premaxilla. The internal flanges of the palatines meet on the midline, but are not co-ossified. When compared with the palatines of *Edmontonia*, those of *Anodontosaurus* are very much reduced and placed far forward. They do not unite with the pterygoids.

The *ectopterygoid* is a moderately long, thin bone which unites with the postero-internal portion of the maxilla and extends backward and inward along the anterior face of the external branch of the pterygoid.

The *pterygoid* is greatly reduced and situated well back. It consists of two wing-like extensions, one of which is produced inward and forward meeting its fellow on the midline of the palate, and one of which is produced forward and outward to meet the ectopterygoid and maxilla. The united portions of the pterygoids underlie the parisphenoid posteriorly and the antero-superior tips meet the vomer. Posteriorly, the pterygoid meets a process of the quadrate, but it is not possible to state if it has developed a third wing or flange for this union.

The *quadrate* is a broad, thin bone and is inclined strongly forward from its articulation with the squamosal. This forward inclination of the quadrate is a result of the great reduction of the mandible. The superior portion of the posterior surface is covered by the rather broad paraoccipital process. Near the distal extremity a long, thin process is developed inward and forward to meet the pterygoid. Near the distal end of the bone the external surface meets the quadratojugal. The large, sub-triangular dermal plate which forms the postero-inferior angle of the skull is thoroughly co-ossified with the jugal and quadratojugal and extends well below the quadrate. The mandibular articulation of the quadrate is broad, but very short, being only 13 mm. in fore and aft diameter and 37 mm. in transverse diameter. It is quite flat transversely, but convex fore and aft.

The *occipital condyle* is reniform and the height is about two-thirds the breadth. The convexity of the articulating surface is rather less than in most plated dinosaurs, thus indicating less flexibility of this joint. The condyle faces backward and downward.

### LOWER JAW (Plate XVIII, figure 2)

The left *mandibular ramus* is complete and splendidly preserved, but the different elements are so thoroughly co-ossified as to make it impossible to positively determine their limits. It is more reduced than that of any

other armoured dinosaur known to the writer and even when the dermal plate which covers it is included, it is very slender and weak.

A large dermal plate covers the external surface of the mandibular ramus and extends below the level of the dentary, as well as covering it superiorly. This plate adds considerably to the breadth of the ramus where it is developed downward and outward just behind its midlength. Superiorly, this dermal scute develops into a broad, flat plate which covers that portion of the dentary normally occupied by teeth and forms a broad, flat, crushing or champing plate. This plate is broadest in its posterior half where it overhangs the internal border of the dentary.

The *dentary* is edentulous, very slender, and, anteriorly, curves strongly inward to conform to the broadly rounded muzzle. The greatest height of the dentary, not including the dermal plate, is 27 mm. and its length is about 200 mm. Antero-internally, the dentary is subcircular in cross-section, cut off at right angles, and rugose. This would suggest that the predentary, which is not present with the specimen, did not separate the dentaries, but that they formed a strong union on the midline. About one-third of the superior border of the dentary is covered by the above-mentioned crushing plate.

The *splenial* covers the internal face of the dentary and appears to extend almost or quite to the symphysis, though anteriorly the bones are so thoroughly fused that it is not possible to positively determine the extent of the splenial.

Posteriorly, the mandible is very much depressed, the bones are thoroughly co-ossified, and there is no coronoid process. The mandibular cotylus is flat, oval in outline, and is located at the extreme posterior end of the ramus. Its greatest diameter, which is almost at right angles to the longer axis of the jaw, is 35 mm.

*Dimensions Of Skull And Mandible Of Type*

| | Mm. |
|---|---|
| Greatest length of skull | 372 |
| Breadth of superior surface just back of orbits | 322 |
| Breadth of muzzle | 212 |
| Height, lower border of mandible to above orbit | 130 |
| Transverse diameter of external naris | 75 |
| Greatest vertical diameter of external naris | 20 |
| Greatest length of orbit | 67 |
| Greatest height of orbit | 30 |
| From posterior edge of external naris to anterior border of orbit | 140 |
| Length of mandibular ramus | 245 |
| Greatest height of mandible, including scute | 40 |
| Distance between internal borders of distal ends of quadrates | 140 |
| Length of quadrate, about | 115 |

DERMAL ARMOUR (Plates XIX and XX)

With the specimen are preserved about one hundred dermal scutes or plates, besides many small, shapeless ossicles. About a dozen of the scutes are of fair size and all are of the same general structure, though there is considerable variation in shape. Some are circular with a high central point (*b*), some ovate with a low keel, others long, narrow, high, thin-sided scutes, and still others are thin, flat plates. There is no sign of a ring of scutes as in *Euoplocephalus* and *Ankylosaurus* or of co-ossified nucal plates as in *Panoplosaurus*[1] and *Edmontonia*.

[1] *Panoplosaurus mirus* Lambe, Trans. Roy. Soc., Canada, sec. IV, Pl. VI (1919).

The dermal armour is of particular interest in comparing *Anodontosaurus* with certain genera which are founded primarily on dermal armour or portions of the skeleton other than the skull. In this class, among the American forms would fall *Nodosaurus*[1] *Stegopelta*[2], *Heirosaurus*[3], *Hoplitosaurus*[4], etc. In all of these the dermal armour is so distinctly different from *Anodontosaurus* that they may be dismissed from further consideration.

The distinguishing feature of the dermal scutes in *Anodontosaurus* is their extreme and uniform thinness (*See* Plate XX). The scutes are of approximately the same thickness throughout, regardless of their size or shape, and even the long, high-keeled scutes are thin walled. These somewhat resemble a very steep-pitch roof with the upper part of the roof developed into a high, narrow ridge. The apex of these scutes is behind the midlength. They are asymmetrical, the narrow apex overhanging, presumably, the external edge. The plates grade from these long, high, narrow ones (*c*), through moderately narrow, high-keeled (*d*), and oval, low-keeled (*a* and *e*), to oval, flat plates (*f*). The exception to the rule of a uniformly thin wall is to be found in some small, circular plates with high, median points (*b*). In these the thickness through the apex is much greater than through other parts of the plate, but even here there is a decided concavity on the inferior surface. Plate XX shows cross-sections of the different types of plates preserved with the specimen. The sections are transverse through the apex of the plates and are natural size.

The plates are made up of thin, dense bone. The external surface is covered with fine, vascular grooves and small pits. The inferior surface is somewhat rougher and lacks the vascular markings, and in most cases also the pitting. The largest plate preserved with the type is 235 mm. long, 137 mm. high, and has an average wall thickness of 7 mm. (Plate XIX, c). There are three of these larger, steep-sided plates preserved.

It is probable that with the loss of teeth *Anodontosaurus* changed its feeding habits and environment and did not need such heavy dermal armour. It might be possible that *Anodontosaurus* had developed a liking for invertebrate animals which were numerous in the Edmonton swamps and the decreased weight of the dermal armour would be less cumbersome in wading through the swamps. The extremely broad body, short, massive limbs, and splayed feet would enable the plated dinosaurs to progress through rather soft ground in spite of the heavy armour.

[1] *Nodosaurus textilis* Marsh, *See* Lull, Am. Jour. Sci., vol. I (Feb. 1921).
[2] *Stegopelta landerensis* Williston, *See* Moodie, Kan. Univ. Sci. Bull., vol. 5, p. 257 (1911).
[3] *Heirosaurus sternbergi* Wieland, Am. Jour. Sci., vol. XXVII, p. 250 (1909).
[4] *Hoplitosaurus marshi* (Lucas), *See* Gilmore, Bull. U. S. N. M., p. 114 (1914).

# A NEW SPECIES OF HORNED DINOSAUR FROM THE UPPER CRETACEOUS OF ALBERTA

*By C. M. Sternberg, Geological Survey, Canada*

CONTENTS



In 1914, Barnum Brown, of the American Museum of Natural History, described a new genus and species of horned dinosaur under the name *Anchiceratops ornatus*.[1] The genotype consists of a fine crest or neck frill, the posterior portion of the cranium, and the bases of the brow horn cores, but lacked the nasal horn core and the anterior portion of the skull.

In 1924, the writer collected from the Edmonton formation, a nearly complete skull, without lower jaws, of a horned dinosaur, which is referable to the above-mentioned genus. The specimen was discovered in the field by the teamster, Mr. G. Paterson, in sec. 8, tp. 32, range 21, W. 4th prin. mer., on the west side of and 70 feet above Red Deer river. This locality is about 12 miles northwest of Morrin, Alberta, and approximately the same as that from which Brown collected his types.

At this horizon the remains of *Anchiceratops* are more numerous than in any other part of the formation. Besides the specimen here described and those collected by Brown, the writer is aware of two skulls and one skeleton which have been collected from this horizon, and two skeletons, too poorly preserved to collect, and numerous disarticulated bones were observed. Most of these specimens are probably referable to *A. ornatus*. The stratum is a sandy clay with much clay ironstone in which many of the bones are preserved. It is below the oyster bed which is to be found throughout most of the region.

The type specimen was preserved in a sandy clay and as is common with the disassociated skulls of horned dinosaurs, in which the brown horns are large, the specimen lay upside down. Before it was completely entombed part of the maxillæ, the antero-inferior edges of the squamosals, and the distal ends of the quadrates were eroded away.

When compared with *A. ornatus* the skull is small; the crest is proportionately narrow and thin; the horns are farther apart at the base and point strongly forward, and the parietal fontanelles are long. The nose is very long and slender and the specific name *longirostris* is here proposed. The anterior portion of *A. longirostris* is very unlike that of *A. ornatus* as restored by Brown in his original description, but it is probable that when a complete skull of that species is secured it will also show an elongate nose.

[1] "Anchiceratops A New Genus of Horned Dinosaur From The Edmonton Cretaceous of Alberta"; Bull. A. M. N. H., Article XXXIII, 1914.

RELATIONSHIP OF ANCHICERATOPS

*Anchiceratops* falls within the *Chasmosaurus-Torosaurus* group, as shown by the large, flat, sub-rectangular crest; long, narrow squamosals, extending almost to the back of the elongated parietals; abbreviated face; long, slender nose or that portion in front of the nasal horn. The nose in front of the nasal horn is unknown in *Torosaurus*, but when known will probably prove to be long and slender. The parietal fontanelles are smaller in *Anchiceratops* than in *Torosaurus*, as shown in the restorations in the monograph on the Ceratopsia[1]. It is possible that these fontanelles are shown too large in *Torosaurus* or there may be variation with the age of the animal. In his original description of the genus, Brown placed *Anchiceratops* as intermediate between *Monoclonius* and *Triceratops*, but it is doubtful with our present information if he would hold to this view. In both *Centrosaurus* (*Monoclonius*) and *Triceratops* the crest is short, round, and strongly arched transversely, and the face is relatively long, whereas the nose is short and deep, in all of which they differ from *Anchiceratops*. Likewise, there is very little resemblance between *Styracosaurus* and *Anchiceratops* except in the great development of the epoccipitals on the parietals.

Dr. Parks regards *Arrhinoceratops*[2] as belonging to the *Chasmosaurus-Torosaurus* group, but notes that his specimen does not seem to be intermediate as would be expected, coming, as it does, from a formation which is intermediate in age. *Anchiceratops* would seem to be more nearly in the direct line and *Arrhinoceratops* might be regarded as an offshoot.

In *Anchiceratops* and *Arrhinoceratops* the inferior surface of the crest is marked by vascular grooves as in *Triceratops*, whereas in the Belly River forms these grooves extend only a short distance from the edge on the under surface. These Edmonton genera also approach the Lance genera in the almost complete closing superiorly of the frontal fontanelle[3] and in the large brow horns rising from the supero-posterior border of the orbits. This is only natural, for an examination of the respective faunas shows that the Edmonton, though intermediate in age, is closer to the Lance than to the Belly River[4]. In the Belly River forms the frontal fontanelles are open superiorly and the brow horns rise from almost directly above the orbits.

*Anchiceratops longirostris* n. sp.

Type, Cat. No. 8535, Geological Survey, Canada

*Generic Characters.* Skull large; brow horns larger than nasal horn; crest large, flat, more or less rectangular, and ornamented on the border with large epoccipital bones; epoccipitals on parietals larger than those on squamosals; a pair of short, knob-like processes on supero-posterior end of crest; squamosals long and narrow.

*Specific Characters.* Skull long and of light construction; nasal horn core small and triangular in cross-section; nose, in front of nasal horn,

[1] Marsh, Hatcher, and Lull: U. S. G. S., Mon. XLIX, Figs. 118-119.

[2] Parks, W. A.: "Arrhinoceratops Brachyops a New Genus and Species of Ceratopsia, from the Edmonton Formation of Alberta"; Univ. of Toronto Studies No. 19, 1925.

[3] *See* Sternberg, C. M.: "Homologies of Certain Bone of the Ceratopsian Skull"; Trans. Roy. Soc., Canada, 3 series, vol. XXI, sec. IV, pp. 135-143, Pl. I, F. fo. (1927).

[4] *See* Sternberg, C. M.: "Notes on the Edmonton Formation of Alberta"; Can. Field Nat., vol. XL, pp. 102-104 (May, 1926).

long and slender; brow horns rising moderately far apart, circular in cross-section, and pointing forward, upward, and slightly outward; fontanelles of moderate size and oval in outline; crest moderately thin.

The skull is apparently that of an old individual, as all the sutures are thoroughly closed by co-ossification of the different bones. The more slender proportions and thinness of the crest can not, therefore, be regarded as juvenile characters.

When viewed from the side (Plate XXI), the skull is very long and flat, the orbit is well in advance of the midline; the anterior naris is long and situated nearer to the orbit than to the end of the beak. The nose, in front of the nasal horn core, is very long and slender, being relatively longer than in any other species known to the writer. The rostral bone resembles that of *Chasmosaurus*[1] and as in that genus the beak is made up largely of the premaxillæ, whereas in *Arrhinoceratops* Parks[2] shows the rostral extending back to the nasal horn core. The beak at the deepest point is less than two-thirds as deep as it is long.

The *nasal horn core* resembles that of *Arrhinoceratops brachyops*. It is triangular in cross-section with the apex of the triangle above, and it points forward and upward. Vascular grooves are not so well developed as on the brow horns, but there is no doubt it carried a fair-sized horny sheath. An epinasal is not discernible, but this would hardly be expected in an old animal. Parks states that *Arrhinoceratops* does not have a nasal horn core, but his illustration shows one. He evidently has reference to the epinasal, for he states later that the nasal bone may have carried a horny sheath. In all of the Belly River Ceratopsia the nasal horn core is made up principally or solely of the nasal bones. In some Belly River forms, young individuals show a separate ossification in front of, or on the tip of, the nasal bones, and this has been called the epinasal. In some species of *Triceratops* the epinasal constitutes the nasal horn core, whereas in others the nasal bones play a very important part in its formation. There seems little doubt that in all of the earlier forms the nasal horn core was composed mainly of the nasal bones.

The *orbit* is moderately large and circular in outline. The centre of the orbit is 650 mm. from the anterior end of the beak and 1,020 mm. from the posterior edge of the crest.

The *brow horn cores*, which are developments of the postorbital bones, are moderately large and circular in cross-section, except at the base where they are sub-triangular. They rise from the supero-posterior border of the orbits and continue upward, forward, and slightly outward, thus differing from *A. ornatus* in which they curve outward, then forward. They taper gradually to the tip, but are farther apart at the base and much smaller than those of *A. ornatus*. The horn cores bear well-defined, longitudinal, vascular grooves. There is a slight flattening on the external and posterior sides at the base of the horn core, thus giving a somewhat triangular cross-section there.

The *frontal fontanelle* is closed superiorly, due to the union of the frontals, thus completing the secondary roof on the superior surface. This frontal fontanelle opens posteriorly, however, and, apparently, is

[1] See Lambe, L. M.: Geol. Surv., Canada, Mus. Bull. No. 12, Pl. VIII (1915).
[2] Loc. cit., Pl. II R.

larger than in *A. ornatus*. This is only natural, for in forms where the brow horns are large the frontal fontanelle is usually nearly or completely closed.

The *supratemporal fossæ* do not appear to differ materially from those of *A. ornatus*. They open posteriorly, as in that species and in the genera *Torosaurus* and *Triceratops*.

The *crest* is large, rectangular, and quite flat (Plate XXII). The fontanelles are proportionately much longer than in *A. ornatus* and, as in that species, are wholly within the parietals. The crest is relatively thin, especially in advance of the fontanelles. The maximum thickness of the crest, through the posterior portions of the squamosals and parietals, is 30 mm., but the average thickness is not more than half this.

The *squamosals* are long and narrow, as in *A. ornatus*. The epoccipitals are so thoroughly fused with the squamosals that they appear as serrated edges rather than separate ossifications. The same is true of the large epoccipitals on the posterior edge of the parietals. The squamosals are marked by vascular grooves both above and below.

The *parietals* resemble those of *A. ornatus*, but are thinner, and the epoccipitals are much thinner and smaller. As in *A. ornatus*, there is a pair of short, thick, hook-like processes, thoroughly fused to the median posterior extremity of the superior surface of the parietals. On the superior surface of the parietal, in advance of the fontanelle, there is an area in which the surface is lowe than the rest of the bone and quite smooth. This is a backward extension of the floor of the supratemporal fossa and the bone is very thin. Except for these areas in advance of the fontanelles the parietals are covered with vascular markings.

### *Measurements of Type*

| | Mm. |
|---|---|
| Length, tip of rostral to extremity of crest | 1,660 |
| Greatest breadth of skull (anterior portion of crest), as restored | 730 |
| Breadth of posterior portion of crest, including epoccipitals | 660 |
| Tip of rostral to anterior edge of nasal horn core, between vertical points | 290 |
| Anterior edge of nasal horn core to anterior edge of frontal fontanelle | 425 |
| Height of nasal horn core | 72 |
| Posterior tip of rostral to anterior edge of nasal horn core | 155 |
| Length from tip of rostral to anterior border of orbit | 600 |
| Length, anterior border of orbit to extremity of crest | 1,060 |
| Greatest depth of nose in front of nasal horn core | 220 |
| Greatest breadth of upper beak (premaxillæ) about | 160 |
| Distance between antero-external edges of orbital rims | 260 |
| Distance between brow horn cores at base | 110 |
| Distance between brow horn cores at tips | 310 |
| Length of brow horn from superior border of orbit | 310 |
| Circumference of brow horn near base | 255 |
| Height of tip of horn core above lowest part of superior border of nasals | 245 |
| Greatest diameter of orbit | 110 |
| Greatest diameter (fore and aft) of parietal fontanelles | 280 |
| Transverse diameter of parietal fontanelles | 150 |
| Tip of rostral to occipital condyle | 800 |
| Occipital condyle to extremity of crest | 860 |

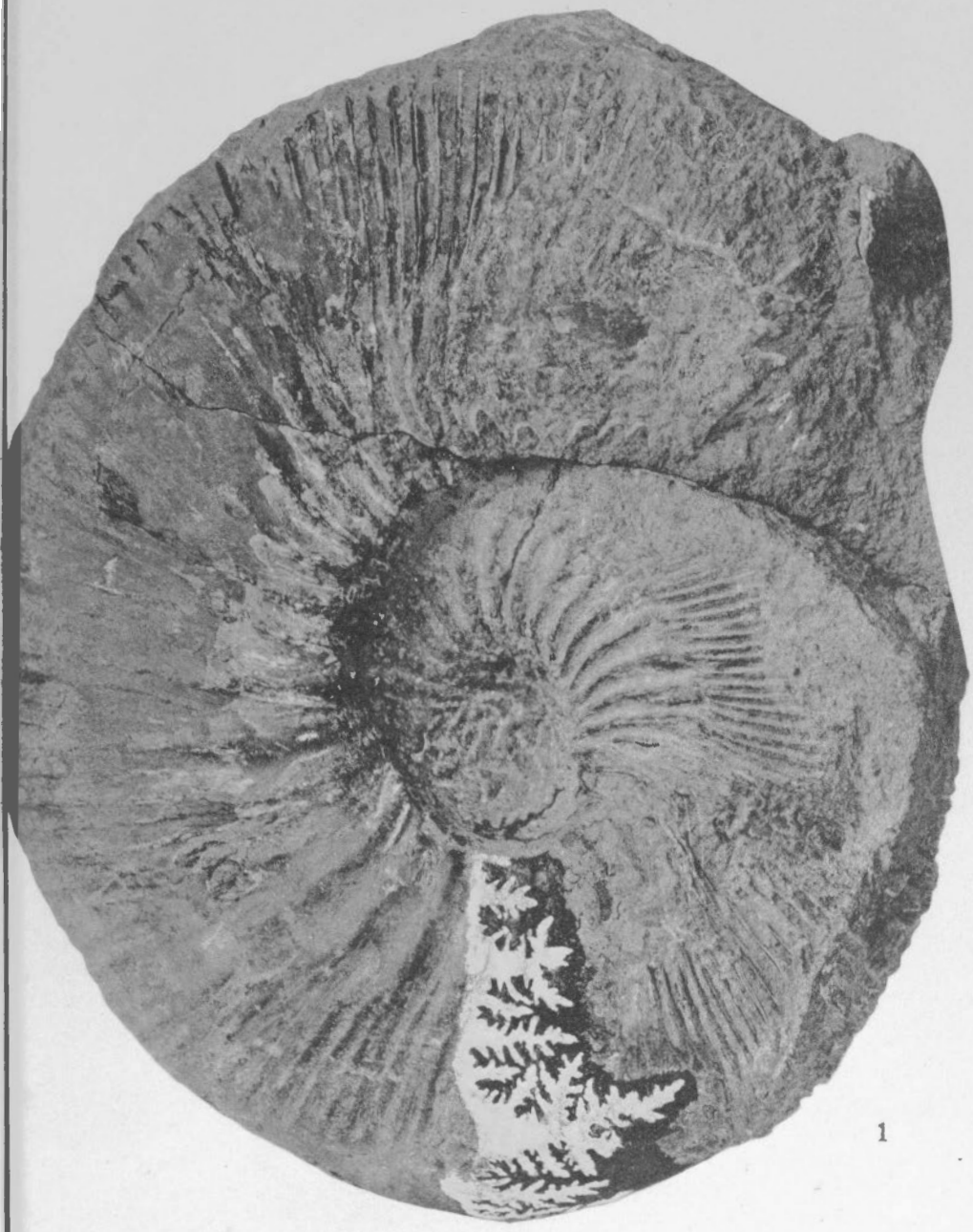
PLATE I

(Natural size)

*Seymourites plenus* McLearn. (Page 5.)

Figure 1. Side view of holotype. National Museum of Canada, Cat. No. 9000.

Plate I



1

PLATE II

(Natural size)

*Seymourites plenus* McLearn. (Page 5.)

Figure 1. Ventral view of holotype. National Museum of Canada, Cat. No. 9000.
Figure 2. Suture line of same specimen.

Plate II

1

2

PLATE III

(Natural size)

*Yakounoceras gitinsi* McLearn. (Page 8.)

Figure 1. Suture line of holotype. National Museum of Canada, Cat. No. 9002.

*Seymourites multus* n. sp. (Page 7.)

Figure 2. Side view of holotype. National Museum of Canada, Cat. No. 9001.

1



2

PLATE IV

(Natural size)

*Yakounoceras gitinsi* McLearn. (Page 8.)

Figure 1. Side view of holotype. National Museum of Canada, Cat. No. 9002.

Plate IV

1

## Plate V

(Natural size)

*Yakounoceras abruptum* n. sp. (Page 9.)

Figure 1. Side view of holotype. National Museum of Canada, Cat. No. 9003.

*Toricelliceras newcombii* (Whiteaves). (Page 12.)

Figure 2. Ventral view of holotype. National Museum of Canada, Cat. No. 5990.
Figure 3. Side view, same specimen.
Figure 4. Suture line at beginning of ultimate whorl, same specimen.

Plate V

PLATE VI

(Natural size)

*Yakounoceras abruptum* n. sp. (Page 9.)

Figure 1. Suture line of holotype. National Museum of Canada, Cat. No. 9003.
Figure 2. Oblique view, same specimen, to show earlier whorls.

1

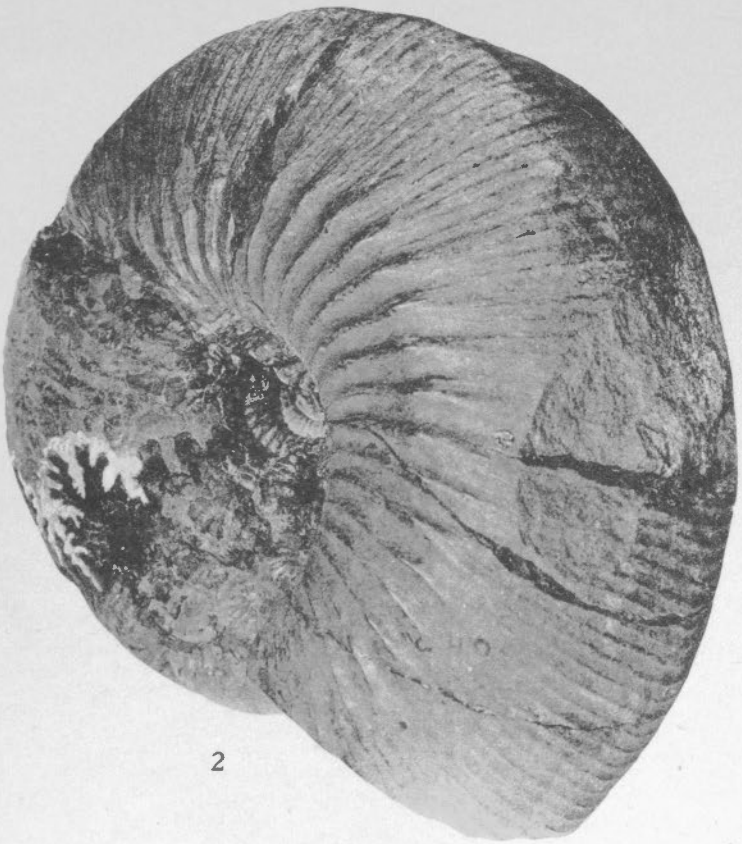


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PLATE VII

(Natural size)

*Yakounoceras ingrahami* n. sp. (Page 9.)

Figure 1. Oblique view of holotype showing suture line. National Museum of Canada, Cat. No. 5012b.

Figure 2. Side view, same specimen.

Plate VII

1

2

PLATE VIII

(Natural size)

*Galilaeites ? penderi* n. sp. (Page 11.)

Figure 1. Ventral view of holotype. National Museum of Canada, Cat. No. 9005.
Figure 2. Side view, same specimen.

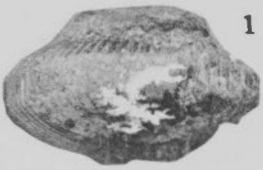
*Yakounoceras torrensi* n. sp. (Page 10.)

Figure 3. Ventral view of holotype. National Museum of Canada, Cat. No. 9004.
Figure 4. Side view, same specimen.

*Yakounoceras gitinsi* McLearn. (Page 8.)

Figure 5. Ventral view of holotype. National Museum of Canada, Cat. No. 9002.

Plate VIII



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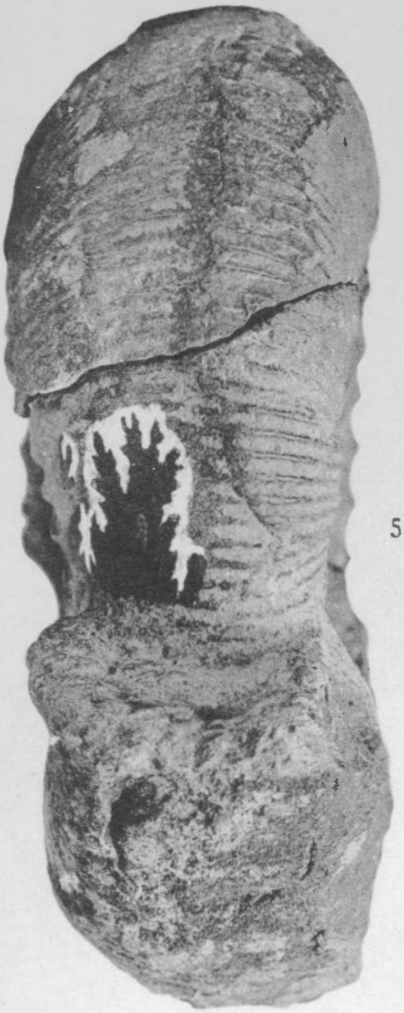

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4

PLATE IX

(Natural size)

*Zemistephanus richardsoni* (Whiteaves). (Page 19.)

Figure 1. Oblique view of plesiotype, showing suture line. National Museum of Canada, Cat. No. 9006.

Figure 2. Side view, same specimen.

Plate IX

1

2

PLATE X

(Natural size)

*Zemistephanus funteri* n. sp. (Page 20.)

Figure 1. Side view of holotype. National Museum of Canada, Cat. No. 9007.

*Zemistephanus richardsoni* (Whiteaves). (Page 19.)

Figure 2. Ventral view of plesiotype. National Museum of Canada, Cat. No. 9006.

Plate X

2

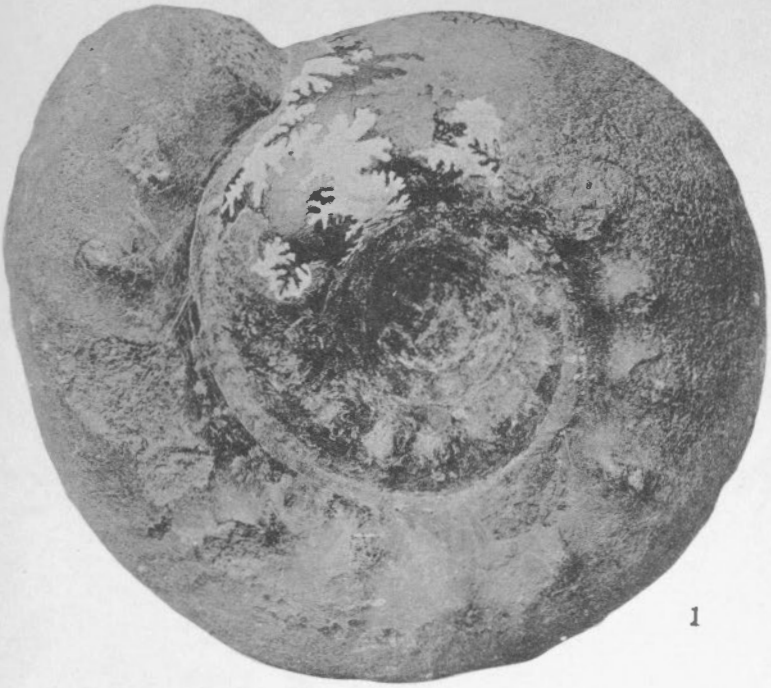

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PLATE XI

(Natural size)

*Zemistephanus vancouveri* n. sp. (Page 20.)

Figure 1. Section of whorls of holotype. National Museum of Canada, Cat. No. 9008.
Figure 2. Side view, same specimen.

*Defonticeras?* sp. (Page 17.)

Figure 3. Oblique view of type. National Museum of Canada, Cat. No. 9014.

Plate XI

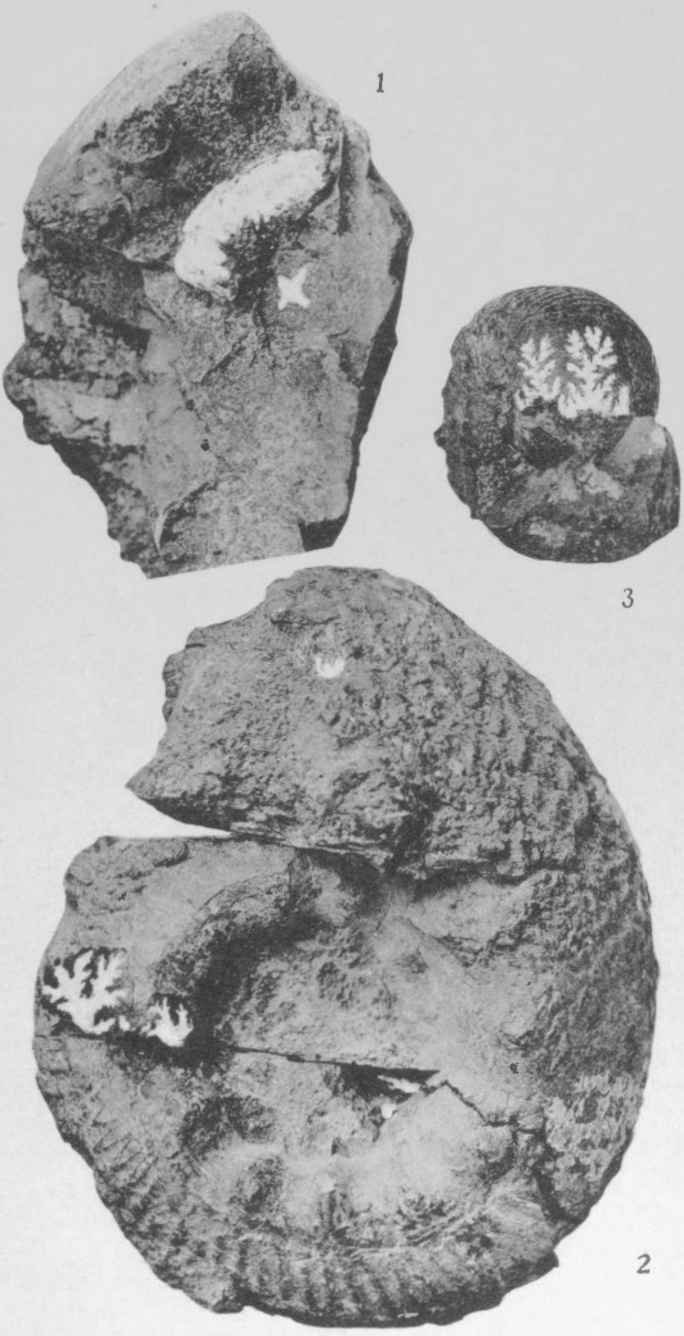

PLATE XII

(Natural size)

*Defonticeras defontii* McLearn. (Page 13.)

Figure 1. Suture line of holotype. National Museum of Canada, Cat. No. 9009.
Figure 2. Ventral view, same specimen.
Figure 3. Side view, same specimen.

*Defonticeras marchandi* n. sp. (Page 14.)

Figure 4. Oblique view of holotype. National Museum of Canada, Cat. No. 9011.
Figure 5. Side view, same specimen.

*Frogdenites?* cf. *profecius* S. Buckman. (Page 18.)

Figure 6. Side view of type. National Museum of Canada, Cat. No. 9015.

Plate XII

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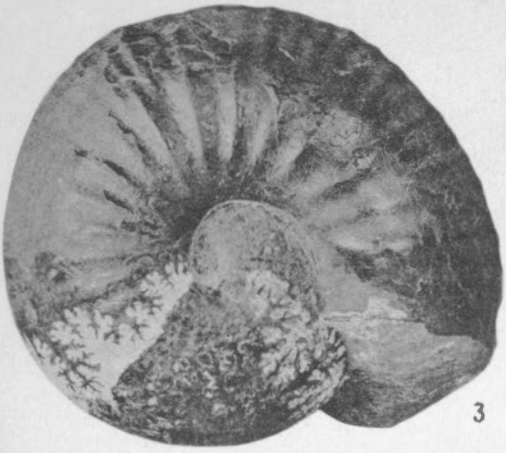

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PLATE XIII

(Natural size)

*Defonticeras maudense* n. sp. (Page 14.)

Figure 1. Suture line of holotype. National Museum of Canada, Cat. No. 9010.

*Defonticeras ellsi* n. sp. (Page 16.)

Figure 2. Side view of holotype. National Museum of Canada, Cat. No. 9013.
Figure 3. Oblique view, same specimen.

*Defonticeras colnetti* n. sp. (Page 15.)

Figure 4. Side view of holotype. National Museum of Canada, Cat. No. 9012.
Figure 5. Oblique view, same specimen.

Plate XIII

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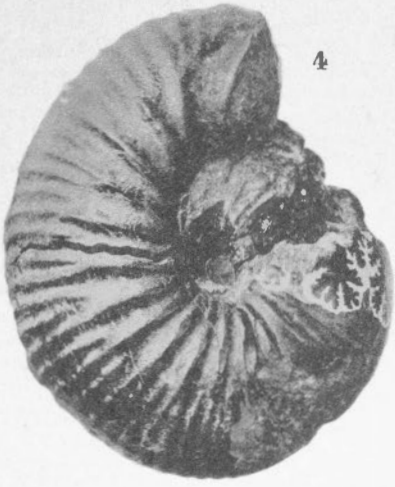

4

PLATE XIV

(Natural size)

*Defonticeras ellsi* n. sp. (Page 16.)

Figure 1. Ventral view of holotype. National Museum of Canada, Cat. No. 9013.

*Defonticeras maudense* n. sp. (Page 14.)

Figure 2. Ventral view of holotype. National Museum of Canada, Cat. No. 9010.
Figure 3. Side view, same specimen.

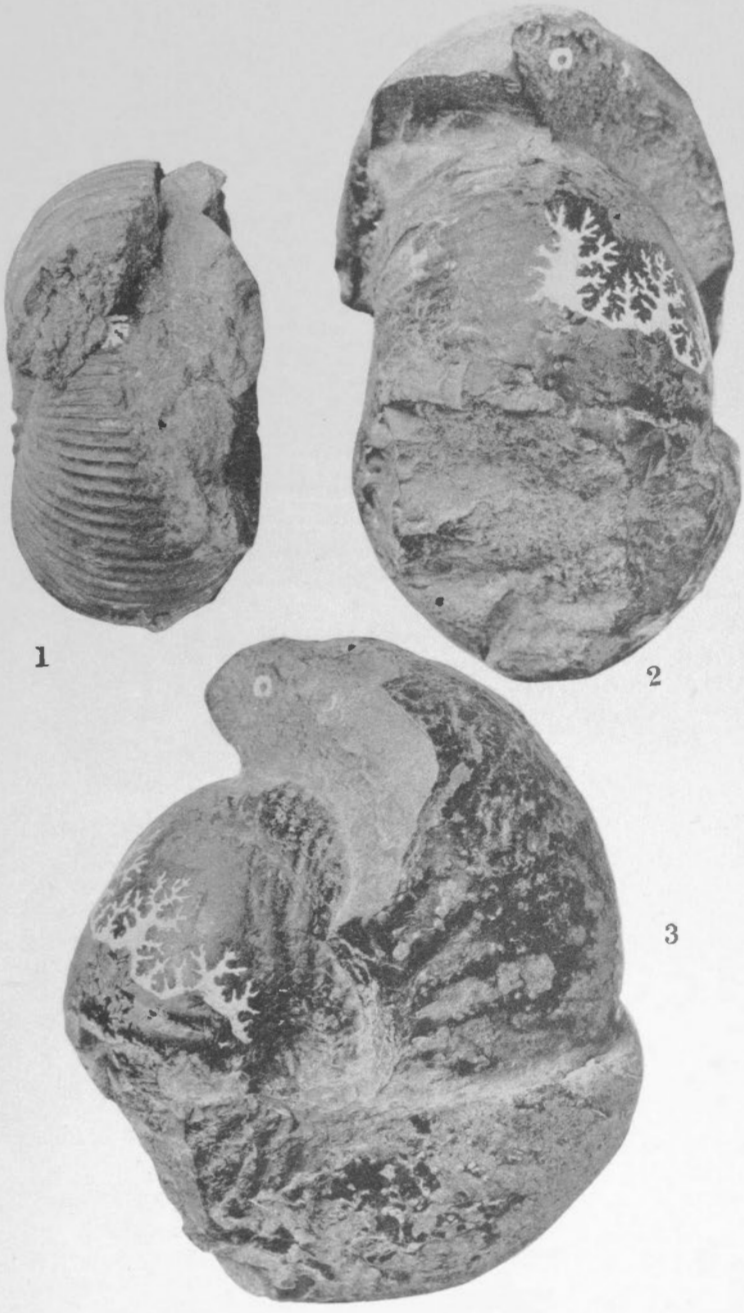

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PLATE XV

(Natural size)

*Defonticeras oblatum* (Whiteaves). (Page 16.)

Figure 1. Side view of holotype. National Museum of Canada, Cat. No. 4964.

*Itinsaites itinsae* McLearn. (Page 26.)

Figure 2. Ventral view of holotype. National Museum of Canada, Cat. No. 9020.
Figure 3. Side view, same specimen.

*Kanastephanus canadensis* n. sp. (Page 25.)

Figure 4. Side view of holotype. National Museum of Canada, Cat. No. 9019.
Figure 5. Ventral view, same specimen.

Plate XV

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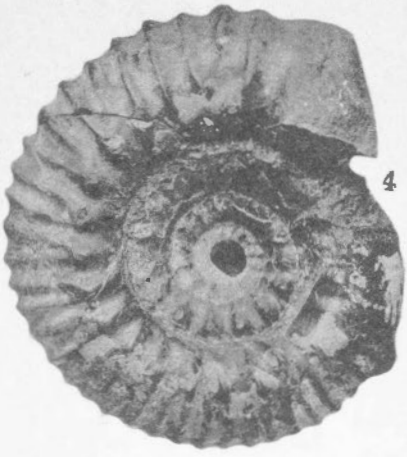


4

PLATE XVI

(Natural size)

*Kanastephanus mackenzii* n. sp. (Page 23.)

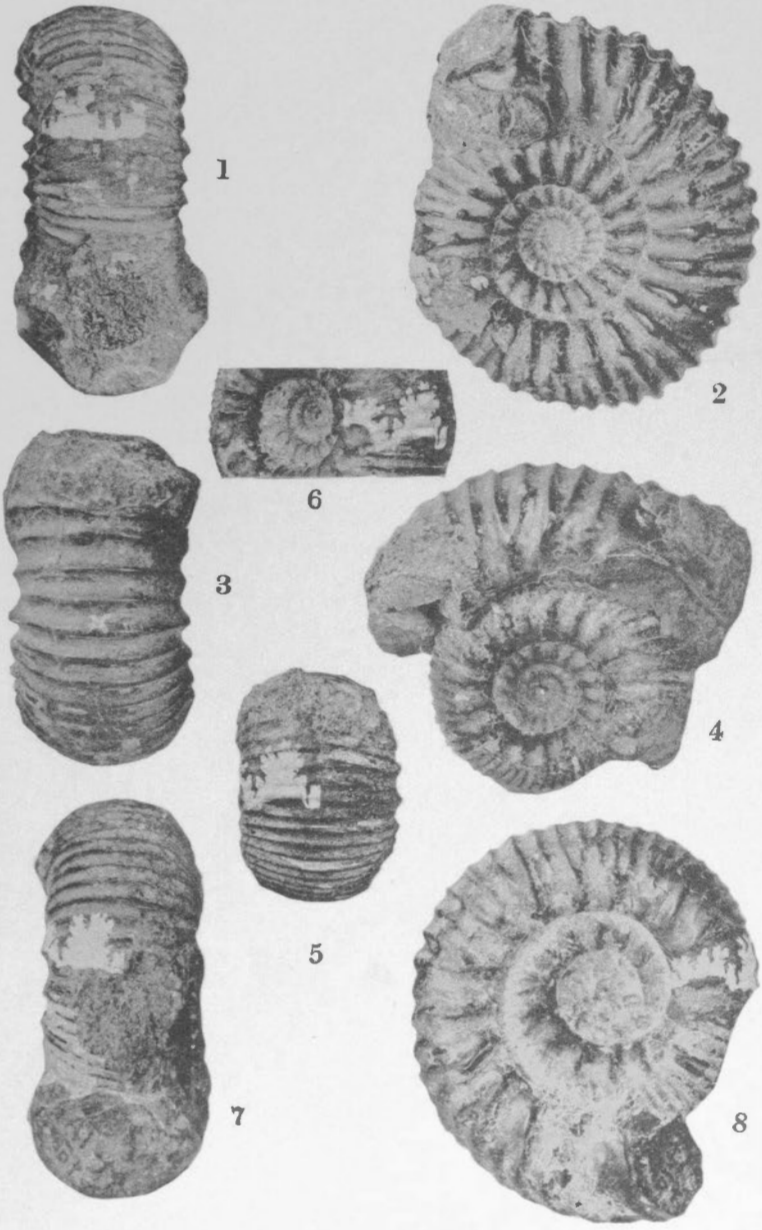
Figure 1. Ventral view of holotype. National Museum of Canada, Cat. No. 9017.
Figure 2. Side view, same specimen.
Figure 3. Ventral view, same specimen, to show lappets.

*Kanastephanus altus* n. sp. (Page 24.)

Figure 4. Side view of holotype. National Museum of Canada, Cat. No. 9018.
Figure 5. Ventral view penultimate whorl of same specimen.
Figure 6. Oblique view penultimate whorl of same specimen, showing suture line.

*Kanastephanus crickmayi* McLearn. (Page 22.)

Figure 7. Ventral view of holotype. National Museum of Canada, Cat. No. 9016.
Figure 8. Side view, same specimen.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7
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PLATE XVII

Skull of *Anodontosaurus lambei*

Type No. 8530, Geol. Surv., Canada

Figure 1. Superior view. ⅓ natural size. (Page 29.)

Figure 2. Lateral view. ⅓ natural size. (Page 29.)

Plate XVII

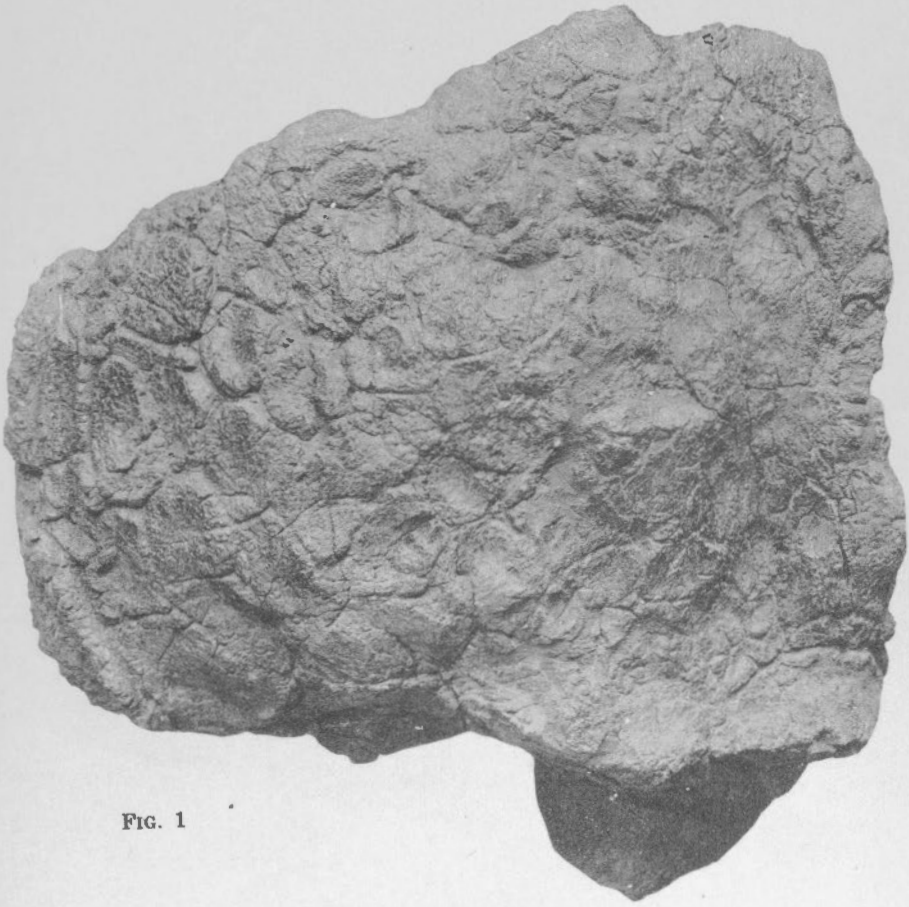

FIG. 1

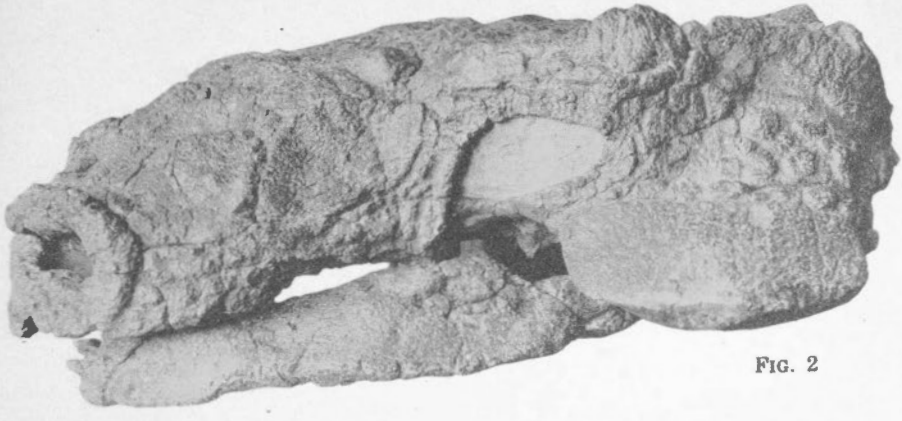

FIG. 2

PLATE XVIII

*Anodontosaurus lambei*

Type No. 8530, Geol. Surv., Canada

Figure 1. Inferior view of skull. ½ natural size. (Page 30.)

Figure 2. Superior view of mandibular ramus. ½ natural size. (Page 31.)

E.pt., ectopterygoid; I.N., internal naris; J., jugal; Mc., mandibular cotylus; Mx., maxilla; Oc., occipital condyle; Pal., palatine; Pmx., premaxilla; Poc., paraoccipital process; Pt., pterygoid; Q., quadrate; Qj., quadrato jugal; V., vomer.

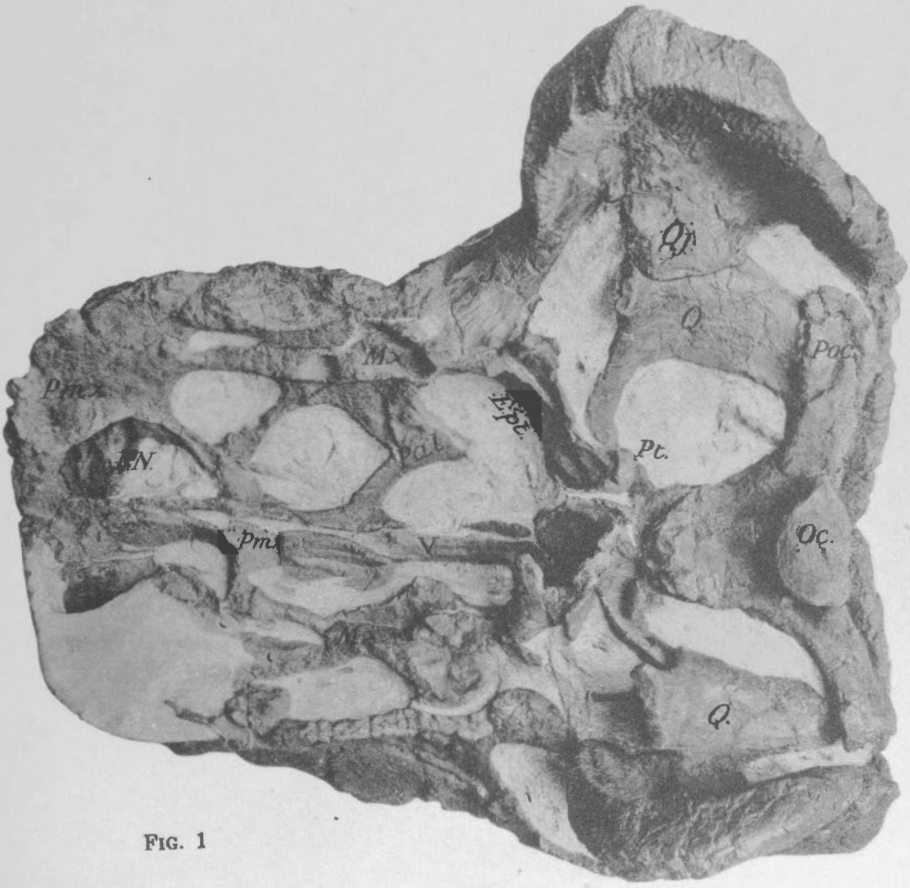


FIG. 1


FIG. 2

PLATE XIX

*Anodontosaurus lambei*

Type No. 8530, Geol. Surv., Canada

Dermal scutes. ½ natural size; a, b, and c, superior view; others, inferior view (Page 32.)

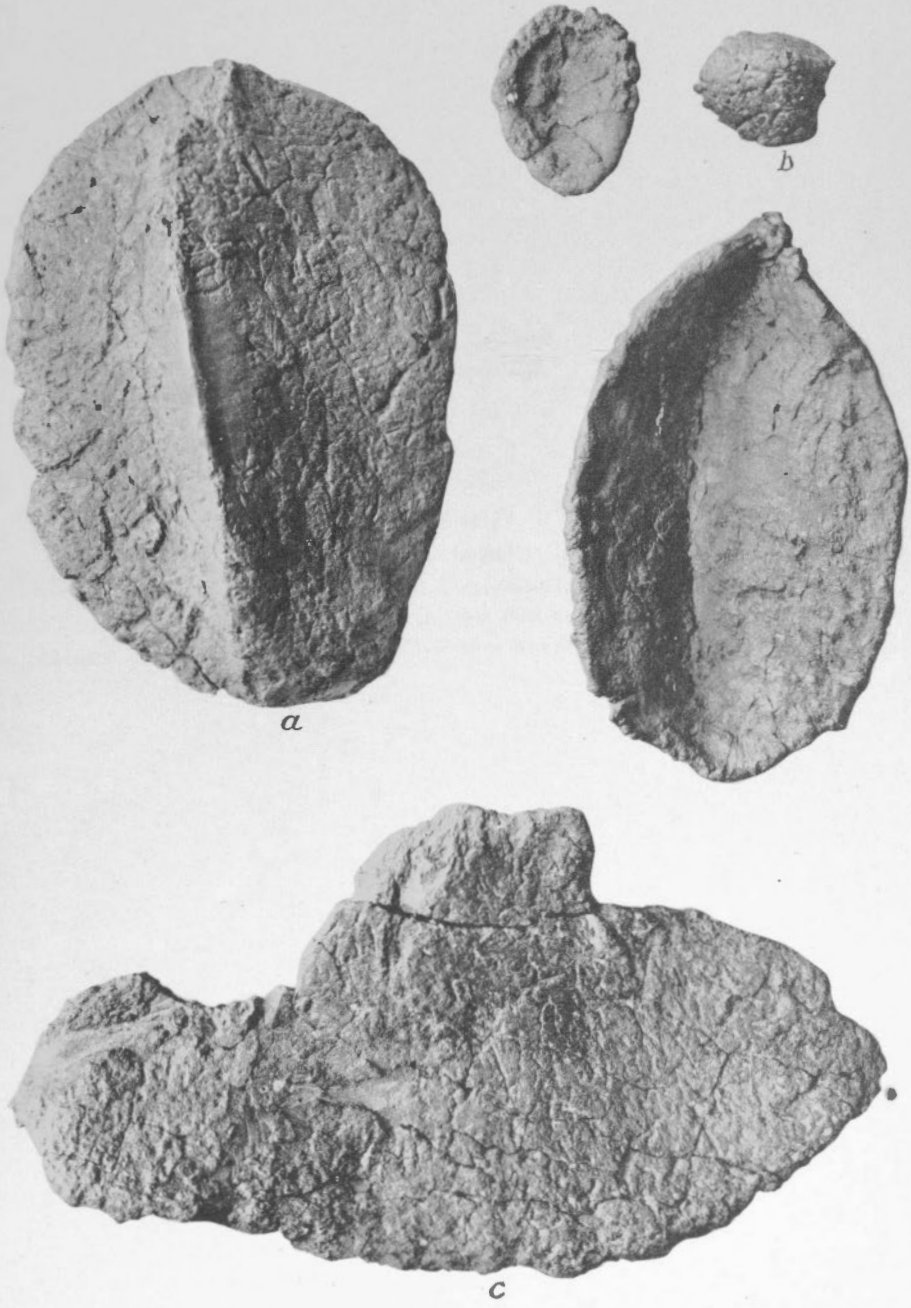
b
a
c

PLATE XX

(Natural size)

*Anodontosaurus lambei*

Type No. 8530, Geol. Surv., Canada

Cross-sections of dermal scutes; a, b, and c are sections of scutes a, b, and c of Plate XIX. (Page 32.)

Plate XX

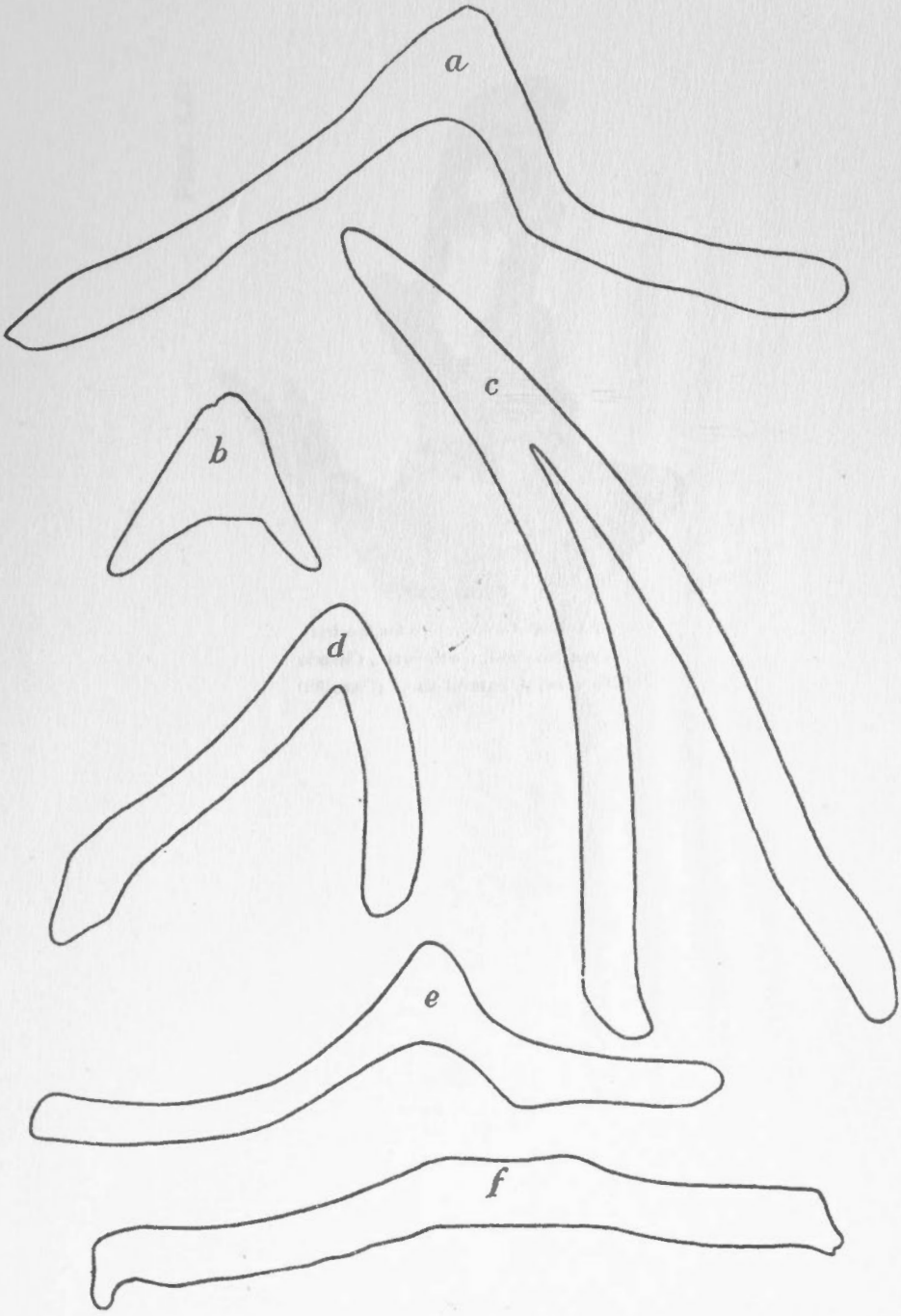

PLATE XXI

Skull of *Anchiceratops longirostris*
Type No. 8535, Geol. Surv., Canada
Side view, $\frac{1}{10}$ natural size. (Page 36.)

Plate XXI

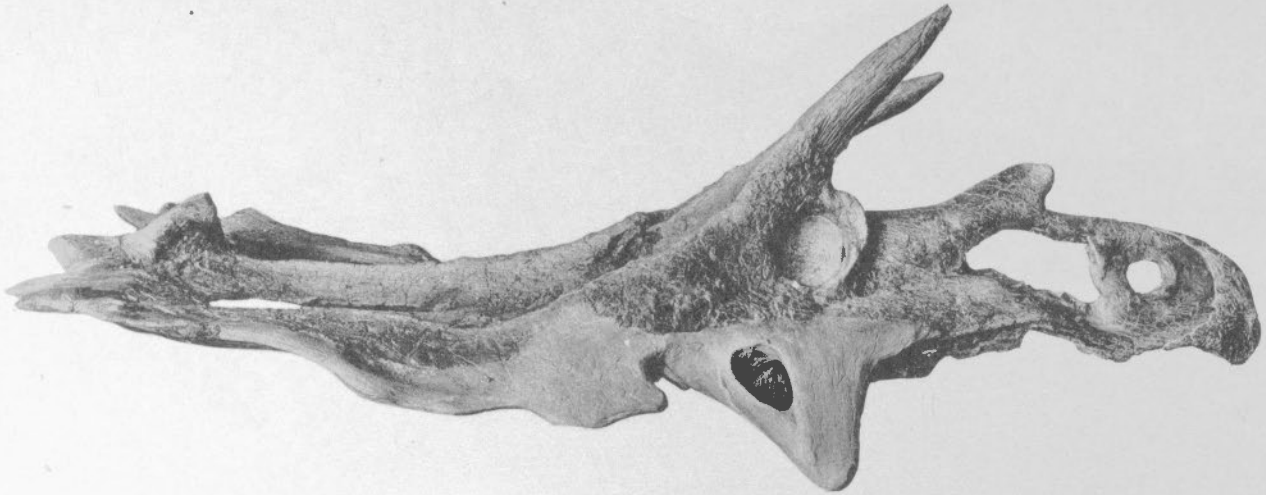

PLATE XXII

Skull of *Anchiceratops longirostris*
Type No. 8535, Geol. Surv., Canada
Superior view, $\frac{1}{10}$ natural size. (Page 37.)