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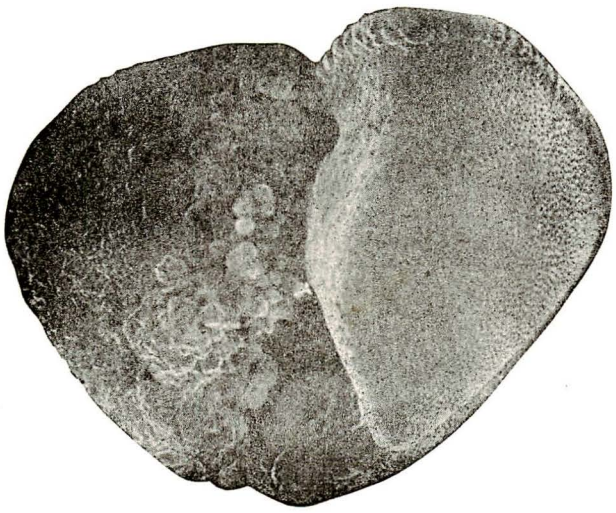

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Fossils on the cover is *Globorotalia truncatulinoides* (D'ORBIGNY, 1839).
The photograph was taken on a scanning electron microscope, JEOL-JSM-2, ×100.

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568. A REVIEW OF SOME CRETACEOUS CORBICULIDS IN NORTH AMERICA*

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北米の白亜紀シジミガヒ類の数種についての再検討：Colorado 大学の Henderson Museum には，故 HENDERSON 教授と協力者達によって採集，研究された白亜紀シジミガヒ類のすばらしい標本が多く保管されている。それらの標本の中で，保存のよい12種について再検討した結果，従来設定されていた亜属 *Leptesthes*, *Veloritina* を再定義し，新属 *Hendersona* を設け，3属9種に整理した。またシジミガヒ類と共存する新種 *Geloina? rodecki* を記載した。また，それぞれの層序的関係や個体発生等より，図表7に示すような類縁関係を明らかにし，北米産のものは他の大陸のものと類縁性が少いことをのべた。　太田喜久

I. Introduction and Acknowledgements

As already known, the original representative of the Corbiculidae can be traced to the Upper Jurassic, and the family in Mesozoic flourished in the Upper Cretaceous, in contrast to the Neomiodontidae, which flourished in the Lower Cretaceous. The prosperity of the Corbiculidae in the Upper Cretaceous is well manifested in the Laramie formation. The representatives of the Cretaceous Corbiculidae in North America were mainly studied by MEEK and HAYDEN (1856, 1860a, b, c), MEEK (1869, 1870a, b, 1872, 1875, 1876, 1877) and WHITE (1878a, b, 1879a, b, 1882, 1883a, b, 1891, 1895). Although more than twenty species were described by their authors from the Cretaceous formations, the stratigraphical relationship of the species was not clear at that time. Entering this century, the stratigraphical studies on the related districts were carried on along with their economic significance by many geologists and paleontologists (BOWEN, 1915, CALVERT, BEEKLY, BARNETT and PISHEL, 1914, HENDERSON, 1907, 1910, 1920, 1935, LEE, 1912, REESIDE, 1924, STANTON, 1916, 1920, STANTON and KNOWLTON, 1897, STANTON and HATCHER, 1905, VEATCH, 1907), and the stratigraphical sequences and correlation of the Cretaceous in North America were founded by them. The paleontological study of the Corbiculidae was excellently made by HENDERSON (1907, 1910, 1935) but there have been few subsequent works.

There are many well-preserved specimens of Corbiculidae in the University of Colorado Museum which were collected by the late Professor Junius HENDERSON and by many students. In this paper, I describe the following ten species which are based on particularly well-preserved specimens.

Hendersona subelliptica (MEEK and HAYDEN), new genus

* Received December 23, 1969; read November 29, 1969, at Kagoshima.

Hendersona umbonella (MEEK) [=*Corbicula obesa* WHITE]
Hendersona cardiniaeformis (WHITE)
Leptesthes fracta (MEEK)
Leptesthes berthoudi (WHITE)
Leptesthes augheyi (WHITE)
Veloritina derkeei (MEEK)
Veloritina cleburni (WHITE)
Veloritina occidentalis (MEEK and HAYDEN) [=*Corbicula cytheriformis* MEEK and HAYDEN]
Geloina (?) *rodecki* OHTA, new species

At this point, I wish to express my sincere thanks to Prof. Hugo G. RODECK, Director of the University of Colorado Museum, and Dr. Peter ROBINSON, Curator of Geology in the Museum, for the privilege of studying the many well-preserved specimens which are kept in the Museum. My thanks go to Prof. Bruce F. CURTIS, Chairman of the Department of Geological Sciences, and also to Dr. Erle G. KAUFFMAN, Associate Curator of the Division of Invertebrate Paleontology of the U. S. National Museum, for the privilege of studying the type collection of Mesozoic Corbiculidae. Thanks are due to Dr. ROBINSON and Mrs. Kirk NEVIN for their invaluable advice and critical reading of the manuscript, and Mr. Tom ZEILER for his assistance in photography.

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II. Terms used in this paper

(A) Size of shell.—Generally the following terms are used: small, medium and large. However, these terms are subjective in many cases. Therefore I shall use the following five grades: (1) very small (<10 mm), (2) small (10 mm-30 mm), (3) medium (31 mm-50 mm), (4) large (51 mm-70 mm), (5) very large (> 70 mm). Of course, this standard should be used only for the Corbiculidae, in which case size always refers to the length (L) of shell.

(B) Inflation of shell.—In this paper the inflation of shell is represented by the ratio of W ($\frac{1}{2}$ thickness of shell) to height (H), and the following three grades are used: (1) small (0.3-), (2) medium (0.3-0.5), (3) large (0.5+).

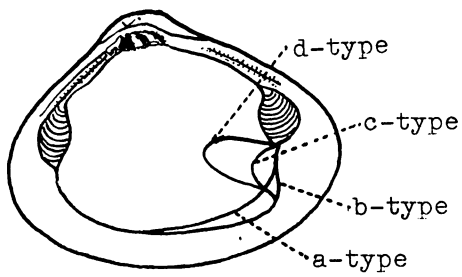
(C) Sinupalliated nature:

a-type: non-sinuated or with a slight curve near the posterior adductor.

b-type: abruptly and nearly vertically bent from the ventral line with a slight curve near the posterior adductor.

c-type: a fairly deep, rounded sinus, but forming less than a semicircle.

d-type: deep and subtrigonal sinus.



Text-fig. 1. The types of sinuation in the Corbiculidae.

In the taxonomy of the Corbiculidae, the nature of pallial sinus went unnoticed until recently. TRYON and STANTON (1893, p. 103) found differences among

the pallial sinuses in the remains of fossils in the Upper Cretaceous, but they did not use these differences as standards of classification of the Corbiculidae. Of course, the nature of the pallial sinus is related to an ecological condition to some extent, and therefore I have tried to classify the Corbiculidae with regard to their sinupalliated nature as well as their other characteristics.

III. Systematic description

Family Corbiculidae

Genus *Hendersona* OHTA, nov.

Type-species.—*Tellina subelliptica* MEEK and HAYDEN, 1856, Lance formation (Upper Cretaceous), South Dakota.

Diagnosis.—Shell of small to large size, equivalve, inequilateral, suboval to subelliptical; beak small, not much elevated, prosogyrous, anterior to midpoint; posterior carinae absent or very weak; without escutcheon and lunule; surface usual and some imbrications of growth; pallial line abruptly curved from the ventral-line and bent near the posterior adductor scar (b-type); adductor scars strongly impressed; hinge cyrenoid, dentition as formulated:

AIII	AI	3a	1	3b	PI	PIII
AII		2a	2b	4b	PII	

cardinals diverging from beak with weak grooves; laterals long, transverse crenulations, posterior laterals very remote from cardinals, but nearly as long as anterior laterals.

Remarks.—The characteristics of this genus are the b-type sinupalliated nature and a subelliptical to subovate outline of the shell. MEEK (1876) ascribed *subelliptica* to the group of *Corbicula* (*Leptesthes*) *fracta*, the type of subgenus. In fact, *Corbicula* (*Leptesthes*) *subelliptica* is similar to *C.* (*L.*) *fracta* in the outline of shell and hinge structure, but differs from the latter in the b-type sinupalliated nature. The sinupalliated nature of this genus is more similar to that of *Leptesthes* and *Veloritina* than that of *Eocallista, Tetoria, Fulpia, Dentonia* and *Corbicula,* but differs from them in the degree of sinuation. On the basis of the differences in pallial sinus, I propose this new genus. The species of this genus flourished mostly in the Laramie formation and numerous specimens were collected by Prof. Junius HENDERSON et al. from many localities in North America. It is named in honor of the late Prof. Junius HENDERSON, who made valuable contributions to the knowledge of the Mesozoic Corbiculidae of North America.

Hendersona subellipitca
(MEEK and HAYDEN)

Pl. 32, figs. 1–9; text-fig. 2

1856. *Tellina subelliptica,* MEEK and HAYDEN, *Phi. Acad. Nat. Sci., Pr.,* 8, p. 83.
1876. *Corbicula* (*Leptesthes*) *subelliptica,* MEEK, *Rept. U.S. Geol. Surv., Terr.,* 9, p. 523, pl. 43, fig. 9.
1878. *Corbicula* (*Leptesthes*) *subelliptica,* WHITE, *12th Ann. Rept., pt.* 1, p. 79.
1883. *Corbicula* (*Leptesthes*) *subelliptica,* WHITE, *3rd Ann. Rept. U.S. Geol. Surv.,* p. 437, pl. 20, figs. 10, 11.
1905. *Corbicula* (*Leptesthes*) *subelliptica,* SCHUCHERT, *U.S. Nat. Mus., Bull.* 53, pl. 1, p. 167.
1914. *Corbicula subelliptica,* CALVERT, BEEKLY, BARNETT and PISHEL, *U.S. Geol. Surv., Bull.* 575, p. 20.
1920. *Corbicula subelliptica,* HENDERSON, *Colo. Geol. Surv., Bull.* 19, p. 43, 49.

Material.—Holotype: USGS 441, right valve, from loc. Cherry Creek, South

Dakota (MEEK Coll.); Plesiotype: USGS 8123, right valve, from loc. Bijou Creek, Colorado (WHITE Coll.). Henderson Museum: No. 12664 (Pl. 32, Figs. 1-7), left and right valves, from loc. NW of Briggsdale, Colorado (J. HENDERSON and E. G. SMITH Coll.); No. 12633 (Pl. 32, Figs. 8, 9), right valve and right internal mould, from loc. 2 miles S. of Cornish, Weld Co., Colorado (J. HENDERSON and E. G. SMITH Coll.).

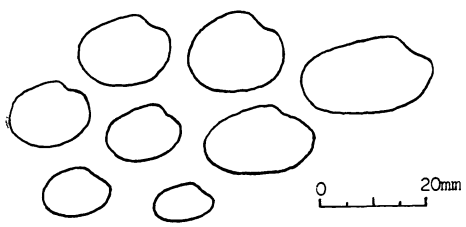
Description.—Shell small-sized for the genus, ovate to subelliptical in outline, longer than high, and the inflation of shell small; test thin; beak small, not much elevated, prosogyrous, placed a little in advance of the center; antero-dorsal margin slightly concave in front of umbo, smoothly sloping down into the anterior margin; postero-dorsal margin gently convex, longer than the anterior dorsal one; posterior margin fairly long and truncated or rounded; ventral margin gently arched; posterior carination absent or very weak; surface ornamented with fine growth-lines and some prominent concentric ribs; ligament external; hinge cyrenoid; cardinal teeth stout with grooves, radiating from the beak; 3a small, opisthocline, represented by the terminal thickening of AIII; 1 stout with groove, orthocline; 3b stout, prosocline; 2a fairly stout, opithocline, remote from AII; 2b stout with groove, a little prosocline; 4b elongate but not strong, very prosocline; lateral teeth elongated along the antero- and postero-dorsal margins, apparently cross-striated; antero-laterals about same as postero-ones in length; nymph comparatively wide, adductor scars strongly impressed, fairly large, placed near the both ends of the lateral teeth; pallial line sinuated, but shallow, somewhat abruptly and vertically with the ventral line, bent upward and curved near posterior adductor scar (b-type); pedal scar not clearly impressed.

Observation and comparison.—A large number of well-preserved specimens exhibiting the internal and external characters are kept in the University of Colorado Museum, and these can certainly be referred to *Hendersona subelliptica*. The ratio of height to length is comparatively constant, ranging from about 0.8 to 0.7. The inflation of shell is somewhat variable between the younger

Measurements in mm.—

Specimen	Length	Height	W (½ thickness)	H/L	W/H
12664 (bivalve)	17.0	14.0	5.0	0.8	0.35
" (right valve)	18.5	14.0	4.0	0.8	0.30
" (left valve)	19.0	15.0	—	0.8	—
" (right valve)	17.5	13.5	4.0	0.77	0.30
" (bivalve)	16.0	12.0	4.0	0.75	0.33
12633 (bivalve)	22.0	15.0	5.0	0.68	0.33
" (")	26.0	19.0	5.3	0.73	0.27
" (")	19.0	13.0	4.0	0.68	0.30
" (")	23.0	16.0	5.0	0.69	0.31
" (")	21.0	15.0	4.0	0.71	0.26
USGS 441 (right valve)	11.5	8.0	—	0.69	— (holotype)
" 8123 (")	20.0	16.0	4.0	0.80	0.25

and adult specimens, ranging from about 0.35 to 0.25. The variation of outline of shell is a fairly wide range from ovate to subelliptical as shown in text-fig. 2. In the younger stage it exhibits a subelliptical outline, but in the adult stage the forms are varied from subelliptical to subovate. The characteristics of this species are generally small size, medium inflation and subelliptical outline of shell.



Text-fig. 2. The variation of outline of *Hendersona subelliptica*.

In the outline of shell this species is somewhat similar to *C. fracta* and *C. cardiniaeformis*, although the size of shell is very different from the latter two species. Similar size and outline of shell appear in *Corbicula macropistha* WHITE from the Laramie formation. WHITE (1878, p. 78) pointed out that the specific character of *C.* (*Leptesthes*) *macropistha* (Syntypes, USGS 8124, 12475, WHITE Coll.) is the peculiar flattening of the umbonal and upper middle portion of the shell. This characteristic, however, is not clear in all specimens which are named as *C.* (*L.*) *macropistha* by HENDERSON (No. 12633, Pl. 32, Figs. 8, 9). Also the outline and the inflation of shell are included in the variation range of *H. subelliptica*, and furthermore both species often coexist with each other in the same beds. Therefore, the specimen which are named as *C.* (*L.*) *macropistha* by HENDERSON are not related to *macropistha*, but closely related to *H. subelliptica*.

Occurrence.—The Laramie formation of northern Colorado and Lance formation of South Dakota and Montana.

Hendersona umbonella (MEEK)

Pl. 32, figs. 10-18; text-fig. 3

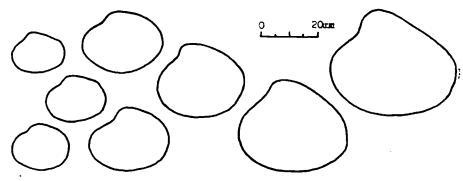
1875. *Corbicula umbonella* MEEK, *Hayden Surv., Bull. 2nd ser.*, no. 1, p. 44.
1878. *Corbicula obesa*, WHITE, *Bull. U.S. Geol.* and *Geogr., Terr., Art.* 28, no. 6, p. 712.
1878. *Corbicula obesa* WHITE, *12th Ann. Rept.*, pt. 1, p. 72, pl. 23, figs. 3a-e.
1883. *Corbicula umbonella* WHITE, *3rd Ann. Rept. U.S. Geol. Surv.*, p. 438, pl. 21, figs. 7-10.
1883. *Corbicula obesa*, WHITE, *3rd Ann. Rept. U.S. Geol. Surv.*, p. 437, pl. 23, figs. 7-11.
1903. *Corbicula* (*Cyanocyclas*) *umbonella*, DALL, *Wagner Free Inst., Tr.*, 3, pt. 6, p. 1451.
1903. *Corbicula* (*Cyanocyclas*) *obesa*, DALL, *Ibid,*, p. 145.
1920. *Corbicula umbonella*, HENDERSON, *Colo. Geol. Surv., Bull.* 19, p. 43.

Material.—USGS 12468 (Plesiotype), from loc. 15 miles north of Orchard station, Colorado (WHITE Coll.); USGS 9025 (Syntypes), from loc. Crow and Bijau Creeks, northern Colorado (WHITE Coll.). Henderson Museum, No. 13550 (Pl. 32, Figs. 10, 11), left and right valves, from loc. R. 61W. south of Cornish, Colorado (HENDERSON and SMITH Coll.); No. 12764 (Pl. 32, Figs. 13, 17, 18), bivalve, from loc. east of Osgood, Colorado (HENDERSON and SMITH Coll.); No. 12700 (Pl. 32, Figs. 15, 16), left and right valves, from loc. SE of Fosston, Colorado; No. 7782 (Pl. 32, Fig. 14), left valve, from loc. NW of Morgan, Colorado (HENDERSON and SMITH Coll.).

Description.—Shell of medium size, moderately inflated; sides somewhat

regularly convex, inequilateral, suboval or subtrihedral in marginal outline; transverse length somewhat greater than the height; beaks small, not prominent, prosogyrous, and placed at a third of shell length from front; without lunule; antero-dorsal margin slightly concave in front of umbo, meeting with regularly rounded anterior margin; ventral margin broadly convex; posterior margin regularly rounded or somewhat truncated; postero-dorsal margin a little convex; posterior carination absent or very weak. Surface marked only by fine growth-lines and imbrications of growth and with two or three irregular radiating rugae on the posterior area. Hinge teeth strong; cardial teeth stout with grooves, radiating from the beak; 3a very small, opisthocline, represented by the terminal thickening of AIII; 1 stout with groove, more or less prosocline; 4b elongate but thin, very prosocline; lateral teeth elongate, strong and finely crenulated, the length of anterior laterals subequal to posterior ones; anterior laterals more or less curved near adductor scar; posterior laterals remote from the cardinals, elongate and nearly straight; nymph comparatively wide, fairly regular fine nods on the surface; adductor scars strongly impressed, fairly large; pallial line sinuated, curved near posterior adductor scar (b-type); pedal scar not clearly impressed.

Observation and comparison.—When *C. obesa* is compared with *H. umbonella*, one cannot distinguish a difference between them in the sinupalliated nature, outline, size, inflation or surface ornamentation of shell. WHITE (1882, p. 439) said, "Shell resembling *Corbicula obesa* WHITE, in most respects, but it is proportionally longer, the umbones are fuller and more elevated, and upon the posterior portion there are upon each valve two or three indistinct radiating rugae. Upon other parts the surface is more than usually smooth." Having examined a great many well-preserved specimens from the type locality of *C. obesa* and the holotype and paratype specimens (USGS 12468, 9025), I have found that the above differences between *H. umbonella* and *C. obesa* pointed out by WHITE are very doubtful. As illustrated in text-fig. 3, the younger forms of *C. obesa* are suboval or subtrihedral and their umbones are not prominent, but their umbones gradually



Text-fig. 3. The variation of outline of *Hendersona umbonella*.

Measurements in mm.—

Specimen	Length	Height	W (½ thickness)	H/L	W/H
13550 (left valve)	36.0	30.0	13.0	0.83	0.43
12700 (right valve)	30.5	26.0	12.0	0.85	0.46
" (left valve)	—	22.0	8.0	—	0.36
12764 (bivalve)	34.0	27.0	10.0	0.78	0.37
13550 (right valve)	31.0	27.0	11.0	0.87	0.41
12700 (right valve)	27.0	24.0	9.0	0.89	0.38

protrude with growth. Two or three indistinct radiating rugae can be seen upon the posterior portion of *C. obesa* in general, and particularly upon the specimens which have the posterior carinations. Therefore I think *C. obesa* is synonymous with *H. umbonella*. Some trancated forms of *H. umbonella* are very similar to *C. augheyi*, but this species differs from the latter in the sinupalliated nature. I believe that the differences between them depend upon their ecological differences. Some younger forms of *H. umbonella* are also quite similar to some younger ones of *H. cardiniaeformis* in the outline of shell and the pallial sinus, but their adult forms can be distinguished from each other by their size and their surface ornamentation. As may be determined from their occurrences and ontogenetical relationship, they are closely related to each other, and perhaps *H. cardiniaeformis* derived from *H. umbonella*.

Occurrences.—The Laramie formation of northeastern Colorado.

Hendersona cardiniaeformis (WHITE)

Pl. 32, figs. 19–27; text-fig. 4

1878. *Corbicula cardiniaeformis* WHITE, *12th Ann. Rept. U.S. Geol. Surv., Terr.*, pt. 1, p. 73, pl. 25, figs. 5a, b.
1878. *Corbicula cardiniaeformis*, WHITE, *Bull. U.S. Geol. Geogr. Surv., Terr.*, vol. 4, no. 3, p. 711.
1883. *Corbicula (Leptesthes) cardiniaeformis*, WHITE, *3rd Ann. Rept. U.S. Geol. Surv.*, p. 437, pl. 22, figs. 10–15.
1903. *Corbicula (Leptesthes) cardiniaeformis*, DALL, *Wagner Free Inst., Tr.*, 3, pt. 6, p. 1447.
1907. *Corbicula cardiniaeformis*, HENDERSON, *Univ. Colo. Stud.*, 4, p. 152.
1920. *Corbicula cardiniaeformis*, HENDERSON, *Colo. Geol. Surv., Bull.* 19, p. 43, 44, 47.

Material.—Holotype, USGS 9024, bivalve, from loc. Crow Creek, northern Colorado (WHITE Coll.). Henderson Museum No. 5255, left valves (Pl. 32, Figs. 19, 22), from loc. SE of Cornish, Colorado; No. 13549, 13262, left valves (Pl. 32, Figs. 20, 21), from loc. E. of Cornish, Colorado; No. 12772, left valve (Pl. 32, Fig. 23), from loc. E. of Osgood, Colorado; No. 5221, left valve (Pl. 32, Fig. 26), from loc. NE of Osgood, Colorado, near type locality (J. HENDERSON and E. G. SMITH Coll.); No. 2041, left and right internal moulds (Pl. 32, Figs. 24, 25, 27), from loc. Crow Creek Dam, 25 miles NE of Greeley, Colorado (J. HENDERSON and H. W. CLATWORTHY).

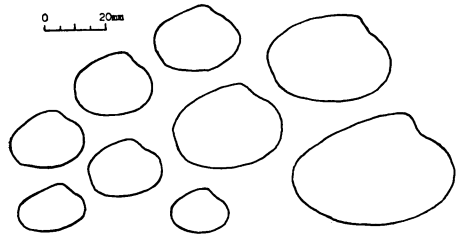
Description.—Shell of large size; inflation of shell medium to large; inequilateral, subelliptical in marginal outline; transverse length greater than the height; beaks small, not prominent, prosogyrous, and placed about a third of shell length from the front; without lunule; antero-dorsal margin slightly concave in front of umbo, elongate, and meeting with a more or less narrow, regularly rounded anterior margin; ventral margin broadly rounded; posterior margin regularly rounded or somewhat truncated; postero-dorsal margin elongated, nearly straight or slightly convex; posterior carinations from beaks to posterior margin weak but distinct. Surface ornamented with fine concentric growth-lines and some imbrications of growth, sometimes *H. umbonella*-like irregular radiating rugae on the posterior area. Hinge teeth comparatively strong; cardinal teeth stout with groove, radiating from the beak; 3a small, opisthocline and connect with AIII, 1 stout with groove, prosocline; 3b stout, very prosocline; indistinct development of AO and PO-like teeth on the left valve; lateral teeth elongated,

Measurements in mm.—

Specimen	Length	Height	W (½ thickness)	H/L	W/H
13549 (left valve)	37.0	29.0	10.0	0.78	0.34
13262 (")	40.0	28.0	11.0	0.70	0.39
13553 (right valve)	32.0	25.0	10.5	0.78	0.42
2041 (")	51.0	40.0	14.0	0.78	0.35
5255 (bivalve)	35.0	27.0	10.0	0.77	0.37

finely crenulated; anterior laterals about equal to posterior ones in length; adductors subequal and strong; pallial sinus b-type.

Observation and comparison.—I observed many well-preserved specimens which have been collected from the many localities of northern Colorado including the type locality. This species has a fairly wide range of variation in the outline of shell. As shown in text-fig. 4, some younger forms are



Text-fig. 4. The variation of outline of *Hendersona cardiniaeformis*.

very similar to *H. umbonella* in outline, posterior carination and pallial sinus. The adult forms, however, can easily be distinguished from *H. umbonella* by their outline and large size. As already pointed out by WHITE (1878, p. 73), the adult forms of this species are surely similar to *C. fracta* in the outline of shell. He considered this species a variation of *fracta*. However, I am of the opinion that this species is more closely related to *H. umbonella* than *C. fracta* for the following reasons: (a) The younger forms of this species are similar to *H. umbonella*. (b) This species is the same as *H. umbonella* in the sinupalliated nature and differs from that of *C. fracta*. This species is also similar to *C. planumbona* in the outline of shell, but the ratio of height to length of this species is smaller than that of *planumbona*. I did not observe any well-preserved specimens of *C. planumbona*, and therefore I can not draw any conclusions concerning the relationship between the two species.

Occurrence.—The Laramie formation of northeastern Colorado.

Genus *Leptesthes* MEEK, 1870

Type-species.—*Cyrena* (*Corbicula*?) *fracta* MEEK, 1870, Upper Cretaceous, Wyoming (original designation).

Diagnosis (emended).—Shell of large size, equivalve, inequilateral, longitudinally subelliptical or subovate, posterior margin narrower than the other, and subtruncated. Umbo not prominent, beak rather depressed, prosogyrous, anterior to mid-point; surface only showing very obscure lines and somewhat stronger imbrications of growth; pallial line shows a fairly deep, rounded sinus but forming less than a semicircle (c-type); escutcheon and lunule absent; adductor scars strongly impressed; hinge cyrenoid; cardinal teeth stout but neither

bifid nor grooved, radiating from the beak; 3a comparatively well developed; lateral very long, finely and transversely crenulated; posterior laterals very remote from the cardinals, but about the same as anterior ones in length.

Remarks.—MEEK (1870) established *Leptesthes* as a subgenus of *Cyrena* based on *Cyrena fracta* MEEK from the Laramie formation for the reason that *Leptesthes* has some characteristics of both *Cyrena* and *Corbicula* without agreeing exactly with either. That is, the anterior laterals of *Leptesthes* are similar to those of *Corbicula* in their elongation and fine-crenulation, but the posterior laterals of this subgenus agree with those of *Cyrena*, being shorter and more remote from the cardinal teeth than in *Corbicula*. *Cyrena* LAMARCK (1818) is synonymous with *Corbicula* MEGERLE (1811), *Corbicula*, *Veloritina*, *Leptesthes* and the other genera of Corbiculidae have generally fine crenulation on their lateral teeth and also indistinguishable difference between the length of the anterior and posterior laterals. However, there are some differences among their degrees of remoteness from the cardinals, but not many difference among the length of their laterals. Therefore, the subgeneric characteristics of *Leptesthes* become obscure. I emended the definition of *Leptesthes* in the following way to rank it as a genus; the longitudinally subelliptical or subovate outline of shell and the c-type sinupalliated nature are the characteristics of this genus. The longitudinally subelliptical form is very common in some genera of Unionidae but its form is unique in the Corbiculidae. *Hendersona subelliptica* from the Laramie formation of North America has a somewhat similar form, but differs from this genus in its sinupalliated nature. In its sinupalliated nature, this genus is similar to *Veloritina* but easily distinguishable from the latter by having no lunule, and a different outline of shell.

Leptesthes fracta (MEEK)

Pl. 33, figs. 1-6; text-fig. 5

1870. *Cyrena (Corbicula ?) fracta* MEEK, *U.S. Geol. Surv., 4th Ann. Rept., Terr.*, p. 298.
1878. *Corbicula (Leptesthes) fracta*, WHITE, *U.S. Geol. Surv., 12th Ann. Rept., Terr.*, pt. 1, p. 75-77, pl. 21, fig. 5.
1883. *Corbicula (Leptesthes) fracta*, WHITE, *U.S. Geol. Surv., 3rd Ann. Rept.*, p. 439, pl. 20, figs. 2-6.
1897. *Corbicula fracta*, STANTON and KNOWLTON, *Bull. Geol. Soc. Am.*, vol. 8, p. 144.
1907. *Corbicula fracta*, HENDERSON, *Univ. Colo. Stud.*, 4, p. 152.
1912. *Corbicula fracta*, LEE, *Bull. U.S. Geol. Surv.*, vol. 510, p. 7-219, pls. 79-83.

Material.—USGS 7742 (Syntype), from loc. Hallville Coal Mines, Wyoming (MEEK Coll.); USGS 8104 (Plesiotypes), from loc. Black Butte Station, Wyoming (WHITE Coll.). Henderson Museum No. 10523, right valves, left and right internal moulds (Pl. 33, Figs. 1-4), from loc. Black Buttes, Wyoming; No. 10485, left internal mould (Pl. 33, Fig. 5), from loc. 6 miles E. of Point of Rock, Wyoming; No. 17859, left internal mould (Pl. 33, Fig. 6), from loc. Weld, Colorado (J. HENDERSON and E. G. SMITH Coll.).

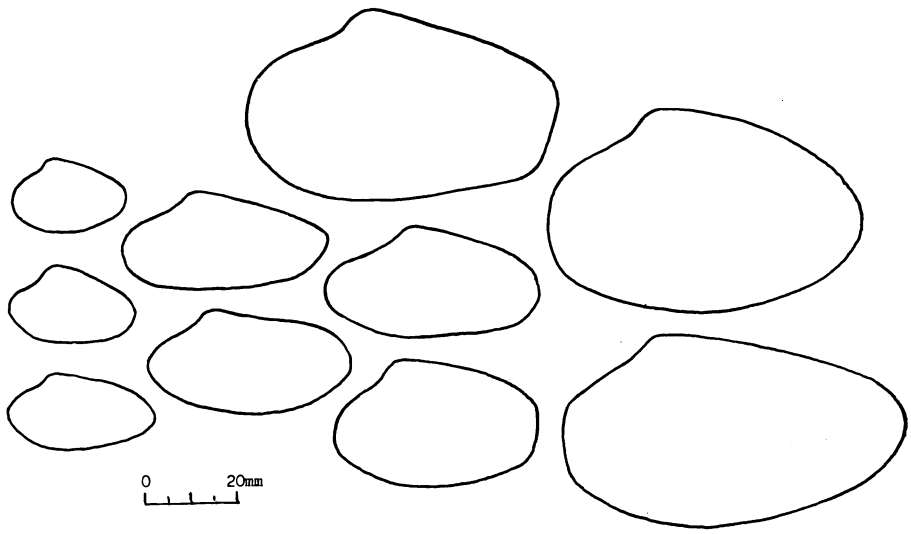
Description.—Shell very large size; longitudinally subelliptical or subovate in outline, much longer than high; the inflation of shell small; test thick; beak small, not much elevated, prosogyrous, placed about a third of shell length from the front; no lunule; antero-dorsal margin slightly concave in front of umbo; anterior margin rounded; ventral mar-

Measurements in mm.—

Specimen	Length	Height	W ($\frac{1}{2}$ thickness)	H/L	W/H
10523 (bivalve)	74.0	44.0	10.0	0.59	0.23
" (right valve)	59.0	38.0	10.0	0.64	0.26
" (bivalve)	54.0	34.0	10.0	0.63	0.29
10835 (")	44.0	25.0	7.0	0.57	0.28
17859 (")	34.0	23.0	7.0	0.68	0.30
10485 (")	44.0	21.0	6.0	0.48	0.29

gin broadly arched; posterior margin narrower than the other, and subtruncated; dorsal margin sloping gradually with slight convexity; posterior carination indistinct. Surface marked with fine concentric growth-lines and some imbrication of growth. Hinge teeth comparatively strong; cardinal teeth stout but neither bifid nor grooved, radiating from the beak; 3a small but distinctly developed, opisthocline, represented by the terminal thickening of AIII; 1 stout; acline; 3b stout and strongest in the cardinals, very prosocline, laterals elongated along the antero- and postero-dorsal margins; apparently cross-striated; linear posterior lateral teeth very remote from the cardinals but they are the same as the anterior ones in length; adductor scars strongly impressed, fairly large, placed near the both ends of the lateral teeth; pallial line shows a fairly deep, rounded sinus but forming less than a semicircle (c-type).

Observation and comparison.—I examined many specimens from the Laramie formation, Black Buttes, Wyoming (no. 10523) and 6 miles east of Point of Rocks, Wyoming (no. 10485) which were collected by HENDERSON and SMITH. The position of the umbo and the ratio of



Text-fig. 5. The variation of outline of *Leptesthes fracta*.

height to length apparently vary to some extent (see Text-fig. 5). The specimens which have a submedian umbo and a comparatively large ratio of height to length are similar to *Hendersona cardiniaeformis*, as already pointed out by MEEK. He asserted that *H. cardiniaeformis* is probably a variety of *H. fracta*. I can not agree with his opinion, however, because the sinupalliated nature of *H. cardiniaeformis* differs from that of *H. fracta*. The immature forms of this species also bear some resemblance to *H. subelliptica* in the outline of shell, and WHITE (1878) thought that *H. subelliptica* belonged to *Leptesthes*. However, the sinupalliated nature of *H. subelliptica* differs from that of *L. fracta*. The difference in sinupalliated natures perhaps indicates a difference in ecological conditions, and therefore *H. subelliptica* is not related to this species. *Corbicula crassatelliformis* (MEEK) was distinguished from *L. fracta* from the same locality by MEEK (1870, p. 315) for the reasons that it had a more trigonal outline, more prominent post-umbonal slopes, and proportionally stronger ridges of growth. However, among the numerous examples of the variety of *L. fracta* which were obtained from the above localities are many specimens which show a direct gradation to that type of form which cannot be separated from *L. fracta*. I have treated it as synonymous with *L. fracta*.

Occurrence.—The Mesaverde and equivalent strata of southern Wyoming and northwestern Colorado, and the Laramie formation of northeastern Colorado.

Leptesthes berthoudi (WHITE)

Pl. 33, figs. 7-11

1882. *Corbicula berthoudi* WHITE, *Proc. U.S. Nat. Mus.*, vol. 5, p. 94, pl. 4, figs. 1-3.

1883. *Corbicula berthoudi*, WHITE, *3rd Ann. Rept., U.S. Geol. Surv.*, p. 438, pl. 21, figs. 1-3.

1907. *Corbicula berthoudi*, HENDERSON, *Univ. Colo. Stud.*, vol. 4, p. 152.

1920. *Corbicula berthoudi*, STANTON, *Prof. Pap., U.S. Geol. Surv.*, p. 29, figs. 1-3.

Material.—USGS 11556 (Syntype), from loc. valley of South Platte River, Colorado (WHITE Coll.). Henderson Museum No. 12699, left and right valves (Pl. 33, Figs. 7, 8), from loc. SE of Fosston, Colorado; No. 17827, right valve (Pl. 33, Fig. 11), from loc. 1.5 miles E. of Fosston, Colorado (J. HENDERSON and E. G. SMITH Coll.).

Description.—Shell of large size, subelliptical to subtetrahedral in outline, moderately inflated, much longer than high; test thick; antero-dorsal margin slightly concave in front of the umbo, passing gradually into smoothly arched ventral; postero-dorsal margin gently curved and turned at posterior margin and postero-ventral corners with obtuse angles; umbo recurved, large, rising fairly high above hinge margin, prosogyrous, situated a third of shell length from front; without lunule and escutcheon; surface with dense concentric lines and some imbrications of growth; adductor subelliptical and subequal to each other and fairly large, strongly impressed; pallial sinus c-type; hinge cyrenoid; cardinals divergent from beak: 3a very small, tuberculiform, opisthocline, formed by a thickening of lateral AIII at its posterior end, defined from it by change of orientation; 1 fairly stout with groove, prosocline, situated below beak; 3b stout, large with groove, trigonal, very prosocline; laterals long and fine crenulated; AI elongated, narrow and curved along the margin of adductor; AIII long, stout but rounded at top, gently convex; PI and PIII very

Measurements in mm.—

Specimen	Length	Height	W (½ thickness)	H/L	W/H
12724 (bivalve)	57.0	47.0	16.0	0.82	0.34
" (")	56.0	46.0	16.0	0.82	0.34
" (")	48.0	40.0	14.0	0.83	0.35
" (right valve)	32.0	29.0	12.0	0.90	0.41
" (bivalve)	37.0	33.0	13.0	0.89	0.39

remote from cardinals, long, stout, gently curved.

Observation and comparison.—The outline varies to some extent between the immature and adult specimens, and also among the adult specimens. The immature specimens are ovate or subelliptical in outline, and the inflation of shell is fairly large, but the adults are subtetrahedral to subelliptical in outline, the inflation of shell is small, and the degree of protrusion of the umbo has increased. Among the adult specimens, the outline is also variable in the posterior marginal outline. Among specimens which were collected from the same bed, the subtetrahedral outline is truncated at the posterior margin, whereas the subelliptical outline is rounded. When this species was described by WHITE (1882), it was the largest specimen known. However, it may be determined from my examination of a large sample of specimens which were collected by many students from many localities, that this is not the largest specimen in the Corbiculidae. This species resembles *H. cardiniaeformis* in its large size and its outline of shell, although it is isolated from that species with regard to their sinupalliated natures. This species is very similar to *L. fracta* in its pallial sinus and absence of a lunule. It is probably included in the genus *Leptesthes*, but is specifically distinct from the latter in its outline and inflation of shell. I think this species was probably derived from some subelliptical form of *L. fracta* in the Late Fox-hill or Early Laramie age, and flourished in the Laramie age.

Occurrence.—Laramie formation, valley of South Platte River, northeastern Colorado.

Leptesthes augheyi (WHITE)

Pl. 34, figs. 3-6

1882. *Corbicula augheyi* WHITE, *Proc. U.S. Nat. Mus.*, vol. 5, p. 95, pl. 4, figs. 4-6.
1883. *Corbicula augheyi*, WHITE, *3rd Ann. Rept., U.S. Geol. Surv.*, pl. 21, figs. 4-6.
1920. *Corbicula augheyi*, HENDERSON, *Colo. Geol. Surv., Bull.* 19, p. 43, 47.

Material.—USGS 11557 (Syntypes), from loc. valley of South Platte River, Colorado (WHITE Coll.). Henderson Museum No. 12698, left and right valves (Pl. 34, Figs. 3-6), from loc. SE of Fosston, Colorado; No. 5229, right valve, from loc. E. of Fosston, Colorado; No. 17827, bivalve, from loc. 1.5 miles E. of Fosston, Colorado (J. HENDERSON and E. G. SMITH Coll.).

Description.—Shell of large size, highly inequilateral, subtetrahedral, much longer than high, moderately inflated; test thick; antero-dorsal margin fairly concave in front of the umbo, passing gradually into the anterior margin;

Measurements in mm.—

Specimen	Length	Height	W (½ thickness)	H/L	W/H
5229 (right valve)	43.0	33.0	14.0	0.76	0.42
12698 (left valve)	43.0	35.0	13.0	0.81	0.37
17827 (bivalve)	56.0	47.0	15.0	0.83	0.31
17827 (")	58.0	48.0	18.0	0.82	0.37
12698 (left valve)	36.0	29.0	12.0	0.75	0.44

ventral broadly arched; postero-dorsal margin much longer, nearly straight, forming an obtuse angle with the posterior margin; posterior end truncated, the direction of the truncated margin usually a little drawn perpendicularly with the base of the shell; umbo prosogyrous, considerably elevated above the hinge margin, placed at about one third of shell length from the anterior end; lunule and escutcheon absent; two obtused ridges extending from the umbo to the postero-dorsal angle, difining a slightly concave posterior dorsal slope; surface ornamented with the fine growth-lines and some imbrication of growth; anterior scar more or less stronger than anterior one, both ones strongly impressed; pallial sinus c-type; hinge the same as the preceding.

Observation and comparison.—The degree of protrusion of the umbo is variable in the process of growth; in the immature stage the degree of protrusion is slight and similar to some truncated forms of *L. fracta* and *C. planumboana.* However, the degree of protrusion gradually increases with growth. The outline in adult specimens is fairly constant among about fifty specimens from the Laramie formation east of Fosston, Colorado. The subtetrahedral outline, fairly distinct posterior ridges and protruded umbo are the characteristics of this species. I once considered *L. augheyi* to be synonymous with *L. berthoudi,* because the above mentioned characteristics can to some extent be seen in the adult specimens of *L. berthoudi,* and both species generally coexist in the same beds. However, I have treated it as a valid species having a comparatively constant outline of shell as well as the other above characteristics. This species is probably closely related to *L. berthoudi.*

Occurrence.—The Laramie formation of northeastern Colorado.

Genus *Veloritina* MEEK, 1872

Type-species.—*Cyrena* (*Corbicula*) *durkeei* MEEK, 1870, Lower Cretaceous, Wyoming.

Diagnosis (emended).—Shell of medium size, equivalve, inequilateral, subtrigonal, provided with a fairly sharp posterior carina; the ratio of length to height large; umbo prominent, rising above hinge margin, recurved, prosogyrous, anterior to mid-point; lunule clear, fairly deep; surface usual and some imbrications of growth; pallial line fairly deep, rounded sinus, but forming less than a semicircle (c-type); anterior adductor scar small but strongly impressed; dentition as formulated below:

AIII	AI	3a	1	3b	PI	PIII
AII		2a	2b	4b	PII	

cardinals diverging from beak with weak grooves; lateral long; posterior

laterals very remote from cardinals.

Remarks.—MEEK (1872, p. 493) established *Veloritina* as a subgenus of *Corbicula* on *Corbicula durkeei* from the Bear River formation. He clarified the subgeneric character, as being a remarkable trigonal outline of shell and elongated lateral teeth which are nearly or quite smooth, rather than transversely striated. However, the crenulation of the lateral teeth is very faintly visible under a microscope, and may even be detected with the naked eye. And the crenulation of the lateral teeth can be seen not only in the Corbiculidae but also in the laterals of some genera of the Neomiodontidae and Arcticidae. Therefore, in order to propose *Veloritina* as a genus rather than a subgenus, I have emended MEEK's definition in the following way: the characteristics of this genus are a c-type sinupalliated nature, a large ratio of height to length, and a clear lunule. In general, the presence of a lunule is not characteristic of the Corbiculidae, but *Veloritina* has a lunule. This exception is the most unusual found in the Corbiculidae, but nevertheless, *Veloritina* is a valid genus in the Corbiculidae as proved by its hinge nature as well as by ecological evidence. *Veloritina* is similar to *Leptesthes* in its sinupalliated nature, but differs from it in its outline of shell and possession of a lunule. This is also similar to *Corbicula* s. s. and *Fulpia* in many ways, but easily distinguishable from them by its sinupalliated nature, which is c-type as opposed to the a-type *Corbicula* s. s. and the d-type *Fulpia*.

Veloritina durkeei (MEEK)

Pl. 34, figs. 7–9

1869–1870. *Cyrena (Corbicula) durkeei* MEEK, *Am. Phil. Soc., Pr.*, 11, p. 431.

1870. *Corbicula (Veloritina) durkeei*, MEEK, *Hayden Surv., 4th Ann. Rept.*, p. 293, 294, 298.

1872. *Corbicula (Veloritina) durkeei*, MEEK, *Hayden Surv., 6th Ann. Rept.*, p. 478, 494.

1876. *Corbicula (Veloritina) durkeei*, MEEK, *King Surv., 40th Par.*, 4, p. 167, pl. 16, fig. 6.

1878. *Corbicula (Veloritina) durkeei*, WHITE, *Hayden Surv., 12th Ann. Rept.*, pt. 1, p. 79, 91.

1883. *Corbicula (Veloritina) durkeei*, WHITE, *U.S. Geol. Surv., 3rd Ann. Rept.*, p. 437, 473, pl. 8, figs. 8–11.

1895. *Corbicula durkeei*, WHITE, *U.S. Geol. Surv., Bull.* 128, p. 28, 29, 36, 40, pl. 4, figs. 1–4.

1907. *Corbicula durkeei*, VEATCH, *U.S. Geol. Surv., Prof. Pap.*, 56, p. 61, 62, pl. 8, fig. 2.

Material.—Henderson Museum No. 10555, left internal mould and right valve (Pl. 34, Figs. 7, 8); from the Bear River formation loc. Stowe Creek, E. of Knight, Wyoming; No. 10541, left valve (Pl. 34, Fig. 9), from loc. 9 miles SE of Evanston, Wyoming (J. HENDERSON and E. G. SMITH Coll.); USGS 8148, 8166 (Plesiotype), from loc. Mouth of Sulphur Creek and 7 miles north of Evanston, Wyoming (WHITE Coll.).

Description.—Shell of medium size highly inequilateral, trigonal to subtrigonal in outline, degree of inflation medium, a little longer than high; test fairly thick; antero-dorsal margin short, slightly concave in front of umbo, passing gradually into ventral; ventral margin broadly arched; postero-dorsal margin unusually long, nearly straight, turning somewhat abruptly toward ventral; umbo prominent, high above hinge margin, incurved, prosogyrous, lying one-fourth of shell length from front; lunule fairly deep, large, clear and circumscribed by anobtuse ridge

Measurements in mm.—

Specimen	Length	Height	W (½ thickness)	H/L	W/H
10555 (bivalve)	48.0	44.0	13.0	0.92	0.30
" (")	41.0	37.0	15.0	0.90	0.40
" (")	27.0	23.0	8.0	0.85	0.34
" (")	24.0	21.0	6.5	0.87	0.30
" (")	24.0	21.0	4.0	0.87	0.20

but ornamented in the same way as the other area; posterior area behind it crescentic, fairly contorted, occupying about one-sixth of whole surface, defined by a fairly sharp posterior carina running from beak to postero-ventral angle; convexity greatest near center; surface marked with the usual lines and some imbrications of growth. Internally, adductors slightly anisomyarian; anterior scar ovate, comparatively small and strongly impressed; posterior scar ovate, large, located close to posterior lateral teeth; pallial line shows a fairly deep sinus, rounded, but forming less than a semicircle (c-type); dentition formula given above; 2a small, trigonal, orthocline; 2b stout, acutely trigonal with groove, prosocline; 4b elongated, ridge-like, subparallel to posterior dorsal margin; AII long, curved near adductor, poorly defined from 2a; PII very remote from cardinals, long, linear but slightly convex.

Observation and comparison.—The outline is fairly constant among about a hundred specimens which were collected by HENDERSON and SMITH from the Bear River formation of Wyoming. However, the position of the umbo is variable to some extent. A fairly sharp posterior carination, inequilateral outline, a large ratio of height to length, and a clear lunule are the characteristics of this species. This species is closely related to *Veloritina cleburni* (WHITE, 1878) from the Laramie formation, because the two are similar in every essential characteristics. This species is, however, different from *V. cleburni* in the presence of conspicuous posterior carina and remarkable protruded umbo. This species bears, perhaps, some resemblance to *Veloritina occidentalis* MEEK and HAYDEN, but it may be distinguished from the typical forms of that species by its more distinct posterior carina.

Occurrence.—The Bear River formation, Cretaceous, of southwestern Wyoming and adjacent territory.

Veloritina cleburni (WHITE)

Pl. 34, figs. 10–13

1878. *Corbicula cleburni* WHITE, *Hayden Surv., 12th Ann. Rept.*, pt. 1, p. 73, pl. 23, fig. 1.
1878. *Corbicula cleburni*, WHITE, *Hayden Surv., Bull.* 4, p. 711.
1883. *Corbicula cleburni* WHITE,, *U.S. Geol. Surv., 3rd Ann. Rept.*, p. 437, 473, pl. 20, figs. 7–9.
1907. *Corbicula cleburni*, HENDERSON, *Univ. Colo. Stud.*, 4, p. 152.
1920. *Corbicula cleburni*, HENDERSON, *Colo. Geol. Surv., Bull.* 19, p. 38, 43, 44, 47, 48.

Material.—USGS 9023 (Syntypes), from loc. Crow Creek, Colorado (WHITE Coll.). Henderson Museum No. 12770, left valve (Pl. 34, Fig. 10a, b), from loc. E. of Osgood, Colorado (J. HENDERSON and

Measurements in mm.—

Specimen	Length	Height	W ($\frac{1}{2}$ thickness)	H/L	W/H
13571 (bivalve)	43.0	41.0	15.0	0.95	0.36
12681 (right valve)	48.0	46.0	16.0	0.95	0.34
13554 (left valve)	30.0	30.0	10.0	1.00	0.33
1292 (left valve)	32.0	28.0	11.0	0.87	0.39
12715 (right valve)	26.0	24.0	8.0	0.92	0.33

E. G. SMITH Coll.); No. 17770, left valve (Pl. 34, Fig. 11), from loc. Weld, Colorado (H. A. AURAND Coll.); No. 12681, right valve (Pl. 34, Fig. 12), from loc. E. of Cornish, Colorado (J. HENDERSON and E. G. SMITH Coll.); No. 13554, bivalve (Pl. 34, Fig. 13), from loc. Ditto.

Description.—Shell of medium size, highly inequilateral, subovate in outline; moderately inflated, the ratio of height to length fairly large; test fairly thick; antero-dorsal margin fairly sinuated in front of umbo; ventral margin rounded; posterior dorsal long, gently arcuated, turning to posterior margin without angulation; lunule not deep but fairly wide, clear, circumscribed by an obtuse ridge; obtuse posterior ridge from beak to posterior margin and near-escutcheon absent or very obscure; surface marked with fine concentric growth-lines and fairly regular concentric ribs also on lunule. Internally, hinge teeth same as the preceding species, but AO and PO in left valve more well developed than in *V. occidentalis*; adductors strongly impressed, posterior one more or less larger than anterior; c-type pallial line.

Observation and comparison.—This species certainly belongs to the genus *Veloritina* since it has a lunule and the c-type pallial line. The outline of the shell of this species is comparatively constant. A subovate outline and an umbo which does not protrude notably are the characteristic of this species. WHITE (1878, p. 74) already pointed out the similarity between this species and *C. cytheriformis*, but actually *V. cleburni* is more similar to the adult form of *V. occidentalis* than to *C. cytheriformis*, although it is distinguishable from *V. occidentalis* by its subovate outline of shell. Perhaps this species is derived from *V. occidentalis*, because AO and PO in the left valve are more well-developed than they are in *occidentalis*. This species also bears some resemblance to *V. durkeei*, especially in the outline of shell, but it may be distinguished from the typical forms of that species by its obtuse umbo and weak posterior ridge.

Occurrence.—The Laramie formation, Upper Cretaceous of northeastern Colorado.

Veloritina occidentalis (MEEK and HAYDEN)

Pl. 34, figs. 14–18; text-fig. 6

1856. *Cyrena occidentalis* MEEK and HAYDEN, *Phila. Acad. Nat. Sci., Pr.*, 8, p. 111, 279.

1860. *Cyrena* (*Corbicula*?) *cytheriformis* MEEK and HAYDEN, *Ditto., Pr.*, 12, p. 176, 432.

1872. *Corbicula* (*Veloritina*) *cytheriformis*, MEEK, *Hayden Surv., 6th Ann. Rept.*, p. 478, 511.

1876. *Corbicula cytheriformis*, MEEK, *Hayden Surv., Mon.*, 9, p. 520, pl. 40, fig. 5.

1878. *Corbicula occidentalis*, WHITE, *Hayden Surv., 12th Ann. Rept.*, pt. 1, p. 75, pl. 21, fig. 3.
1878. *Corbicula cytheriformis*, WHITE, *Ditto.*, pt. 1, p. 74, 80, pl. 21, fig. 4.
1878. *Corbicula (Veloritina) occidentalis*, WHITE, *Hayden Surv., Bull.* 4, p. 722.
1883. *Corbicula occidentalis*, WHITE, *U.S. Geol. Surv., 3rd Ann. Rept.*, p. 437, 473, pl. 17, figs. 6-7; pl. 23, figs. 1-6.
1883. *Corbicula cytheriformis*, WHITE, *Ditto.*, p. 437, 473, pl. 22, figs. 1-6.
1885. *Corbicula occidentalis*, WHITEAVES, *Contr. Can. Pal.*, pt. 1, p. 7-9, 11, 40, 67, 68, pl. 1, fig. 3.
1885. *Corbicula cytheriformis*, WHITEAVES, *Ditto.*, p. 7, 8, 11, 68.
1897. *Corbicula occidentalis*, STANTON and HATCHER, *U.S. Geol. Surv., Bull.* 257, p. 44, 52, 111, 120, 121.
1897. *Corbicula cytheriformis*, STANTON and HATCHER, *Ditto.*, p. 33, 38, 41, 44, 52, 111, 120, 121.
1910. *Corbicula occidentalis*, HENDERSON, *Univ. Colo. Stud.*, 7, p. 147, 148.
1912. *Corbicula occidentalis* LEE, *U.S. Geol. Surv., Bull.* 510, p. 34, 35.
1912. *Corbicula cytheriformis*, LEE, *Ditto.*, p. 33, 35, 44, 219, pl. 16, fig. 6.
1916. *Corbicula cytheriformis*, STANTON, *U.S. Geol. Surv., Prof. Pap.* 98, p. 310, 316, pl. 82, fig. 4.
1920. *Corbicula cytheriformis*, STANTON, *Ditto.*, 128, p. 29, pl. 5, fig. 4.
1924. *Corbicula cytheriformis*, REESIDE, *Ditto.*, 134, p. 21.

Material.—USGS 2133 (Holotype), 2134, 2135 (Paratypes), from loc. Bad Lands of Judith River, and near Fort Benton, Montana (MEEK Coll.); USGS 8112 (Plesiotype), from loc. Black Butte Station, Wyoming, and Yampa Valley, Colorado (WHITE Coll.); Henderson Museum No. 11643, left and right internal moulds (Pl. 34, Figs. 14, 18), from loc. NW of Fruitland, San Juan Co., New Mexico (H. K. AURAND and D. E. LOUNSBERRY Coll.); No. 17830, left internal mould (Pl. 34, Fig. 16), from loc. E. of Fosston, Colorado (J. HENDERSON Coll.); No. 7913, right valve (Pl. 34, Fig. 17), from loc. Dru Creek, SE of Torrinton Goshen Co., Wyoming (H. A. AURAND Coll.); No. 2390, bivalve, from the upper Mesa Verde formation loc. W. of Meeker, Colorado (J. HENDERSON Coll.).

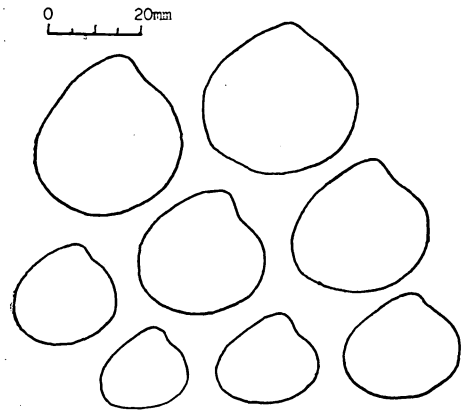
Description.—Shell of medium size, inequilateral, variable in outline from trigonally ovate to orbicular, moderately inflated, the ratio of height to length very large; test fairly thick; antero-dorsal margin fairly concave in front of umbo; ventral margin rounded; postero-dorsal long, gently arcuated, turning to posterior margin with obtuse angulation; lunule not deep, but large, clear, circumscribed by an obtuse ridge; escutcheon clear, defined by a fairly sharp ridge; surface marked with fine concentric growth-lines and fairly regular, strong, concentric ribs; lines and ribs absent on lunule. Internally, anterior rather than posterior adductor strongly impressed; pallial sinus c-type; hinge similar to the preceding; cardinals

Measurements in mm.—

Specimen	Length	Height	W ($\frac{1}{2}$ thickness)	H/L	W/H
7913 (bivalve)	40.0	41.0	13.0	1.02	0.31
" (")	35.0	38.0	13.0	1.08	0.34
" (")	29.0	27.0	8.0	0.93	0.29
2390 (")	22.0	18.0	6.0	0.81	0.33
11634 (")	31.0	26.0	9.0	0.83	0.34

stout, divergent from beak; 3a small, opithocline, formed by a thickening of lateral AIII at its posterior end; 1 stout, trigonal, orthocline, situated below beak; 3b stout, elongated, prosocline; laterals strong, long; posterior laterals very remote from the cardinals; AI elongated, fairly strong and straight; AIII formed by a thickening of anterior shell margin; PI remote from cardinals, long and strong; PIII long, formed by thickening of posterior shell-margin.

Observation and comparison.—This species certainly belongs to the genus *Veloritina*, having a lunule, protruded umbo, c-type pallial sinus and a large ratio of height to length. An oblong ovate outline and fairly regular concentric ribs on the surface are the characteristics of this species. The outline of this species varies greatly during the process of growth; it is generally subtrigonal in the immature stage, but becomes ovately oblong with a gradually increasing ratio of height to length in the adult stage (see Text-fig. 6).



Text-fig. 6. The variation of outline of *Veloritina occidentalis*.

WHITE (1877, p. 209) once considered this species to be identical with *C. cytheriformis*, but preferred to regard them as separate species because of the difference in their outline of shell. On the other hand, STANTON and HATCHER (1905, p. 111) indicated that there is an intermediate form between *V. occidentalis* and *C. cytheriformis*, which occur in the Laramie formation of Wyoming and northwestern Colorado, as well as in the "Western Laramie" of Canada. These two species are apparently not specifically separable, but STANTON and HATCHER treated them as completely separate species. Comparing the holotype of *C. cytheriformis* MEEK and HAYDEN (MEEK, 1876, pl. 40, figs. 5a-e) with the immature forms (Text-fig. 6) of this species, the two species resemble each other inseparably in the outline of shell. I prefer at present to regard *C. cytheriformis* as synonymous with *V. occidentalis*, because the variable outline of *C. cytheriformis* is included in the range of variation of outline of *V. occidentalis*, and both species coexist with each other in many cases (HENDERSON, 1910, p. 148; BOWEN, 1915, p. 111; STANTON and KNOWLTON, 1897; STANTON and HATCHER, 1905, p. 111).

The younger forms of this species are very similar to *V. durkeei* in outline, but the adult form differs from that of *V. durkeei*. I presume this species is probably derived from *V. durkeei*, because they are morphologically and stratigraphically closely related to each other. *Tetoria* (*Paracorbicula*) *yoshimoensis* (OHTA, 1965, p. 168) from the Lower Neocomian in Japan is somewhat similar to this in the outline of shell, but differs from this in the sinupalliated nature.

Occurrence.—Ranges geologically from the Judith River formation to the Lance formation and geographically from northwestern Colorado through Wyoming and Montana to Canada and eastward into the Dakotas.

Geloina ? *rodecki*, new species

Pl. 34, figs. 1, 2

Material.—The holotype (Henderson Museum No. 13577) is an incomplete right valve which was collected by J. W. WILLIAMS from the Laramie formation at Ft. Morgan, Colorado.

Description.—Shell of medium size, equivalve, highly inequilateral, subelliptical in outline, inflation of shell medium; test fairly thick; antero-dorsal margin fairly sinuated in front of umbo; ventral margin broadly rounded, and turning to antero- and postero-margins without obtuse angulation; umbo not prominent, incurved, prosogyrous, lying at a fourth of shell-length from front; without escutcheon and lunule; an obtuse ridge running from beak to postero-ventral angle; convexity greatest near center; surface marked with fine growth-lines and some weak imbrications. Internally, adductors slightly anisomyarian; anterior adductor scar ovate, comparatively small and strongly impressed; posterior one subsquare, large, located close to posterior lateral teeth; dentition cyrenoid as formulated below:

AIII	AI	3a	1	3b	PI	PIII
AII		2a	2b	4b	PII	

3a very small, opisocline, formed by a thickening of lateral AIII at its posterior end; 1 stout, trigonal, orthocline, situated more anterior rather than below the beak; 3b stoutest, fairly long with groove, prosocline; 2a small, opisocline, formed by a thickening of lateral AII; 2b stout, bifid, more or less prosocline, placed below the beak; 4b long but thin, very prosocline; anterior laterals shorter than posterior ones; AI short, curved, distinctly crenulated; AIII thin but long, connected with 3a; AII short, fairly stout, curved, finely crenulated, connected with 2a; posterior laterals very remote from the cardinals; PI and PII long, fairly stout, finely crenulated; PIII formed by a thickening of posterior shell margin.

Measurements.—The holotype (No. 13577, right valve): length of shell about 30 mm, height about 25 mm and $\frac{1}{2}$ thickness about 10 mm.

Observation and comparison.—I found this species among the specimens which are named *Corbicula cardiniaeformis* WHITE from the Laramie formation at Ft. Morgan, Colorado (No. 13577, Coll. J. E. WILLIAMS). The four specimens are all incomplete, but I could examine almost all the features except the nature of pallial sinus. Particularly, the nature of hinge can be observed distinctly.

This species is certainly related to the Corbiculidae, having the cyrenoid dentition and coexisting with *Hendersona cardiniaeformis*. Extraordinary short anterior laterals, the connection of 2a with AII, and bifid cardinals are the characteristics of this species. These characteristics of hinge cannot be seen in an already known Corbiculidae of the Laramie formation. So far as I observed STEPHENSON' illustration and description (1952), the present species is similar to *Dentonia leveretti* (CRAGIN) from the Woodbine formation (Cenomanian) of Texas in the short anterior laterals. However, in *D. leveretti*, 2a is not connected with AII and 3a appears stronger than in *G.* ? *rodecki*. At first, I considered its establishment as a new genus, but the specimens are too incomplete to propose a valid genus. In many of its characteristics, this species is closely related to *Geloina zeylanica* LAMARCK, the type species of the genus, but differs from the latter in the nature of its cardinals. That is, 3a and 2b are not

Explanation of Plate 32

Hendersona subelliptica (MEEK and HAYDEN)

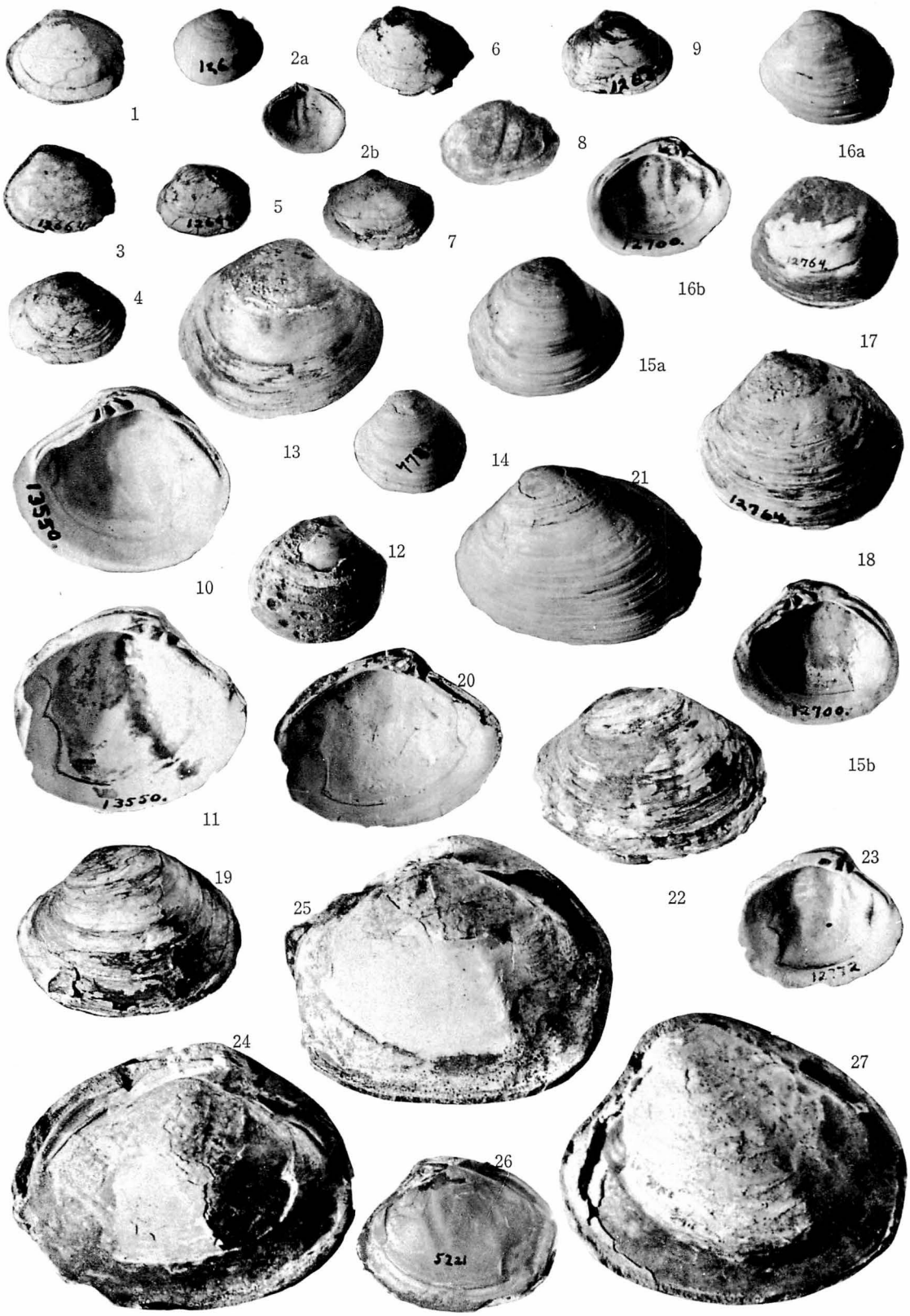
Fig. 1. Left valve (Henderson Museum No. 12664: Laramie formation, NW of Briggsdale Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 2a. Right external cast (No. 12664).
Fig. 2b. Right internal cast (No. 12664).
Fig. 3. Left valve (No. 12664).
Fig. 4. Right valve (No. 12664).
Fig. 5. Left valve (No. 12664).
Fig. 6. Left valve (No. 12664).
Fig. 7. Left valve (No. 12664).
Fig. 8. Right internal mould (No. 12633: Laramie formation S. of Cornish, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 9. Right valve (No. 12633).

Hendersona umbonella (MEEK)

Fig. 10. Right internal cast (No. 13550: Laramie formation S. of Cornish, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 11. Left internal cast (No. 13550).
Fig. 12. Right valve (No. 12648: Laramie formation, S. of Cornish, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 13. Right valve (No. 12764: Laramie formation, E. of Osgood, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 14. Left valve (No. 7782: Fox-Hills sandstone, 1 mile N. and 1 mile W. of NW. Corner of Morgan, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 15a. Right valve (No. 12700: Laramie formation, SE of Fosston, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 15b. Right internal cast (No. 12700).
Fig. 16a. Left external cast (No. 12700).
Fig. 16b. Left internal cast (No. 12700).
Fig. 17. Left valve (No. 12764: Laramie formation, E. of Osgood, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 18. Left valve (No. 12764).

Hendersona cardiniaeformis (WHITE)

Fig. 19. Left valve (No. 5255: Laramie formation, SE of Cornish, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 20. Left valve (No. 13549: Laramie formation, E. of Cornish, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 21. Left valve (No. 13262: Laramie formation, E. of Cornish, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 22. Left valve (No. 5255).
Fig. 23. Left internal cast (No. 12772: Laramie formation, E. of Osgood, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 24. Right internal mould (No. 2041: Laramie formation, above Crow Creek Dam, 25 miles NE of Greeley, Colorado. J. HENDERSON and H.W. CLATWORTHY Coll.).
Fig. 25. Left internal mould (No. 2041).
Fig. 26. Left internal mould (No. 5221: NE of Osgood, Colorado, near type locality. J. HENDERSON and E.G. SMITH Coll.).
Fig. 27. Left internal mould (No. 2041).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independent teeth, but are connected with AII and AIII, and the degree of bifidity of the cardinals is more distinct than in those of the latter. As far as I can tell, this species is the oldest one in the *Geloina* group. It is named in honor of Prof. Hugo H. RODECK who studied the Corbiculidae with Prof. HENDERSON and is contributing to the operation of the Colorado Museum. In this paper, I have tentatively treated it as one species of *Geloina*.

Occurrence.—The Laramie formation of northeastern Colorado.

IV. Concluding remarks

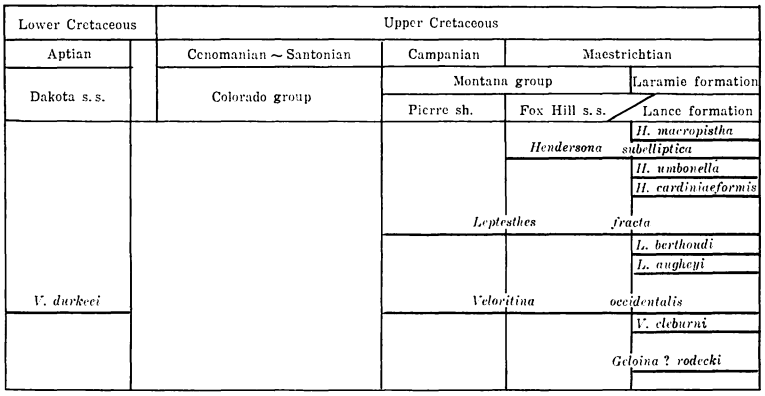
(1) As a result of reexamining the specimens of Corbiculidae which are kept in the University of Colorado Museum, ten species under four genera are recognized.*

Considering the ontogeny and phylogenetic relation between the species, their stratigraphic relations and their occurrences, these species can be summarized as shown in text-fig. 7.

(2) The genus *Veloritina* is characterized by the c-type sinupalliated nature and by a lunule and remarkable subtrigonal outline of shell. This is a unique group in the Corbiculidae and the oldest one in North America. This genus includes *V. durkeei, V. occidentalis* [=*C. cytheriformis*] and *V. cleburni*. The interrelation of these species is shown in text-fig. 7.

(3) The genus *Leptesthes* which is characterized by the elliptical outline of shell and the c-type sinupalliated nature includes *L. fracta, L. berthoudi* and *L. augheyi*. The elliptical form of shell is also one of the unique characteristics of the Corbiculidae. *L. berthoudi* and *L. augheyi* are closely related to each other but it is difficult to determine whether these two species belong to *Leptesthes* or *Veloritina*. I have referred them to the genus *Leptesthes* because of the absence of a lunule.

(4) The genus *Hendersona* which is characterized by the b-type sinupalliated nature includes *H. subelliptica, H. umbonella* [=*C. obesa*] and *H. cardiniae-*



Text-fig. 7. The relationship among some Cretaceous species of Corbiculidae in North America.

* Besides these species, there are some other species which are described from the Cretaceous formations in North America, but I have had no opportunity to examine them.

formis. This was the most flourishing group in the Laramie formation. The relations among these three species are shown in text-fig. 7.

(5) *Geloina*? *rodecki* n. sp. is found in the specimens which were named *Corbicula cardiniaeformis* WHITE from the Laramie formation at Ft. Morgan, Colorado. Perhaps this species is the oldest one in the *Geloina* group.

(6) Comparing the representatives of the Cretaceous Corbiculidae with those of Asia and Europe (CASEY, 1952), there are many unique species in North America. I presume these species developed endemically without any relation to the groups of other areas.

On the other hand, I could not trace the ancestry of the Corbiculidae in North America. This is a moot question which should be resolved in future.

References

BOWEN, C.F. (1915): The stratigraphy of the Montana group, with special reference to the position and age of the Judith River formation in north-central Montana. *U.S. Geol. Survey, Prof. Pap.* 90, 1, p. 95-153.

CASEY, R. (1952): The pelecypod family Corbiculidae in the Mesozoic of Europe and the Near East. *Jour. Washington Acad. Sci.*, 45, (12), p. 366-372.

CALVERT, W.R., BEEKLY, A.L., BARNETT, V.H. and PISHEL, M.A. (1914): Geology of the Standing Rock and Cheyenne River Indian reservations. *U.S. Geol. Survey, Bull.* 575.

DALL, W.H. (1903): Contributions to the Tertiary fauna of Florida. *Wagner Free Inst. Sci., Tr.*, vol. 3.

HENDERSON, J. (1907): Scientific expedition to northeastern Colorado. Paleontology: Account of collections made. *Univ. Colo. Stud.*, vol. 4, p. 149-152.

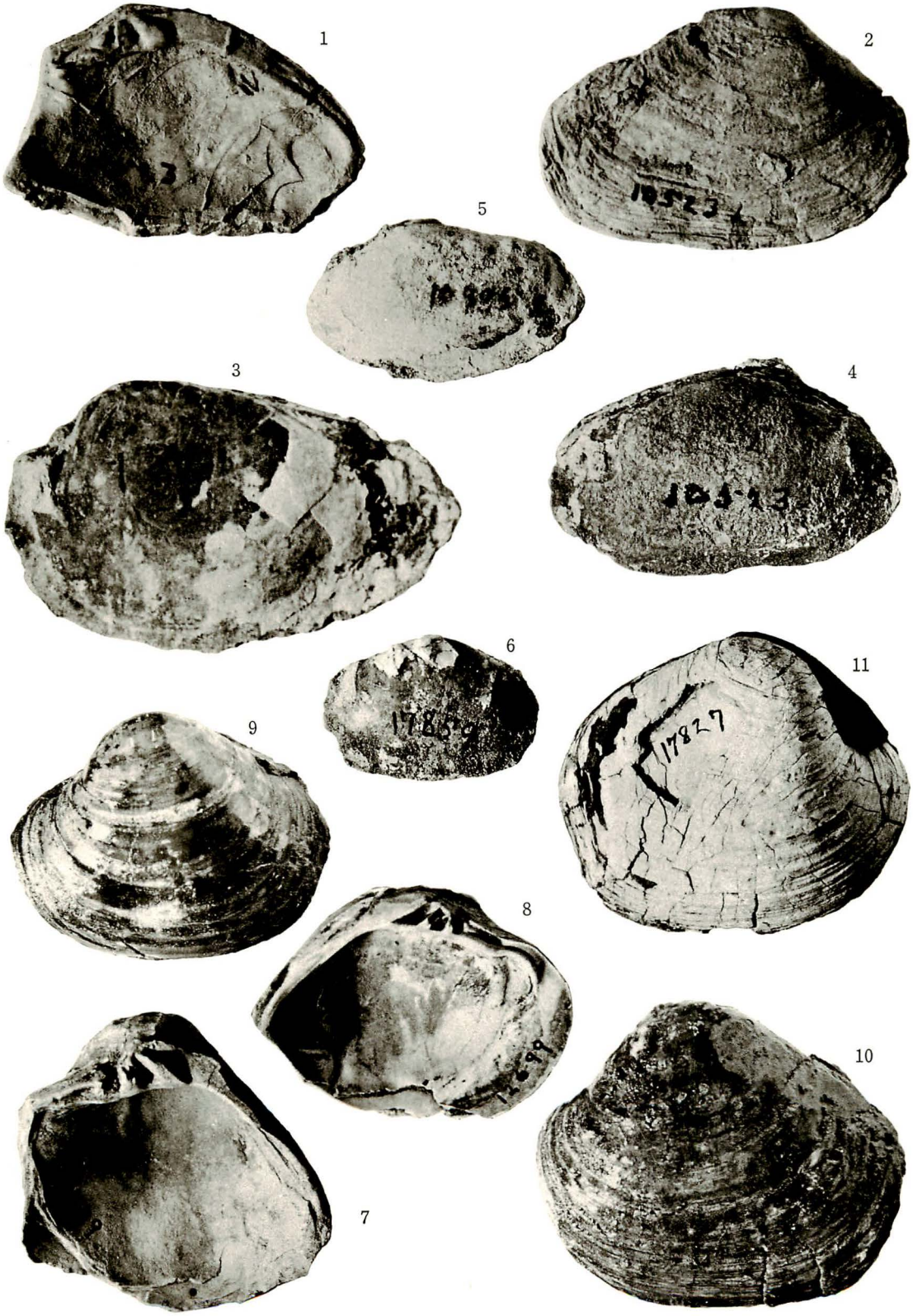
Explanation of Plate 33

Leptesthes fracta (MEEK)

Fig. 1. Right internal cast (Henderson Museum No. 10523: Laramie formation, Black Buttes, Wyoming. J. HENDERSON and E.G. SMITH Coll.).
Fig. 2. Right valve (No. 10523).
Fig. 3. Left internal mould (No. 10523).
Fig. 4. Right internal mould (No. 10523).
Fig. 5. Left internal mould (No. 10485: Mesaverde formation, 6 miles E. of Point of Rocks, Wyoming. J. HENDERSON and E.G. SMITH Coll.).
Fig. 6. Left internal mould (No. 17859: Laramie formation, T. 7, N.R, 61W., Weld, Colorado. J. HENDERSON and E.G. SMITH Coll.).

Leptesthes berthoudi (WHITE)

Fig. 7. Right internal cast (No. 12699: Laramie formation, SE of Fosston, Colorado. J. HENDERSON and E.S. SMITH Coll.).
Fig. 8. Left internal cast (No. 12699).
Fig. 9. Left valve (No. 12724: Laramie formation, E. of Fosston, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 10. Left valve (No. 12724).
Fig. 11. Right valve (No. 17827: Laramie formation, 1 or 2 miles E. of Fosston, Colorado. J. HENDERSON Coll.)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—— (1910): Fossil invertebrates from northwestern Colorado. *Univ. Colo. Stud.*, vol. 7, p. 146-149.

—— (1920): The Cretaceous formations of northwestern Colorado plains. *Colo. Geol. Surv. Boulder. Bull.* 19, p. 7-57.

—— (1935): Fossil non-marine Mollusca of North America. *Geol. Soc. Am., Spe. Pap.* no. 3, p. 1-290.

LEE, W.T. (1912): Coal fields of Grand Mesa and the West Elk mountains, Colorado. *U.S. Geol. Survey, Bull.* 510, p. 7-219, pls. 79-83.

MEEK, F.B. and HAYDEN, F.V. (1856): Descriptions of twenty-eight new species of Acephala and one Gastropod, from the Cretaceous formations of Nebraska Territory. *Phi. Acad. Nat. Sci., Pr.*, vol. 8, p. 70-72.

—— (1860a): Descriptions of new fossil remains collected in Nebraska and Utah, by the exploring expeditions under the command of Capt. J.H. SIMPSON, of U.S. Topographical Engineers. *Philadelphia Acad. Nat. Sci., Pr.*, vol. 12, p. 308-315.

—— and —— (1860b): Descriptions of new organic remains from the Tertiary, Cretaceous and Jurassic rocks of Nebraska. *Philadelphia Acad. Nat. Sci., Pr.*, vol. 12, p. 175-185.

—— and —— (1860c): Systematic catalogue, with synonymy etc., of Jurassic, Cretaceous and Tertiary fossils collected in Nebraska by the exploring expeditions under the command of Lieut. G.K. WARREN, of U.S. Topographical Engineers. *Ditto*, p. 417-432.

—— (1869): A preliminary list of fossils, collected by Dr. HAYDEN in Colorado, New Mexico and California, with brief descriptions of a few of the new species *Am. Phi. Soc., Pr.*, vol. 2, p. 425-431.

—— (1870a): Preliminary paleontological report, consisting of list of fossils, with descriptions of some new types, etc. *Hayden Surv., 4th Ann. Rept.*, p. 287-318.

—— (1870b): Descriptions of fossils collected by the U.S. Geol. Survey under the charge of Clarence KING Esq. *Philadelphia Acad. Nat. Sci., Pr.*, vol. 22. p. 56-64.

—— (1872): Preliminary paleontological report, consisting of lists and descriptions of fossils, with remarks on the ages of the rocks in which they were found, etc. *U.S. Geol. Geogr. Survey, Terr., 6th Ann. Rept.*, p. 431-541.

—— (1875): Notes on some fossils from near the eastern base of the Rocky Mountains, west of Greeley and Evans, Colorado, and some others from about two hundred miles farther eastward, with descriptions of a few new species. *U.S. Geol. Geogr. Survey, Terr., Bull. 2nd ser.*, vol. 1, p. 39-47.

—— (1876): A report on the invertebrate Cretaceous and Tertiary fossils of the Upper Missouri Country. *U.S. Geol. Survey, Terr., Rept.*, vol. 9, p. 521, pl. 40.

—— (1877): Paleontology. Cretaceous species. *U.S. Geol. Expl. 40th Par., Rept.*, vol. 4, pt. 1, 140-182.

OHTA, Y. (1964): On the Corbiculidae from the Lower Neocomian of Japan. *Geol. Rept. Hiroshima Univ.*, no. 14, p. 165-171, pls. 12-13.

REESIDE, J.B. (1924): Upper Cretaceous and Tertiary formations of the western part of the San Juan Basin, Colorado and New Mexico. *U.S. Geol. Survey, Prof. Pap.*, 134, p. 1-70.

STANTON, T.W. and KNOWLTON (1897): Stratigraphy and paleontology of the Laramie and related formations in Wyoming. *Geol. Soc. America, Bull.* 8, p. 127-156.

—— and HATCHER (1905): Geology and paleontology of the Judith River beds. *U.S. Geol. Survey, Bull.* 257, p. 1-174.

—— (1916): Non-marine Cretaceous Invertebrates of the San Juan Basin. *U.S. Geol. Survey, Prof. Pap.*, 98-R, p. 309-319, pls. 79-83.

—— (1920): The fauna of the Cannonball marine member of the Lance formation. *U.S. Geol. Survey, Prof. Pap.*, 128, p. 1-49, pls. 1-9.

STEPHENSON, L.W. (1952): The larger in-

vertebrates fossils of the Woodbine formation (Cenomanian) of Texas. *U.S. Geol. Survey, Prof. Pap.*, 242, p. 1-217, pls. 8-59.

VEATCH, A.C. (1907): Geography and geology of a portion of southwestern Wyoming. *U.S. Geol. Survey, Prof. Pap.*, 56.

Explanation of Plate 34

Geloina ? rodecki sp. nov.

Figs. 1a, 1b, 1c (Holotype): Right external cast, right internal cast and anterior sidesview (Henderson Museum No. 13557: Laramie formation, Ft. Morgan, Colorado. J.E. WILLIAMS Coll.).
Fig. 2. Right valve (No. 13577).

Leptesthes augheyi (WHITE)

Figs. 3a and 3b. Left external and internal casts (No. 12698: Laramine formation, SE of Fosston, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 4. Right internal cast (No. 12698).
Fig. 5. Left valve (No. 12698).
Fig. 6. Left valve (No. 12698).

Veloritina derkeei (MEEK)

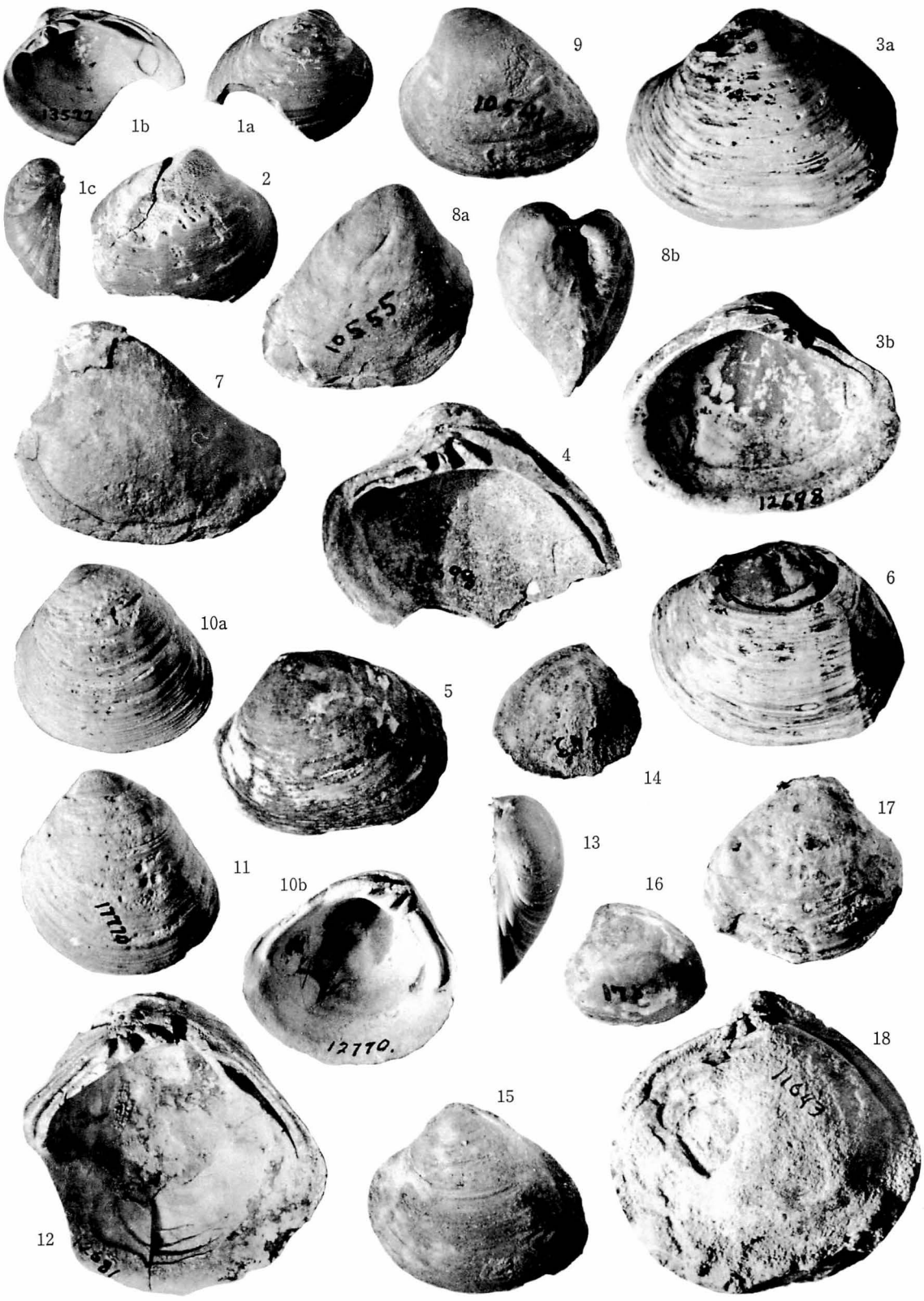
Fig. 7. Left internal mould (No. 10555: Bear River formation, Stowe Creek, E. of Knight, Wyoming. J. HENDERSON and E.G. SMITH Coll.).
Figs. 8a and 8b. Right valve and show its lunule (No. 10555).
Fig. 9. Left valve (No. 10541: Bear River formation, 9 miles SE of Evanston, Wyoming. J. HENDERSON and E.S. SMITH Coll.).

Veloritina cleburni (WHITE)

Figs. 10a and 10b. Left external and internal casts (No. 12770: Laramie formation, E. of Osgood, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 11. Left valve (No. 17770: Laramie formation, Weld, Colorado. H.A. AURAND Coll.).
Fig. 12. Right internal cast (No. 12681: Laramie formation, E. of Cornish, Colorado. J. HENDERSON and E.G. SMITH Coll.).
Fig. 13. Shows a lunule (No. 13554: Laramie formation, E. of Cornish, Colorado. J. HENDERSON and E.G. SMITH Coll.).

Veloritina occidentalis (MEEK and HAYDEN)

Fig. 14. Right internal mould (No. 11643: Fruitland formation, NW of Fruitland, San Juan Co., N. Mexico. H.S. AURAND and D.E. LOUNSBERRY Coll.).
Fig. 15. Left valve (No. 2390: Mesa Verde formation, W. of Meeker, Colorado. J. HENDERSON Coll.).
Fig. 16. Left internal mould (No. 17830: Laramie formation, E. of Fosston, Colorado. J. HENDERSON Coll.).
Fig. 17. Right valve (No. 7913: Lance formation, Dru Creek, SE of Torrinton Goshen Co., Wyoming. H.A. AURAND Coll.).
Fig. 18. Left internal mould (No. 11643).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WHITE, C.A. (1878a): Contributions to invertebrate paleontology. no. 4: Fossils of the Laramie group. *Hayden Survey, 12th Ann. Rept.*, pt. 1, p. 72-80, pls. 21-25.

—— (1878b): Description of new species of invertebrate fossils from the Laramie group. *Bull. U.S. Geol. Geogr. Survey, Terr.*, 4, p. 707-719.

—— (1879a): Contributions to invertebrate paleontology, no. 1: Cretaceous fossils of the western States and Territories. *U.S. Geol. Geogr. Survey, Terr., 11th Ann. Rept.*, p. 273-319.

—— (1879b): Report on the paleontological field-work for the season of 1877. *U.S. Geol. Geogr. Survey, Terr., 11th Ann. Rept.*, p. 161-272.

—— (1882): New molluscan form from the Laramie and Green River groups, with discussion of some associated forms here-to fare known. *Proc. U.S. Nat. Museum*, vol. 5, p. 94-99, pls. 3-4.

—— (1883a): Contributions to invertebrate paleontology. no. 4. Fossils of the Laramie group. *U.S. Geol. Survey, Terr., 12th Ann. Rept.*, pt. 1, p. 49-103.

—— (1883b): A review of the non-marine fossil Mollusca of North America. *U.S. Geol. Survey, 3rd Ann. Rept.*, p. 409-550, pls. 1-32.

—— (1891): Correlation papers. Cretaceous. *U.S. Geol. Survey, Bull.* 82.

—— (1895): The Bear River formation and its characteristic fauna. *U.S. Geol. Survey, Bull.* 128, p. 1-108.

WHITEAVES, J.F. (1885): Contributions to Canadian paleontology. *Can. Geol.* and *Nat. Hist. Surv.*, vol. 1, pt. 1.

—— (1895): Notes on some of the Cretaceous fossils collected during Captain PALLISER's explorations in British North America in 1857-60. *Roy. Soc. Canada, Trans. sect.* 4, p. 101-117.

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 79, pp. 316-336, pls. 35, 36, Sept. 30, 1970

569. MIOCENE BRYOZOA FROM SOUTHWEST HOKKAIDO, JAPAN*

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西南北海道からの中新世こけ虫：従来，日本の中新世こけ虫化石についての報告はないが，今回北海道瀬棚郡今金町北東に位置する貝殻橋砂岩部層（訓縫層）から多産するこけ虫化石を採集する機会を得たのでここに報告する。30属39種を同定し記載した。古環境，地質時代については今後の研究に待つところが多い。　　速水倶子

During stratigraphical work in the Imagane-cho area in the southwestern part of Hokkaido in the summers of 1967 and 1968, the writer was fortunate in collecting abundant specimens of Bryozoa from the Kaigarabashi Sandstone Member of the Kunnui Formation (SAWADA, 1962). These bryozoan specimens, the first record of Miocene Bryozoa from Hokkaido, from the scope of the present article. The stratigraphic position of the Kaigarabashi Sandstone Member is shown in Table 1.

The locality of the fossil bryozoan specimens is the stream cliff of the Tane-gawa immediately northeast of the Kaigarabashi bridge. At this locality richly fossiliferous sandstone facies are exposed; the fossils are mostly scallops (T. NAGAO and Y. SASA, 1934; K. KUBOTA, 1950; K. MASUDA and Y. SAWADA, 1961; S. KANNO, 1962), which occur with the valves detached or intact, and in both cases the shells are generally parallel with the bedding. The bryozoan specimens show two modes of occurrence, one is attached to the valves of the molluscan shells, and the other is as isolated broken stems, branches or fragments of encrusting forms. Their preservation is good as shown in the annexed plates.

The bryozoans identified from the Kaigarabashi Sandstone Member of the Kunnui Formation are listed in Table 2.

From the bryozoan species listed in Table 2, it is evident that the fauna is interesting in yielding species hitherto known only from the Paleogene of North America, a few that have been recorded from the Neogene of New Zealand, many that extend their geographical distribution to low latitudes, some that have been known only from the temperate seas of the North Pacific, besides a few cosmopolitan species. This suggests that the Bryozoa fauna of the Kaigarabashi Sandstone Member may be a mixed one, due either to the mixing of warm and temperate waters at the particular geographical position, or to the possibly changing paleogeographical conditions of the sea area at that time. However, it is also to be kept in mind that since our present knowledge con-

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Table 1. Stratigraphic classification of the rocks distributed in the Setana-Imagane area in southwest Hokkaido (after SAWADA, Y., 1962).

Age	Formation	Thickness (in meters)
Holocene	Alluvial Deposits	
Pleistocene	Lower Terrace Deposits	15 - 20
	Higher Terrace Deposits	20 - 25
Late Pliocene	Minamitoshibetsu Formation	150 - 250
Early Pliocene	Chinkope Formation	150 - 180
	Hanaishi Conglomerate Member	
Late Miocene	Kuromatsunai Formation	100 - 400
Early Miocene	Yakumo Formation	0 - 700
	Kaigarabashi Sandstone Member / Kayano Rhyolite Member	30 - 1150
	Kunnui Formation	
	Chinkopegawa Andesitic Agglomerate Member	
	Kitaizawa Conglomerate Member	
Pre-Tertiary	Pre-Tertiary Basements	

serning the Miocene and Pliocene bryozoan fauna of Japan is inadequate, the peculiarities of the fossil fauna may be only apparent. It is thought that any conclusions concerning the determination of the geological age and correlation of the fauna with other areas, should wait further studies on the bryozoan fauna of Japan. Thus the purpose of the present article is to record the bryozoan fauna from the Kunnui Formation.

The bryozoan fauna as a whole represents a shallow water assemblage judged to be not far from land, and one that lived in clear water and on a clean bottom, that is to say, free from the deposition of muddy sediments. The thermal conditions of the sedimentary basin are thought to have been temperate to warm so far as can be judged from the known geographical distributions of the species identified.

The geological age of the Kaigarabashi Sandstone Member inferred from the scallops is Early Miocene according to the morphogenesis of *Nanaochlamys notoensis* (YOKOYAMA) studied by K. MASUDA (1960), and from the pectinids described by K. MASUDA and Y. SAWADA (1961).

At this place the writer wishes to

Table 2. Bryozoan species identified from the Kaigarabashi Sandstone Member of the Kunnui Formation.

Genus and species	Distribution
Callopora corniculifera (HINCKS)	Recent, California (11–70 m). Pleistocene of California
Callopora aurita (HINCKS)	Recent, Alaska (229 m) and both sides of North Atlantic
Callopora cf. *whiteavesi* NORMAN	Recent, Alaska (0–22 m)
Crassimarginatella kumatae (OKADA)	Recent, Straits of Corea (97–110 m) and Japan (tidal zone to shallow water)
Pyrulella corbula (HINCKS)	Recent, Australia (tidal zone-50 m), New Zealand, East Indian Ocean to Japan. Pleistocene of New Zealand, Kikai-jima and Chiba
Membraniporidra sp. A.	
Tegella aquilirostris (O'DONOGHUE)	Recent, British Columbia
Tegella robertsonae O'DONOGHUE and O'DONOGHUE	Recent, Alaska to California. Pleistocene of Chiba
Tegella unicornis (FLEMING)	Recent, North Pacific from Alaska to California and North Atlantic
Hincksina cf. *periporosa* CANU and BASSLER	Recent, Cuba (261–368 m), Gulf of Mexico (55 m) and Florida Strait (102 m)
Ellisina levata (HINCKS)	Recent, British Columbia (27–37 m) and California (49 m)
Cauloramphus (?) sp. A.	
Onychocella subsymmetrica CANU and BASSLER	Recent, Philippine Islands (35–439 m). Pleistocene of Kikai-jima and Chiba
Micropora coriacea (JOHNSTON)	Recent, Cosmopolitan. Eocene of North Carolina. Miocene of New Zealand. Pleistocene of Chiba
Verminaria areolae SAKAKURA	Pleistocene of Chiba
Microporina articulata (FABRICIUS)	Recent, Cape Tsuika, Japan Sea, off Torishima, Paramushir Island, California, Greenland, and Queen Charlotte Island. Miocene of Noto (Ishikawa) and Hokkaido. Pliocene of Sado (Niigata)
Monoporella fimbriata CANU and BASSLER	Recent, Philippine Islands (35–439 m). Pleistocene of Kikai-jima and Chiba
Cellaria diffusa ROBERTSON	Recent, Galapagos Islands (55 m), according to OSBURN (1950), the known vertical distribution is from shore to 216 m. Pleistocene of California
Figularia cf. *carinata* (WATERS)	Recent, New Zealand. Pliocene of New Zealand
Figularia crassicostulata CANU and BASSLER	Eocene of Florida
Jullienulla sp. A.	
Jullienulla sp. B.	
Membraniporella cf. *bicornis* CANU and LECOINTRE	Miocene of Touraine, France
Reginella nitida OSBURN	Recent, Southern California
Puellina setosa (WATHRS)	Recent, Oregon (37–110 m), Madeila and Naples, British Columbia, and British Islands
Hippothoa fragellum MANZONI	Recent, Pacific coast from Mexico to Panama, Columbia, Peru and Galapagos Islands (shallow water to 183 m). Pliocene of Italy and New Zealand

Table 2. (Continued)

Umbonula arctica (SARS)	Recent, Arctic Ocean to Massachusetts and Capo Cod, and on Pacific coast to Puget Sound
Dakaria subtorquata (D'ORBIGNY)	Recent, Cosmopolitan (tidal zone to 223 m). Miocene of France
"*Schizoporella*" *scissa* BROWN	Recent, San Benito Island (126 m). Miocene of New Zealand
Microporella ciliata (PALLAS)	Recent, Cosmopolitan (shore to 162 m). Miocene of Florida, Maryland and North Carolina. Pleistocene of California and Chiba
Microporella lunifera (HASWELL)	Recent of Queensland, Australia
Microporella sp. A.	
Eurystomella bilabiata (HINCKS)	Recent, Pacific coast of California and Queen Charlotte Island, Japan Sea (151 m). Pleistocene of California and Chiba
Mucronella labiata LEVINSEN	Recent, Cara Sea to Greenland, and Alaska (33 m)
Parasmittina sp. A.	
Rhamphostemella hincksi NORDGAARD	Recent, Greenland, Iceland, and Alaska (46 m)
Rhamphostomella spinigella LORENZ	Recent, Alaska (33–51 m)
Porella acutirostris SMITT	Recent, Pacific, north of southern California, Atlantic coast as far south as Cape Cod (shallow water to 110 m)
Perigastrella rectilineata CANU and BASSLER	Eocene of North Carolina and Mississippi. Oligocene of Alabama

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Descriptions and Remarks on the Bryozoa

Phylum Bryozoa EHRENBERG, 1831

Order Cheilostomata BUSK, 1852

Family Calloporidae NORMAN, 1903

Genus *Callopora* GRAY, 1848

Callopora corniculifera (HINCKS), 1884

Pl. 35, fig. 9

1923. ? *Cauloramphus triangularis* CANU and BASSLER, p. 48, pl. 33, figs. 14–16.
1950. *Callopora corniculifera* (HINCKS); OSBURN, p. 66, pl. 7, fig. 1.
1957. *Callopora corniculifera* (HINCKS); SOULE and DUFF, p. 94.

Description: Zoarium encrusting shell fragments. Zooecia ovate, distal part slightly rounded. Gymnocyst as much as one-third of zooecial length, cryptocyst narrow, descending, delicately crenated. Opecia oval, narrower at distal end. Spines usually 7 to 8 on each side of mural rim. Avicularia minute, sessile, on outer side of mural rim. Ovicell hyperstomial, prominent, globular, and

smooth.

Affinities: The present specimen resembles *C. corniculifera*, but can be distinguished from it by the smaller measurements.

Measurements (in mm):

Zooecia; Lz=0.44
Wz=0.32
Ovicell; hov=0.20
wov=0.26
Opecia; lop=0.20-0.28
wop=0.16

Depository: IGPS* coll. cat. no. 86721.

Callopora aurita (HINCKS), 1877

Pl. 35, fig. 15

1920. *Callopora aurita* (HINCKS); CANU and BASSLER, p. 152, pl. 29, fig. 2.
1950. *Callopora aurita* (HINCKS); OSBURN, p. 65, pl. 7, fig. 2.

Description: Zoarium encrusts shell fragments. Zooecia distinct, ovate, narrower with distal part; walls high and strongly calcified. Gymnocyst small, less than one-third zooecial length. Spines usually two on each side, but occasionally wanting. Avicularia present on each side of operculum, sessile; ovicell hyperstomial, rounded, more or less immersed, with one pair of avicularia, but usually wanting.

Measurements (in mm):

Zooecia; Lz=0.60
Wz=0.52
Ovicell; hov=0.12
wov=0.10
Opecia; lop=0.44
wop=0.32

Depository: IGPS coll. cat. no. 86772.

Callopora cf. *whiteavesi* NORMAN, 1903

Pl. 35, fig. 10

1950. *Callopora whiteavesi* NORMAN; OSBURN, p. 70, pl. 6, fig. 6.

Description: Zoarium encrusts shell fragments. Zooecia distinct, separated by deep furrow, elongated ovate; gymnocyst developed, smooth. Mural rim broad, bearing 6 to 7 spines at each side, small ovate, prominent at distal part. Septulae wanting. Dietellae three at each distal side wall. Ovicell hyperstomial, globular, prominent, smooth, with triangular area at front.

Measurements (in mm):

Zooecia; Lz=0.52
Wz=0.32
Ovicell; hov=0.22
wov=0.24
Opecia; lop=0.38
wop=0.20

Depository: IGPS coll. cat. no. 86723.

Affinities: The present specimen resembles *C. whiteavesi* in measurements, zooecial shape etc., but is distinguishable therefrom by the presence of avicularia.

Genus *Crassimarginatella* CANU, 1900

Crassimarginatella kumatae (OKADA), 1923

Pl. 35, fig. 21

1923. *Membranipora kumatae* OKADA, p. 223, figs. 19, 20.
1926. *Crassimarginatella kumatae* (OKADA); HARMER, p. 224.
1958. *Crassimarginatella kumatae* (OKADA); ANDROSOVA, p. 105, fig. 14.
1965. *Crassimarginatella kumatae* (OKADA); MAWATARI, p. 602, fig. 55a.

Description: Zoarium incrusts shell fragments. Zooecia distinct. Opecia oval or somewhat angular; mural rim slightly elevate, without spines. Gym-

IGPS*=abbreviation for Institute of Geology and Paleontology, Tohoku University, Sendai.

nocyst small and smooth. Walls high, and calcified. Septulae and dietellae wanting. Interzooecial avicularium a little smaller than ovicelled zooecia—non-ovicelled zooecia rare—, elliptical, with a pivot, mural rim of avicularia elevated from zooecia gymnocyst and separated from surrounding zooecia by a shallow furrow. Ovicell hyperstomial, globular, very prominent, granular.

Measurements (in mm):

Zooecia;	Lz=0.38
	Wz=0.32
Ovicell;	hov=0.22
	wov=0.32
Opecia;	lop=0.32-0.34
	wop=0.22-0.24
Interzooecial avicularium;	lav=0.28
	wav=0.24

Depository: IGPS coll. cat. no. 86724.

Pyrulella corbula (HINCKS), 1880

Pl. 35, fig. 11

1926. *Pyaulella corbula* (HINCKS); HARMER, p. 225, pl. 14, fig. 4.
1929. *Pyrulella pyrula* HINCKS, variety; CANU and BASSLER, p. 100, pl. 5, fig. 11.
1935a. *Pyrulella corbula* (HINCKS); SAKAKURA, p. 7, pl. 1, fig. 4.
1952. *Crassimarginatella corbula* (HINCKS); BROWN, p. 55, fig. 112.
1960a. *Crassimarginatella corbula* (HINCKS); KATAOKA, p. 230, pl. XXVI, fig. 8.
1965. *Pyrulella corbula* (HINCKS); MAWATARI, p. 601, text-figs. 53a, b.

Description: Zoarium incrusts shell fragments. Zooecia distinct, separated by a furrow. Opecium oval. Gymnocyst developed, about one-third of zooecium length. Cryptocyst rather broad. Mural rim with 5 or 4 spines on each side. Avicularia and septulae wanting. Dietellae present. Ovicell hyperstomial, prominent, large, smooth.

Measurements (in mm):

Zooecia;	Lz=0.68
	Wz=0.62
Ovicell;	hov=0.24
	wov=0.24
Opecia;	lop=0.32
	wop=0.24

Depository: IGPS coll. cat. no. 86725.

Genus *Membraniporidra* CANU and BASSLER, 1917

Membraniporidra sp. A.

Pl. 35, fig. 20

Description: Zoarium incrusts shell fragments. Zooecia distinct, separated by a furrow. Gymnocyst small. Opecia oval or elongated. No dietellae, no spines. One septulum present in distal wall. No avicularia. Ovicell hyperstomial, large and prominent, smooth.

Measurements (in mm):

Zooecia;	Lz=0.62-0.80
	Wz=0.40-0.56
Ovicell;	hov=0.28
	wov=0.40-0.48
Opecia;	lop=0.40-0.60
	wop=0.32-0.36

Depository: IGPS coll. cat. no. 86772.

Affinities: The present specimen resembles *M. porosa* OSBURN, 1950, but differs from it by the smaller measurements.

Genus *Tegella* LEVINSEN, 1909

Tegella aquilirostris (O'DONOGHUE), 1923

Pl. 35, fig. 23

1950. *Tegella aquilirostris* (O'DONOGHUE); OSBURN, p. 83.

Description: Zoarium incrusts shell fragments. Zooecia distinct. Gymnocyst vestigial or wanting. Opecia oval;

mural rim very narrow, bearing one pair spines at distal part. Ovicell hyperstomial, triangular in shape. Septulae present. Dietellae wanting.

Depository: IGPS coll. cat. no. 86773.

Tegella robertsonae O'DONOGHUE and O'DONOGHUE, 1926

Pl. 35, fig. 22

1935a. *Tegella robertsoni* O'DONOGHUE and O'DONOGHUE; SAKAKURA, p. 8, pl. 1, fig. 5.
1950. *Tegella robertsonae* O'DONOGHUE; OSBURN, p. 81, pl. 9, fig. 5.
1957. *Tegella robertsonae* (O'DONOGHUE and O'DONOGHUE); SOULE and DUFF, p. 95.

Description: Zoarium incrusts shell fragments. Zooecia distinct, separated by a shallow furrow. Gymnocyst vestigial or wanting. Cryptocyst very small and heavy crenated. Mural rim rather broad, bearing one to 3 spines on each side. Especially distal one pair of spines stout. Two septulae present at lateral wall. Dietellae wanting. Avicularia paired, one very large, sharp triangular, other small and sometimes wanting. Ovicell hyperstomial at distal part of zooecia.

Measurements (in mm):

Zooecia; Lz=0.66
Wz=0.36-0.38
Opecia; lop=0.34-0.40
wop=0.24-0.32

Depository: IGPS coll. cat. no. 86774.

Remarks: OSBURN's quoting of the author of this species seems to be a typographical error for O'DONOGHUE and O'DONOGHUE.

Tegella unicornis (FLEMING), 1828

Pl. 35, fig. 18

1935b. *Tegella unicornis* (FLEMING); SAKAKURA, p. 107.
1936. *Tegella unicornis* (FLEMING); OSBURN, p. 541.
1950. *Tegella unicornis* (FLEMING); OSBURN, p. 78, pl. 9, fig. 2.
1965. *Tegella unicornis* (FLEMING); MAWATARI, p. 601, fig. 52a.

Description: Zoarium incrusts shell fragments. Zooecia distinct, ovate, separated by a furrow. Gymnocyst almost wanting. Mural rim rather broad, bearing one or two paired spines at distal end; more anterior pair small, often wanting. Avicularium very large at distal end. Ovicell hyperstomial, prominent, with triangular rib in front. Septulae wanting.

Measurements (in mm):

Zooecia; Lz=0.92
Wz=0.68
Opecia; lop=0.52
wop=0.48

Depository: IGPS coll. cat. no. 86775.

Family Hincksinidae CANU and BASSLER, 1927

Genus *Hincksina* NORMAN, 1903

Hincksina cf. *periporosa* CANU and BASSLER, 1928

Pl. 35, fig. 14

1928. *Hincksina periporosa* CANU and BASSLER, p. 22, pl. 2, figs. 8-11.

Description: Zoarium incrusts shell fragments. Zooecia distinct, separated by a deep furrow, surrounded by a line of interjunctural pores, oval. Gymnocyst small, smooth. Mural rim very thin and bears 4 to 5 spines on each side. Septulae and dietellae wanting. No avicularia. Ovicell hyperstomial,

small. There are pyriform zooeciules between the zooecia; their appearance is sporadic.

Measurements (in mm):

Zooecia; Lz=0.44
Wz=0.30
Opecia; lop=0.34
wop=0.16

Depository: IGPS coll. cat. no. 86776.

Genus *Ellisina* NORMAN, 1903

Ellisina levata (HINCKS), 1882

Pl. 35, fig. 8

1933. *Ellisinidra levata* HINCKS; CANU and BASSLER, p. 19.
1950. *Ellisina levata* (HINCKS); OSBURN, p. 50, pl. 4, fig. 4.

Description: Zoarium incrusts shell fragments. Zooecia distinct, separated by a furrow, ovate, a little elongate. Mural rim narrow, not bearing spines. Gymnocyst small. Septulae and dietellae both present. Interzooecial avicularia small, triangular. Ovicell hyperstomial, prominent, smooth.

Affinities: The present specimens resembles *E. brevis* CANU and BASSLER, 1920, but differs from it in the smaller measurements.

Measurements (in mm):

Zooecia; Lz=0.44
Wz=0.32
Ovicell; hov=0.18
wov=0.20
Opecia; lop=0.36
wop=0.30

Depository: IGPS coll. cat. no. 86777.

Genus *Cauloramphus* NORMAN, 1903

Cauloramphus ? sp.

Pl. 35, fig. 17

Description: Zoarium incrusts shell fragments. Zooecia distinct, separated by deep grooves, and pores. Opecia ovate, narrower at distal part. Mural rim rather broad, bearing 4 to 6 spines on each side. Gymnocyst small, vestigial. Septulae and dietellae both present. No avicularia.

Affinities: The present specimen is ill-preserved, and no avicularia are seen, thus the doubts whether the present specimens belong to *Cauloramphus*.

Measurements (in mm):

Zooecia; Lz=0.68–0.76
Wz=0.46–0.56
Opecia; lop=0.52–0.58
wop=0.28–0.40

Depository: IGPS coll. cat. no. 86778.

Family Onychocellidae JULLIEN, 1881

Genus *Onychocella* JULLIEN, 1882

Onychocella subsymmetrica CANU and BASSLER, 1929

Pl. 36, fig. 18

1929. *Onychocella subsymmetrica* CANU and BASSLER, p. 124, pl. 12, figs. 7, 8, text-fig. 30.
1935a. *Onychocella subsymmetrica* CANU and BASSLER; SAKAKURA, p. 10, pl. II, fig. 1.
1960a. *Onychocella subsymmetrica* CANU and BASSLER; KATAOKA, p. 233, pl. XXVIII, fig. 3.
1965. *Onychocella subsymmetrica* CANU and BASSLER; MAWATARI, p. 603, text-figs. 59c, d.

Description: Zoarium incrusts shell fragments, unilamellar or bilamellar. Zooecia distinct, united at their mural rim, hexagonal. Mural rim thick and salient. Cryptocyst flat and deep, granular, shorter than opecium. Opecium semielliptical, very close to mural rim; proximal border somewhat concave.

Onychocellarium narrow and elongate, a little longer than zooecia length.

Measurements (in mm):

Zooecia;	Lz=0.48
	Wz=0.40
Opecia;	lop=0.20-0.28
	wop=0.20-0.24
Onychocellarium;	Lon=0.65
	Won=0.36
Opecia of onychocellarium;	hoo=0.16-0.14
	woo=0.08

Depository: IGPS coll. cat. no. 86779.

Family Microporidae HINCKS, 1880

Genus *Micropora* GRAY, 1848

Micropora coriacea (JOHNSTON), 1847

Pl. 36, fig. 19

1923. *Micropora coriacea* ESPER; CANU and BASSLER, p. 58.
1927. *Micropore coriacea* (ESPER); CANU and BASSLER, p. 7, pl. 1, fig. 6.
1935a. *Micropora coriacea* (ESPER); SAKAKURA, p. 11, pl. 2, fig. 8.
1952. *Micropora coriacea* (ESPER); OSBURN, p. 105, pl. 11, fig. 3.
1952. *Micropora coriacea* (JOHNSTON); MAWATARI, p. 274, text-fig. 9.
1952. *Micropora coriacea* (JOHNSTON); BROWN, p. 126, text-fig. 74.
1960b. *Micropora coriacea* (ESPER); KATAOKA, p. 396.
1965. *Micropora coriacea* (JOHNSTON); MAWATARI, p. 603, text-fig. 61a.

Description: Zoarium incrusts shell fragments, bilamellar or unilamellar. Zooecia distinct, separated by salient, thickened walls, hexagonal or diamond shaped, arranged quincuncially in a radiating mosaic fashion. Aperture semicircular, situated at distal extremity of zooecium, its proximal lip straight. Frontal cryptocyst granulated, depressed, rising sharply at proximal lip of aperture, punctured by two small opeciulae. Gymnocyst very narrow or wanting. Avicularia and ovicell not found.

Measurements (in mm):

Zooecia;	Lz=0.56
	Wz=0.44
Aperture;	hap=0.12
	wap=0.20

Depository: IGPS coll. cat. no. 86780.

Remarks: *Micropora coriacea* ascribed to the authorship of ESPER and so used by many previous authors, should be changed to JOHNSTON, because ESPER's original *Flustra coriacea* represents a species different from the present one, as pointed out by BROWN (1952, p. 126).

Genus *Verminaria* JULLIEN, 1888

Verminaria areolae SAKAKURA, 1935

Pl. 35, fig. 4

1935a. *Verminaria areolae* SAKAKURA, p. 12, pl. II, fig. 5, text-fig. 3.
1936. *Microporina areolae* (SAKAKURA); SAKAKURA, p. 264.

Description: Zoarium incrusts shell fragments or stones. Zooecia distinct, elongated oblong, separated by a furrow. Frontal cryptocyst, depressed, almost flat, finely granulated; perforated marginally by a few areolar pores and two opeciules. Aperture transverse, semielliptical with straight proximal border. Peristome rather thin and smooth. Avicularium elliptical, with pivot and above aperture.

Measurements (in mm):

Zooecia;	Lz=0.88
	Wz=0.40
Aperture;	hap=0.08
	wap=0.16

Depository: IGPS coll. cat. no. 86781.

Remarks: Being provided with many

opeciules, SAKAKURA placed this species in *Verminaria* (1935a), but later (1936) he transfered it to *Microporina*, because of the presence of avicularia and the wanting of ovicell. But according to the writer's interpretation of *Microporina*, the genus is characterized by having "zoarium erect, jointed segments". Thus, she is in doubt whether the present specimen which is identical with SAKAKURA's *areolae*, can be placed in *Microporina*, and at present retains it in the genus *Verminaria*.

Genus *Microporina* LEVINSEN, 1909

Microporina articulata (FABRICIUS), 1828

Pl. 35, figs. 1, 2

1929. *Microporina japonica* CANU and BASSLER, p. 139, pl. 14, figs. 9-11.
1936. *Microporina articulata* (FABRICIUS); SAKAKURA, pp. 259-267, pl. 15, figs. 1-9.
1956. *Microporina articulata* (FABRICIUS); MAWATARI, p. 120.
1958. *Microporina articulata* (FABRICIUS); ANDROSOVA, p. 125.
1965. *Microporina articulata* (FABRICIUS); MAWATARI, p. 603, figs. 62a, b.

Description: Zoarium erect, cylindrical, of jointed segments, branching formed of 10 rows of zooecia. Zooecia large, elongate; frontal almost covering thick ectocyst. Porous cryptocyst under ectocyst. These pores fill the whole front almost to operculum. Aperture nearly semicircular; distal to aperture; an oval avicularium. No ovicell.

Measurements (in mm):

Zooecia;	Lz	0.88-1.32
	Wz	0.36
Aperture;	hap	0.12
	wap	0.22

Depository: IGPS coll. cat. no. 86782.

Family Aspidostomatidae JULLIEN, 1888

Genus *Monoporella* HINCKS, 1881

Monoporella fimbriata CANU and BASSLER, 1927

Pl. 36, fig. 16

1927. *Monoporella fimbriata* CANU and BASSLER, p. 4, pl. 1, fig. 2.
1929. *Monoporella fimbriata* CANU and BASSLER; CANU and BASSLER, p. 156, pl. 17, figs. 6-11.
1935a. *Monoporella fimbriata* CANU and BASSLER; SAKAKURA, p. 15, pl. IV, fig. 1.
1960a. *Monoporella fimbriata* CANU and BASSLER; KATAOKA, p. 239, pl. XXXV, fig. 10.

Description: Zoarium incrusts shell fragments. Zooecia distinct, separated by a furrow, very large hexagonal. Front, with cryptocyst, shallow, convex, sometimes carinated, cover with tremopores and with granules; mural rim salient, thick, round, growing thin towards base; proximal border straight and bearing two small lateral indentations. Ovicell very large, prominent, globular, smooth, buried in distal zooecium, surrounded by costules.

Measurements (in mm):

Zooecia;	Lz	0.92-1.12
	Wz	0.68-0.72
Aperture;	hap	0.12
	wap	0.20

Depository: IGPS coll. cat. no. 86783.

Family Cellariidae HINCKS, 1880

Genus *Cellaria* ELLIS and SOLANDER, 1786

Cellaria diffusa ROBERTSON, 1905

Pl. 35, fig. 16

1923. *Cellaria fissurifera* CANU and BASSLER,

p. 85, pl. 34, figs. 15-18.

1950. *Cellaria diffusa* ROBERTSON; OSBURN, p. 117, pl. 12, fig. 9.

1957. *Cellaria diffusa* ROBERTSON; SOULE and DUFF, p. 101.

Description: Zoarium free, cylindrical, articulated, segment. Internode long, formed of 15 or 16 rows of zooecia. Zooecia separated by a slight prominent wall, of elongate hexagonal shape. Aperture semilunar, surrounded by a thin peristome and a pair of teeth of proximal margin of aperture. Cryptocyst flat. Avicularium almost as large as ordinary zooecium or sometimes larger than zooecium, its opecium somewhat round. Ovicell endotoichal, covered by a lamella, convex and transverse, presents at distal margin.

Measurements (in mm):

Zooecia;	Lz=0.50
	Wz=0.28
Aperture;	hap=0.10
	wap=0.16

Depository: IGPS coll. cat. no. 86784.

Family Cribrilinidae HINCKS, 1880

Genus *Figularia* JULLIEN, 1886

Figularia cf. *carinata* (WATERS), 1923

Pl. 35, figs. 3, 19

1952. *Figularia carinata* (WATHRS); BROWN, p. 185, text-figs. 129, 130.

Description: Zoarium incrusts shell fragments. Zooecia hexagonal or ovate. Frontal shield formed of 4 to 5 pairs of costae; lacunar pores rounded. Aperture rough quadrangular. No oral spines, no dietellae. Avicularium interzooecial, spatulate, with pivot, almost as large as zooecial length. Ovicell hyperstomial, rounded, prominent, and with two oeciopores on frontal.

Measurements (in mm):

Zooecia;	Lz=0.42
	Wz=0.40
Aperture;	hap=0.10
	wap=0.20
Interzooecial avicularium;	hav=0.48
	wav=0.16

Affinities: The present specimen resembles *F. carinata*, but differs from it in the presence of large interzooecial avicularium, and by the larger measurements.

Depository: IGPS coll. cat. no. 86785.

Figularia crassicostulata CANU and BASSLER, 1920

Pl. 36, fig. 12

1920. *Figularia* (?) *crassicostulata* CANU and BASSLER, p. 316, pl. 43, fig. 9.

Description: Zoarium incrusts shell fragments. Zooecia distinct. Frontal shield formed of 7 to 8 pairs of costae. Lacunar pores rounded and large, 5 to 6 on one line. No avicularia, ovicell, dietellae, or spines.

Measurements (in mm):

Zooecia;	Lz=0.68
	Wz=0.40
Aperture;	hap=0.06
	wap=0.16

Depository: IGPS coll. cat. no. 86786.

Genus *Jullienula* BASSLER, 1953

Jullienula sp. A.

Pl. 35, figs. 12, 13

Description: Zoarium encrusts shell fragments. Zooecia large, and furrow distinct, deep. Frontal of 7 to 8 pairs of costae. Lacunar pores slit-like, 6 to 8 on one line. No dietellae. Ovicell not found. Aperture inverted, lyriform, without oral spines; proximal border

almost straight, cardelles present. Interzooecial avicularium large and sporadic.

Measurements (in mm):

Zooecia; Lz=0.92
Wz=0.56
Aperture; hap=0.20
wap=0.18

Depository: IGPS coll. cat. no. 86787.

Remarks: This and next species may represent undescribed forms, but naming is avoided at present because of the lack of specimens for a comparative study.

Jullienula sp. B.

Pl. 35, fig. 7

Description: Zoarium encrusts shell fragments. Zooecia distinct. Frontal of 4 or 5 pairs of costae; apertural bar stout, very thick, triangular on each side. Lacunar pores obscured, lumen pores large and clear, 1-2 on one costae. Aperture inverted, lyriform, without oral spines; proximal border almost straight and cardelles present. Hyperstomial ovicell surrounded with slit-like pores. Avicularia not seen.

Measurements (in mm):

Zooecia; Lz=0.60
Wz=0.40
Ovicell; hov=0.36
wov=0.28
Aperture; hap=0.12
wap=0.12

Depository: IGPS coll. cat. no. 86788.

Genus *Membraniporella* SMITT, 1873

Membraniporella cf. *bicornis* CANU and LECOINTRE, 1927

Pl. 36, fig. 17

1927. *Membraniporella bicornis* CANU and LECOINTRE, p. 25, pl. VII, fig. 1.

Description: Zoarium encrusts shell fragments. Zooecia moderately large and distinct, separated by deep grooves. Frontal arched, formed of 5 to 6 pairs of costae. Apertural bar almost cylindrical shaped. No avicularia, ovicell, spines, or dietellae.

Measurements (in mm):

Zooecia; Lz=0.80
Wz=0.60

Affinities: The present specimen resembles *M. bicornis*, but differs from it in being larger in measurements.

Depository: IGPS coll. cat. no. 86789.

Genus *Reginella* JULLIEN, 1886

Reginella nitida OSBURN, 1950

Pl. 36, fig. 9

1950. *Reginella nitida* OSBURN, p. 181, pl. 28, fig. 1.

Description: Zoarium incrusts shell fragments. Zooecia moderately large, distinct. Frontal formed of 6 to 8 pairs of costae. Lacunar pores rounded and large, 6 on one line. No spines, no avicularia and no dietellae. Ovicell hyperstomial and large. Proximal border of aperture thick. Aperture semicircular.

Measurements (in mm):

Zooecia; Lz=0.64
Wz=0.40-0.48
Ovicell; hov=0.36
wov=0.36
Aperture; hap=0.08-0.10
wap=0.20

Depository: IGPS coll. cat. no. 86790.

Genus *Puellina* JULLIEN, 1886

Puellina setosa (WATERS), 1899

Pl. 35, fig. 5

1950 *Puellina setosa* (WATERS); OSBURN, p.

186, pl. 29, fig. 4.

Description: Zoarium incrusts shell fragments. Zooecia small, but with much variation, shorter than zooecia but may be as broad as long, their inflated costate areas cause them to appear very distinct. Mural rim bearing 6 to 8 spines; their lateral pairs stout. No avicularia. Ovicell hyperstomial and center of it very prominent. Dietellae and septulae both present.

Measurements (in mm):

Zooecia;	Lz	=0.44
	Wz	=0.32
Ovicell;	hov	=0.16
	wov	=0.28
Aperture;	hap	=0.04
	wap	=0.08

Depository: IGPS coll. cat. no. 86791.

Family Hippothoidae LEVINSEN, 1909

Genus *Hippothoa* LAMOUROUX, 1821

Hippothoa flagellum MANZONI, 1870

Pl. 35, fig. 6

1929. *Hippothoa flagellum* MANZONI; CANU and BASSLER, p. 247, pl. 22, fig. 7.
1935a. *Hippothoa flagellum* MANZONI; SAKAKURA, p. 18.
1935b. *Hippothoa flagellum* MANZONI; SAKAKURA, p. 110.
1952. *Hippothoa distans* MACGILLIVRAY; BROWN, p. 203, text-fig. 142.
1952. *Hippothoa flagellum* MANZONI; OSBURN, p. 278, pl. 30, figs. 7, 8.
1965. *Hippothoa distans* MACGILLIVRAY; MAWATARI, p. 612, text-figs. 92a-c.

Description: Zoarium incrusts shell fragments, or other bryozoa; uniserial, with lateral branches. Zooecia elongate ovate, without dorsal expansion; aperture ovate, with a round sinus in the proximal border. Ovicell hyperstomial, short. No avicularia.

Measurements (in mm):

Zooecia;	Lz	=0.40
	Wz	=0.24
Ovicell;	hov	=0.24
	wov	=0.18

Depository: IGPS coll. cat. no. 86792.

Family Umbonulidae CANU, 1904

Genus *Umbonula* HINCKS, 1880

Umbonula arctica (SARS), 1851

Pl. 36, fig. 13

1933. *Discopora pavonella* ALDER; OKADA, p. 215.
1952. *Umbonula arctica* (SARS); OSBURN, p. 299, pl. 36, fig. 6.
1956. *Umbonula arctica* (SARS); MAWATARI, p. 124.
1958. *Umbonula arctica* (SARS): ANDROSOVA, p. 167, text-fig. 97.

Description: Zoarium incrusts shell fragments. Zooecia roughly quadrangular; frontal area nearly flat, with a row of areolae pores. Aperture rather straight on proximal border; peristome thin, sometimes scarcely visible; on the proximal border where it projects forward as a short, broad mucro. Both sides of aperture with oval avicularium, very slightly elevated. No ovicell, oral spines, or cardelles.

Measurements (in mm):

Zooecia;	Lz	=0.56
	Wz	=0.44
Aperture;	hap	=0.12
	wap	=0.16

Depository: IGPS coll. cat. no. 86793.

Family Schizoporellidae JULLIEN, 1903

Genus *Dakaria* JULLIEN, 1903

Dakaria subtorquata (D'ORBIGNY), 1852

Pl. 36, fig. 8

1895. *Smittia (Watersipora) cucullata* (BUSK); NEVIANI, p. 120, Tav. VI, fig. 5.
1930. *Pachycleithonia nigra* CANU and BASSLER, p. 25, pl. 4, figs. 9-13.
1952. *Watersipora cucullata* (BUSK); OSBURN, p. 472, pl. 56, figs. 1-5.
1957. *Dakaria subovoidea* (D'ORBIGNY); HARMER, p. 1022, pl. LXIX, figs. 11, 12, 14, text-fig. 111.
1965. *Dakaria subovoidea* (D'ORBIGNY); MAWATARI, p. 617, text-figs. 115a-c.
1967. *Dakaria subtorquata* (D'ORBIGNY); WEISBORD, p. 68, pl. 10, fig. 1.

Description: Zoarium incrusts shell fragments. Zooecia distinct very shallow furrow, rather regular in form. Front regularly rounded, tremocyst smooth with numerous large pores. Aperture large and varies in its proportions. Peristome very thick, typically simple and slightly elevated. No oral spines, no avicularia. No evidence of ovicells externally.

Measurements (in mm):

Zooecia; Lz=0.64
Wz=0.44
Peristome; hper=0.28
wper=0.36

Depository: IGPS coll. cat. no. 86794.

Genus *Schizoporella* HINCKS, 1877

"Schizoporella" scissa BROWN, 1952

Pl. 36, fig. 4

1952. *"Schizoporella" scissa* BROWN, p. 245, figs. 178, 179.

Description: Zoarium incrusts shell fragments. Zooecia distinct, ovate or of irregular form. Frontal pleurocyst and smooth, thin walled; mural rim semicircular, bearing 8 to 10 spines at distal part; proximal rim almost straight and slit-like median sinus present proximally. Septule and dietellae both present at distal wall. Marginal part of zooecia, with a few large areolar pores. Avicularia and ovicell not found.

Measurements (in mm):

Zooecia; Lz=0.44-0.52
Wz=0.32-0.44
Aperture; hap=0.16
wap=0.12

Depository: IGPS coll. cat. no. 86795.

Family Microporellidae HINCKS, 1880

Genus *Microporella* HINCKS, 1877

Microporella cilliata (PALLAS), 1766

Pl. 36, fig. 6

1890. *Microporella ciliata* PALLAS; ORTMANN, p. 38, pl. 3, fig. 5.
1895. *Microporella (Fenestrulina) ciliata* (PALLAS); NEVIANI, pp. 82 and 105, Tav. V, figs. 24, 25.
1923. *Microporella ciliata* (PALLAS); CANU and BASSLER, p. 118, text-figs. 20A-I.
1923. *Microporella ciliata* (PALLAS); OKADA, p. 227.
1929. *Microporella ciliata* (PALLAS); OKADA, p. 26, pl. II, fig. 5, text-fig. 11.
1929. *Microporella ciliata* (PALLAS); CANU and BASSLER, p. 331, pl. 40, figs. 2-4.
1931. *Microporella ciliata* (PALLAS); PRENANT, p. 2.
1934. *Microporella ciliata* (PALLAS); OKADA, p. 13.
1935a. *Microporella ciliata* (PALLAS); SAKAKURA, p. 25.
1936. *Microporella ciliata* (PALLAS); OKADA and MAWATARI, p. 63.
1937. *Microporella ciliata* (PALLAS); OKADA and MAWATARI, p. 440, pl. XI, fig. 1.
1949. *Microporella noaillanensis* VIGNEAUX, p. 67.
1952. *Microporella ciliata* (PALLAS); BROWN, p. 250, text-fig. 184.
1952. *Microporella ciliata* (PALLAS); MAWATARI, p. 241, pl. XII, fig. 12.
1952. *Microporella ciliata* (PALLAS); OSBURN, p. 377, pl. 44, fig. 1.

1957. *Microyorella ciliata* (PALLAS); KATAOKA, p. 146.
1957. *Microporella ciliata* (PALLAS); SOULE and DUFF, p. 114.
1958. *Microporella ciliata* (PALLAS); ANDROSOVA, p. 149, text-fig. 75.
1960. *Microporella ciliata* (PALLAS); KATAOKA, p. 254, pl. XXXI, fig. 4.
1965. *Microporella ciliata* (PALLAS); LAGAAIJ and GAUTIER, Chart.
1967. *Microporella ciliata* (PALLAS); WEISBORD, p. 72, pl. 10, fig. 2.
1967. *Microporella ciliata* (PALLAS); RUCKER, p. 829, pl. 14, fig. F.

Description: Zoarium incrusts shell fragments. Zooecia distinct, ovate or somewhat hexagonal; front with numerous small tremopores, except when heavily calcified. Aperture nearly semicircular, straight on proximal border. Ascopore lunate, situated in midline a little proximal to aperture. A single avicularium located at side of ascopore. Ovicell hyperstomial, globose, very prominent, and porous. No spines.

Measurements (in mm):

Zooecia;	Lz=0.68
	Wz=0.48
Ovicell;	hov=0.28
	wov=0.40
Aperture;	hap=0.08
	wap=0.12

Depository: IGPS coll. cat. no. 86796.

Microporella lunifera (HASWELL), 1880

Pl. 36, fig. 5

1957. *Microporella lunifera* (HASWELL); HARMER, p. 965, pl. LXII, fig. 34.

Description: Zoarium incrusts shell fragments. Zooecia distinct, separated by a shallow furrow, elongate ovate; front heavily calcified, tremopores sometimes visible. Aperture semicircular; proximal border straight. One pair of avicularia, small, not elevated, located on both sides of ascopore. Ascopore semilunar. Ovicell hyperstomial, globose, rather prominent, frequently surrounded by a series of large pores, but sometimes wanting.

Measurements (in mm):

Zooecia;	Lz=0.64
	Wz=0.40
Ovicell;	hov=0.28
	wov=0.40
Aperture;	hap=0.06
	wap=0.10

Depository: IGPS coll. cat. no. 86800.

Microporella sp. A.

Pl. 36, fig. 2

Description: Zoarium incrusts shell fragments. Zooecia distinct, separated by shallow furrow, ovate, somewhat hexagonal; front with numerous small tremopores. Aperture roughly semicircular, or quadrangular. A single avicularium, stout, rather large, located at side of umbonate process. Ovicell hyperstomial, very large, umbonate process, with many pores.

Measurements (in mm):

Zooecia;	Lz=0.68
	Wz=0.40
Aperture;	hap=0.08–0.12
	wap=0.12–0.18

Depository: IGPS coll. cat. no. 86801.

Family Eurystomellidae LEVINSEN, 1909

Genus *Eurystomella* LEVINSEN, 1909

Eurystomella bilabiata (HINCKS), 1884

Pl. 36, fig. 3

1923. *Eurystomella bilabiata* (HINCKS); CANU and BASSLER, p. 142, pl. 37, fig. 6.
1935a. *Eurystomella bilabiata* (HINCKS); SAKAKURA, p. 25, text-fig. 7.
1952. *Eurystomella bilabiata* (HINCKS); MA-

WATARI, p. 280.

1952. *Eurystomella bilabiata* (HINCKS); OSBURN, p. 389, pl. 58, fig. 5.

1957. *Eurystomella bilabiata* (HINCKS); SOULE and DUFF, p. 118.

1960b. *Eurystomella bilabiata* (HINCKS); KATAOKA, p. 396, pl. 41, fig. 3.

Description: Zoarium encrusts shell fragments. Zooecia distinct, separated by furrow, roughly quadrangular, broad and rounded distally, narrowed and truncated at proximal end; front not heavily calcified, without pores, often rising into a broad low umbo. Aperture hat-shaped with a very narrow brim, rounded distally and becoming abruptly wider near almost straight proximal border. No avicularia, no spines. Ovicell hyperstomial.

Measurements (in mm):

Zooecia;	Lz=0.68
	Wz=0.48
Aperture;	hap=0.16
	wap=0.24

Depository: IGPS coll. cat. no. 86802.

Family Mucronellidae LEVINSEN, 1902

Genus *Mucronella* HINCKS, 1880

Mucronella labiata (LEVINSEN), 1886

Pl. 36, figs. 10, 20

1952. *Mucronella labiata* (LEVINSEN); OSBURN, p. 437, pl. 52, figs. 1, 2.

Description: Zoarium encrusts shell fragments. Zooecia large, elongate quadrangular, distinct, separated by deep furrow; frontal densely and minutely granulated, with one to two rows of small lateral pores. Aperture roughly semicircular, proximal border straight with a broad, short lyrula. Peristome high, proximal. Ovicell hyperstomial, large, hemispherical, distal end often sloped downward toward base of succeeding zooecium. Spines not found.

Measurements (in mm):

Zooecia;	Lz=0.80-0.88
	Wz=0.44
Ovicell;	hov=0.30
	wov=0.40
Aperture;	hap=0.24
	wap=0.28

Depository: IGPS coll. cat. no. 86803.

Genus *Parasmittina* OSBURN, 1952

Parasmittina sp. A.

Pl. 36, fig. 7

Description: Zoarium encrusts shell fragments. Zooecia distinct, with shallow furrow; frontal a pleurocyst with a row of areolar pores; peristome high, forming tube in ovicelled zooecia. One to three avicularia present at proximal border of peristome. Distal part of aperture bearing 4 spines. Ovicell hyperstomial, prominent, perforated by numerous pores.

Measurements (in mm):

Zooecia;	Lz=0.52
	Wz=0.36
Peristome;	lper=0.24
	wper=0.24

Affinities: The present specimen resembles *P. alaskensis* OSBURN, 1952, but differs from it in the presence of four spines.

Depository: IGPS coll. cat. no. 86806.

Genus *Porella* GRAY, 1848

Porella acutirostris SMITT, 1867

Pl. 36, fig. 15

1936. *Porella acutirostris* SMITT; OSBURN, p. 542.

1952. *Porella acutirostris* SMITT; OSBURN, p. 394, pl. 46, fig. 4.

1956. *Porella acutirostris* SMITT; MAWATARI, p. 129, fig. 10h-k.
1958. *Porella acutirostris* SMITT; ANDROSOVA, p. 163, text-fig. 93.

Description: Zoarium encrusts shell fragments. Zooecia distinct, hexagonal or oval, separated by a salient thread. Frontal slightly convex, smooth, with several pairs of areolar pores in marginal portion. Aperture semicircular, rather straight proximally, surrounded by thin, prominent peristome. Avicularium, median, suboral, acute, on a prominent umbo including broad chamber. Ovicell hyperstomial.

Measuremnets (in mm):

Zooecia; Lz=0.48
Wz=0.28
Peristome; lper=0.16
wper=0.20

Depository: IGPS coll. cat. no. 86805.

Genus *Rhamphostomella* LORENZ, 1886

Rhamphostomella hincksi NORDGAARD, 1906

Pl. 36, fig. 1

1952. *Rhamphostomella hincksi* NORDGAARD; OSBURN, p. 428, pl. 50, fig. 3.

Description: Zoarium encrusts shell fragments. Zooecia distinct, with shallow furrow; frontal somewhat inflated, smooth, with a row of conspicuous areolar pores between which costal ribs extend for a short distance at front. Aperture nearly round, without either cardelles or lyrula. Ovicell hyperstomial, large, prominent, smooth, with several pores.

Measurements (in mm):

Zooecia; Lz=0.60
Wz=0.44
Ovicell; hov=0.36
wov=0.36
Aperture; hap=0.20
wap=0.16

Depository: IGPS coll. cat. no. 86806.

Rhamphostomella spinigera LORENZ, 1886

Pl. 36, fig. 11

1920. *Rhamphostomella spinigera* LORENZ; CANU and BASSLER, p. 476, text-figs. 134S, T.
1936. *Rhamphostomella spinigera* LORENZ; OSBURN, pp. 538, 542.
1952. *Rhamphostomella spinigera* LORENZ; OSBURN, p. 429, pl. 51, fig. 1.

Description: The present specimen agrees with OSBURN's description (1952). Zoarium encrusts shell fragment. Zooecia distinct with deep separating grooves; front somewhat inflated, smooth; one row of marginal areolations. Aperture somewhat rounded; proximal border bisinuate, with a cardelle at tip. Peristome thin, bearing 4 stout spines. Avicularian umbo located at one side of aperture, rarely extends to midline of front.

Measurements (in mm):

Zooecia; Lz=0.65
Wz=0.40
Aperture; hap=0.18
wap=0.20

Depository: IGPS coll. cat. no. 86807.

Family Phylactellidae CANU and BASSLER, 1917

Genus *Perigastrella* CANU and BASSLER, 1917

Perigastrella rectilineata CANU and BASSLER, 1920

Pl. 36, fig. 14

1920. *Perigastrella rectilineata* CANU and BASSLER, p. 582, pl. 73, figs. 14-19.

Description: Zoarium encrusts shell fragments. Zooecia distinct, disposed in linear rows; frontal smooth, convex, umbonate process. Aperture semielliptical; peristome thin, a little salient and bearing 4 to 6 spines in distal part. Ovicell hyperstomial, globular, smooth, and prominent, fixed in part on distal zooecium. No avicularia.

Measurements (in mm):

Zooecia; Lz=0.36-0.44
Wz=0.32
Aperture; hap=0.08
wap=0.08-0.10

Depository: IGPS coll. cat. no. 86808.

References

ANDROSOVA, E.I. (1958): Bryozoa of the older Cheilostomata of the north part of the Japan Sea. (in Russian). *Issledovaniya Dalinevostochnykh Morei V, Akademiya Nauk SSSR*, pp. 90-204, 104 text-figs.

BROWN, D.A. (1952): The Tertiary Cheilostomatous Polyzoa of New Zealand *Brit. Mus. (Nat. Hist.), Zool.*, pp. 1-405, 296 text-figs.

CANU, F. and BASSLER, R.S. (1920): North American Early Tertiary Bryozoa. *U.S. Nat. Mus., Bull.* 106, pp. 1-877, 162 pls.

—— and —— (1923): North American Later Tertiary and Quarternary Bryozoa. *Ibid.*, 125, pp. 1-302, 47 pls.

—— and —— (1927): Classification of the Cheilostomatous Bryozoa. *Proc. U.S. Nat. Mus.*, vol. 69, no. 14, pp. 1-43, 1 pl.

—— and —— (1928): Fossil and Recent Bryozoa of the Gulf of the Mexico Region. *Ibid.*, vol. 72, pp. 1-165, 34 pls.

—— and —— (1929): Contributions to the biology of the Philippine Archipelago and adjacent regions; Bryozoa. *Proc. U.S. Nat. Mus., Bull.* 100, vol. 9, pp. 1-685, 94 pls.

—— and —— (1930): The Bryozoan Fauna of the Galapagos Islands. *Proc. U.S. Nat. Mus.*, vol. 76, art. 13, pp. 1-78, 14 pls.

—— and —— (1933): The Bryozoan Fauna of the Vincentown Limesand. *U.S. Nat. Mus., Bull.* 165, pp. 1-108, 21 pls.

—— and LECOINTRE, G. (1927): Les Bryozoaires Cheilostomes des Faluns de Touraine et d'Anjou. *Mém. Soc. Géol. France (N.S.)*, tome III, pp. 19-50, pls. 6-11.

HARMER, S.F. (1926): The Polyzoa of the Siboga Expedition, Pt. II, pp. 24-501, pls. XIII-XXXIV.

—— (1957): *Op. cit.* Pt. IV, pp. 642-1147, pls. XLII-LXXIV.

KANNO, S. (1962): Molluskan fauna from the so-called Setana Formation, Southwestern Hokkaido, Japan. *Sci. Rep. Tokyo Univ. Education*, Sec. C, vol. 8, no. 73, pp. 49-62.

KATAOKA, J. (1957): Bryozoa from the Daishaka Formation (Pliocene), Minami-Tsugaru-Gun, Aomori Prefecture. *Trans. Proc. Paleont. Soc. Japan, N.S.*, No. 28, pp. 143-153, 1 pl.

—— (1960a): Bryozoa Fauna from the "Ryukyu Limestone" of Kikai-jima, Kagoshima Prefecture, Japan. *Sci. Rep. Tohoku Univ. 2nd ser.*, vol. 32, no. 2, pp. 214-272, 13 pls.

—— (1960b): Bryozoa from Mogami-Tai, Japan Sea. *Ibid.*, Spec. vol., no. 4, pp. 394-399, 1 pl.

KUBOTA, K. (1950): Illustrated Cenozoic fossils 9 (Fossil Pectinidae of Setana series). *Cenozoic Res.*, no. 6, pp. 12-18, 2 pls.

LAGAAIJ, R. and GAUTIER, Y.V. (1965): Bryozoa assemblages from marine sediments of the Rhône delta, France. *Micropaleontology*, vol. 11, no. 1, pp. 39-58, 34 figs., 1 chart.

MASUDA, K. (1960): On the Morphogenesis of *Nanaochlamys*. *Sci. Rep. Tohoku Univ. 2nd ser.* Spec. vol. no. 4, pp. 371-383, pl. 39, 10 text-figs.

—— and SAWADA, Y. (1961): Some New Tertiary Pectinids from Southwestern Hokkaido, Japan. *Japan Jour. Geol. Geogr.*, vol. 32, no. 1, pp. 20-29, 1 pl.

MAWATARI, S. (1952): Bryozoa of Kii Pe-

ninsula. *Publ. Seto Mar. Biol. Lab.*, II (2), pp. 261–288, 1 pl.

—— (1956): Cheilostomatous Bryozoa from the Kurile Island and the Neighbouring Districts. *Pacific Science*, vol. X, no. 2, pp. 113–135, 15 text-figs.

—— (1965): Bryozoa; *in* New Illustrated Encyclopedia of the Fauna of Japan. pp. 585–628. (in Japanese) *Hokuryu-Kan*.

NAGAO, T. and SASA, Y. (1934): Recent geological history and Cainozoic formations of the southwestern part of Hokkaido (4). *Jour. Geol. Soc. Japan*, vol. 41, no. 488, pp. 211–216.

NEVIANI, A. (1895): Briozoi fossili della Fornesina e Monte Mario presso Roma. *Paleontgr. Italica* I, pp. 77–140, 2 pls.

OKADA, Y. (1923): On a Collection of Bryozoa from the Straits of Corea. *Annot. Zool. Japon*, vol. 10, art. 22, pp. 215–234.

—— (1929): Report of the Biological Survey of Mutsu Bay, 12, Cheilostomatous Bryozoa of Mutsu Bay. *Sci. Rep. Tohoku Imp. Univ., 4th Ser. Biology*, vol. IV, no. 1, pp. 11–35, 5 pls.

—— (1933): On a Collection of Bryozoa from the Northern Kurile Expedition. *Bull. Biogeogr. Soc. Japan*, vol. 4, no. 3, pp. 213–216.

—— (1934): Bryozoa Fauna in the Vicinity of the Shimoda Marine Biological Station. *Sci. Rep. Tokyo Bunrika Daigaku, Sec. B*, vol. 2, no. 26, pp. 1–20, 2 pls.

—— and MAWATARI, S. (1936): Bryozoa

Explanation of Plate 35

(All enlarged 25 times and all from the same locality)

Figs. 1, 2. *Microporina articulata* (FABRICIUS).
1. Porous cryptocyst under ectocyst.
2. Another zoarium covering thick ectocyst.

Figs. 3, 19. *Figularia* cf. *carinata* (WATERS).
3. Ovicelled zoarium.
19. Another non-ovicelled zoarium.

Fig. 4. *Verminaria areolae* SAKAKURA.
Fig. 5. *Puellina setosa* (WATERS).
Fig. 6. *Hippothoa fragellum* MANZONI.
Fig. 7. *Jullienula* sp. B.
Fig. 8. *Ellisina levata* (HINCKS).
Fig. 9. *Callopora corniculifera* (HINCKS).
Fig. 10. *Callopora* cf. *whiteavesi* NORMAN.
Fig. 11. *Pyrulella corbula* (HINCKS).
Figs. 12, 13. *Jullienula* sp. A.
13. Interzooecial avicularia shown in middle part.
Fig. 14. *Hincksina* cf. *periporosa* CANU and BASSLER.
Fig. 15. *Callopora aurita* (HINCKS).
Fig. 16. *Cellaria diffusa* ROBERTSON.
Fig. 17. Cauloramphus (?) sp. A.
Fig. 18. *Tegella unicornis* (FLEMING).
Fig. 20. *Membraniporidra* sp. A.
Fig. 21. *Crassimarginatella kumatae* (OKADA).
Fig. 22. *Tegella robertsonae* O'DONOGHUE and O'DONOGHUE.
Fig. 23. *Tegella aquilirostris* (O'DONOGHUE).

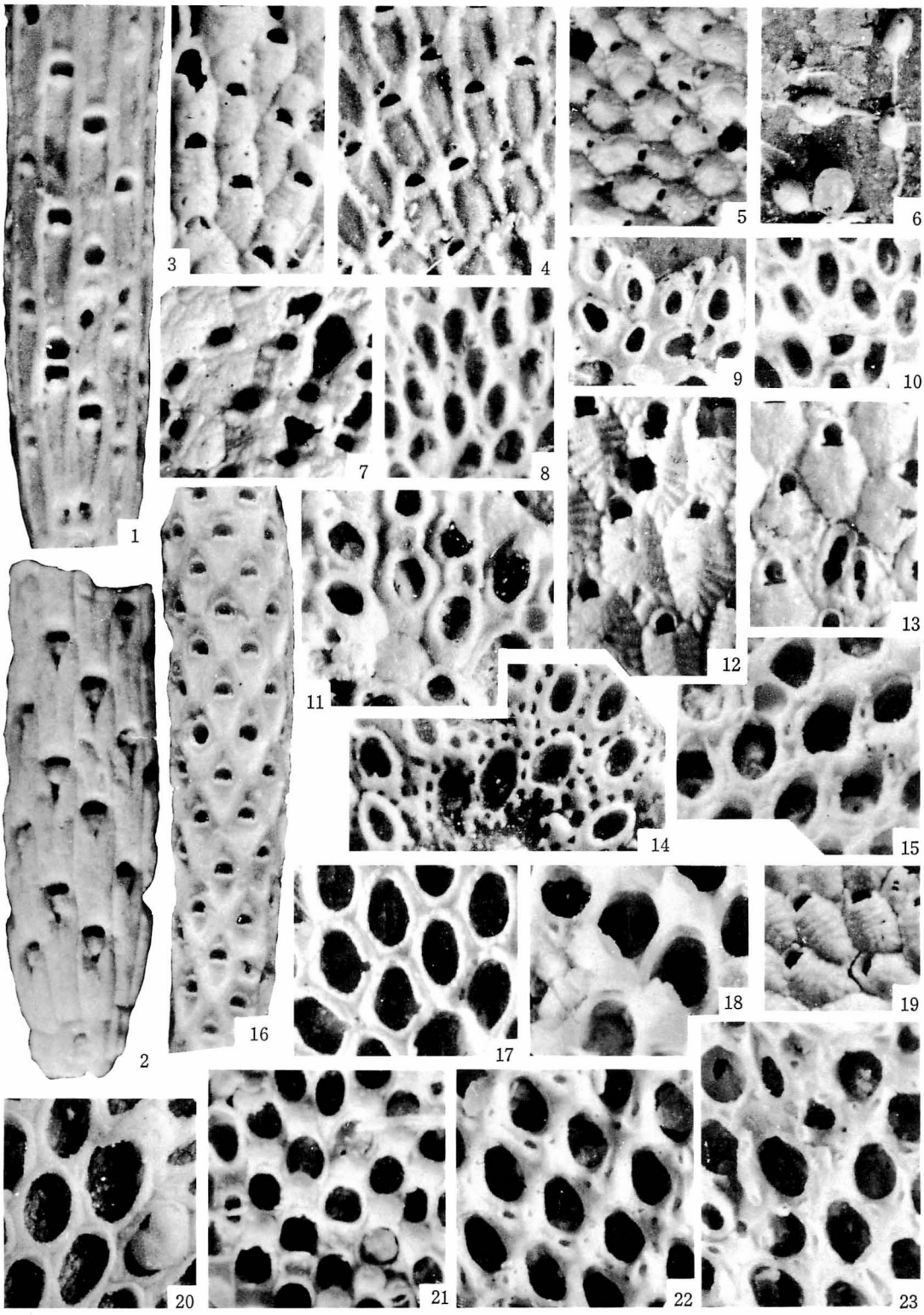

Photo by KUMAGAI

Fauna collected by the "Misago" during the Zoological Survey around Izu Peninsula (II). *Ibid.*, vol. 3, no. 49, pp. 53–73, 2 pls.

—— and —— (1937): On the Collection of Bryozoa along the Coast of Onagawa Bay and its Vicinity, the Northern Part of Honshu, Japan. *Sci. Rep. Tohoku Imp. Univ., 4th Ser., Biology*, vol. 11, no. 4, pp. 433–445, 1 pl.

ORTMANN, A. (1890): Die Japanische Bryozoenfauna. *Arch. f. Naturgesch.*, Bd. 1, H. 1, pp. 1–74, 4 pls.

OSBURN, R.C. (1936): Bryozoa collected in the American Arctic by Captain R.A. Bartlett. *Jour. Washington Acad. Sci.*, vol. 26, no. 12, pp. 538–543, 1 text-fig.

—— (1950): Bryozoa of the Pacific Coast of America. pt. 1, Cheilostomatous-Anasca. *Allan Hancock Pacific Expedition*, vol. 14, no. 1, pp. 1–269.

—— (1952): Op. cit. pt. 2, Cheilostomatous-Ascophora, vol. 14, no. 2, pp. 270–611.

PRENANT, M. (1931): Sur une collection de Bryozoaires de la Mer du Nord appartenant au Musée royal d'Histoire Nat. Belgique. *Bull. Mus. roy. d'Hist. Nat. Belgique.* tome 7, no. 17, pp. 1–6.

RUCKER, J.B. (1967): Paleoecological analysis of Cheilostome Bryozoa from Venezuela-British Guiana shelf sediments. *Bull. Marine Sci.*, vol. 17, pp. 787–839, 16 figs.

SAKAKURA, K. (1935a): Pliocene and Pleistocene Bryozoa from the Boso Peninsula (I). *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. II*, vol. 4, pp. 1–48, 7 pls.

—— (1935b): Bryozoa from Toyama Bay, Sea of Japan. *Annot. Zool. Japon.*, vol. 15, no. 1, pp. 106–119, 1 pl., 2 text-figs.

—— (1936): On *Microporina articulata* (Fabricius), a Cheilostomatous Bryozoa. *Jour. Geol. Soc. Japan*, vol. 43, no. 15, pp. 259–267, 1 pl.

SAWADA, Y. (1962): The geology and paleontology of the Setana and Kuromatsunai areas in southwest Hokkaido, Japan. *Mem. Muroran Inst. Tech.*, vol. 4, no. 1, pp. 1–110, 13 tables, 9 text-fig., 8 pls.

SOULE, J.D. and DUFF, M.M. (1957): Fossil Bryozoa from the Pleistocene of Southern California. *Proc. Calif. Acad. Sci., 4th Ser.*, vol. 29, no. 4, pp. 87–146.

VIGNEAUX, M. (1949): Revision des Bryozoaires néogènes du Bassin d'Aquitaine et essai de classification. *Mém. Soc. Géol. France*, vol. 60, pp. 1–155, 40 figs.

WEISBORD, N.E. (1967): Some Late Cenozoic Bryozoa from Cabo Blanco, Venezuela. *Bull. Amer. Paleont.*, vol. 53, no. 237, pp. 1–237, 12 pls.

Imagane	今 金
Kaigarabashi	貝殻橋
Kunnui	訓 縫
Tane-gawa	種 川

Explanation of Plate 36

(All enlarged 25 times and all from the same locality)

Fig. 1. *Rhamphostomella hincksi* NORDGAARD.
Fig. 2. *Microporella* sp. A.
Fig. 3. *Eurystomella bilabiata* (HINCKS).
Fig. 4. *"Schizoporella" scissa* BROWN.
Fig. 5. *Microporella lunifera* (HASWELL).
Fig. 6. *Microporella ciliata* (PALLAS).
Fig. 7. *Parasmittina* sp. A.
Fig. 8. *Dakaria subtorquata* (D'ORBIGNY).
Fig. 9. *Reginella nitida* OSBURN.
Figs. 10, 20. *Mucronella labiata* LEVINSEN.
10. Ovicelled zoarium.
20. Non-ovicelled part of the same zoarium.
Fig. 11. *Rhamphostomella spinigella* LORENZ.
Fig. 12. *Figularia crassicostulata* CANU and BASSLER.
Fig. 13. *Umbonula arctica* (SARS).
Fig. 14. *Perigastrella rectilineata* CANU and BASSLER.
Fig. 15. *Porella acutirostris* SMITT.
Fig. 16. *Monoporella fimbriata* CANU and BASSLER.
Fig. 17. *Membraniporella* cf. *bicornis* CANU and LECOINTRE.
Fig. 18. *Onychocella subsymmetrica* CANU and BASSLER.
Fig. 19. *Micropora coriacea* (JOHNSTON).

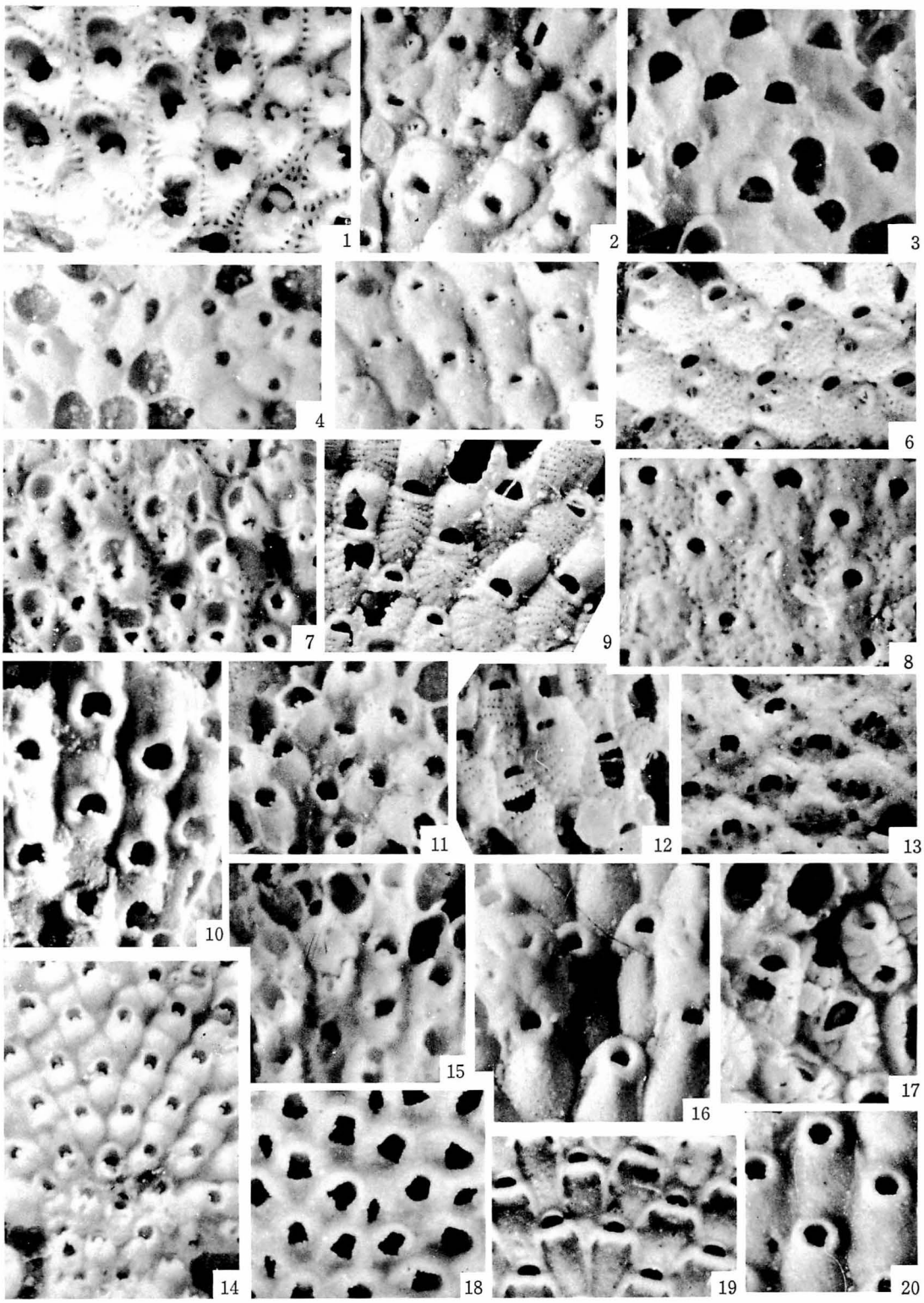

Photo by KUMAGAI

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 79, pp. 337-354, pls. 37, 38, Sept. 30, 1970

570. LOWER TRIASSIC AMMONOIDS FROM THE KITAKAMI MASSIF*

YUJI BANDO

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北上山地から産出した下部三畳紀アンモナイト：北上山地南部の下部三畳系は下位より平磯層・大沢層の二層よりなるが，平磯層より Scythian 最初期を代表する *Glyptophiceras* が産出し，また，大沢層の中部付近から Scythian 後期を示す *Meekoceras* 動物群を検出した。宮城県女川町小乗の大沢層と上位の風越層との境界付近からは *Leiophyllites* 動物群が産出し，その結果，北上山地の下部三畳系は Otoceratan より Prohungaritan に至る一連の層序が発達していることが明らかとなった。　　坂東祐司

Introduction

Only a single species of Lower Triassic ammonites, *Subcolumbites* cf. *perrinismithi* (ARTHABER), from the Kitakami Massif has been described. This ammonite is from the upper part of the Osawa Formation at Isatomae, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture, in the southern Kitakami Massif. The Lower Triassic System in the Kitakami Massif consists of two formations, i. e. the Hiraiso in the lower and the Osawa in the upper. From the stratigraphical position in the geological column the Hiraiso Formation has been considered as the Lower Scythian and the Osawa as the Upper Scythian. Dr. Koichiro ICHIKAWA once reported on the occurrence of *Ophiceras* from the Hiraiso Formation, and the ammonite and stratigraphic horizon were refered to his Tatean age of Lower Scythian age, but this ammonite was not described.

Recently Dr. Yoshio ONUKI collected some ammonite specimens from the shale beds at the boundary between the Osawa and Fukkoshi formations at Konori in Onagawa-cho, Ojika-gun, near Ishinomaki City, and on the other hand, Dr. Keiji NAKAZAWA of the Kyoto University collected some of interesting ammonites of the genera *Meekoceras* and *Euflemingites* from the calcareous black shales of the Osawa Formation at Hiraiso coast in Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture.

The geological structure of the Triassic System in the Kitakami Massif is rather simple compared with that of southwest Japan and therefore, the stratigraphic succession of the rocks and of the ammonites can be worked out easier than at any other locality in Japan. The writer recently reported on the occurrence of *Meekoceras* and *Euflemingites* from the Osawa Formation and discussed about their stratigraphic significance (BANDO, 1968).

Up to date, the ammonoid fossils newly obtained from the Kitakami Massif are as follow :

* Received March 23, 1970; read January 20, 1970 at Sendai.

Species	Formation	Locality
Glyptophiceras cf. *gracile* SPATH	Hiraiso	Hiraiso
Flemingites sp.	Osawa	Osawa
Euflemingites sp.	Osawa	Osawa
Meekoceras spp.	Osawa	Osawa
Xenoceltites ? sp.	Osawa	Osawa
Danubites sp.	Osawa	Osawa
Leiophyllites cf. *pitamaha* (DIENER)	Osawa	Konori
Leiophyllites aff. *pradyumna* (DIENER)	Osawa	Konori
Leiophyllites sp.	Osawa	Konori
Danubites aff. *ambika* DIENER	Osawa	Konori

Of these ammonites the genus *Glyptophiceras* which was firstly found from the Hiraiso Formation is known to occur from the lowest horizon of the Scythian stage, the Lower Otoceratan or Lower Induan substage, and in Japan it besides the Kitakami Massif is known only from Tomisu in the Maizuru Zone, Hyogo Prefecture. The genus *Glyptophiceras* originally belong to the *Ophiceras* fauna and was regarded as the characteristic ammonite of Otoceratan (SPATH, 1930, p. 30).

The biostratigraphic succession of the ammonoids from the Hiraiso and Osawa Formation is as follows:

4. *Leiophyllites* cf. *pitamaha* zone
3. *Subcolumbites perrinismithi* zone
2. *Meekoceras* and *Euflemingites* zone
1. *Glyptophiceras* cf. *gracile* zone

The lithologic facies of the Hiraiso Formation at the type locality is characterized by calcareous light green gray sandstones with thin bands of argillaceous limestones and conglomerates at the basal part and lies on the Upper Permian Toyoma Formation which is readily recognized by the black shale facies in which fossils are quite rare.

Lower Triassic System in the Kitakami Massif

As already mentioned above, the Lower Triassic System of the Kitakami Massif consists of the two formations, of which the lower comprises sandstone facies and the upper shale facies. These formations are distributed along the eastern and western marginal parts of the southern Kitakami Massif, because the general geologic structure is a synclinolium with axis of SSW trend, thus the Lower Triassic strata crop out along the eastern and western parts of the massif and lie on the Permian Toyoma Formation. At the Hiraiso coast the Toyoma Formation intercalates in the black slate facies thin bands of limestone, but no fossils have been reported from it, and is overlain by a 2-3 m thick conglomerate. In general, the Lower Triassic System is characterized by a megacyclothem commencing from coarse sandstone and conglomerate facies at the basal part and grading upwards to the fine black shale facies at the upper part.

Historically, the geological surveys of the Triassic System in the type area have been undertaken by many authors, especially by KUROSAWA (1929) and MABUTI (1932) who discovered "*Pecten*" *ussuricus* (BITTNER), "*Pecten*" *sichoticus* (BITTNER), "*Pecten*" cf. *discites* (SCHLOTHEIM), *Pecten alberti virgalensis* (WITTENBURG) etc. from Tate near Isatomae, by SHIIDA (1939) who surveyed the area of the type locality and subdivided the

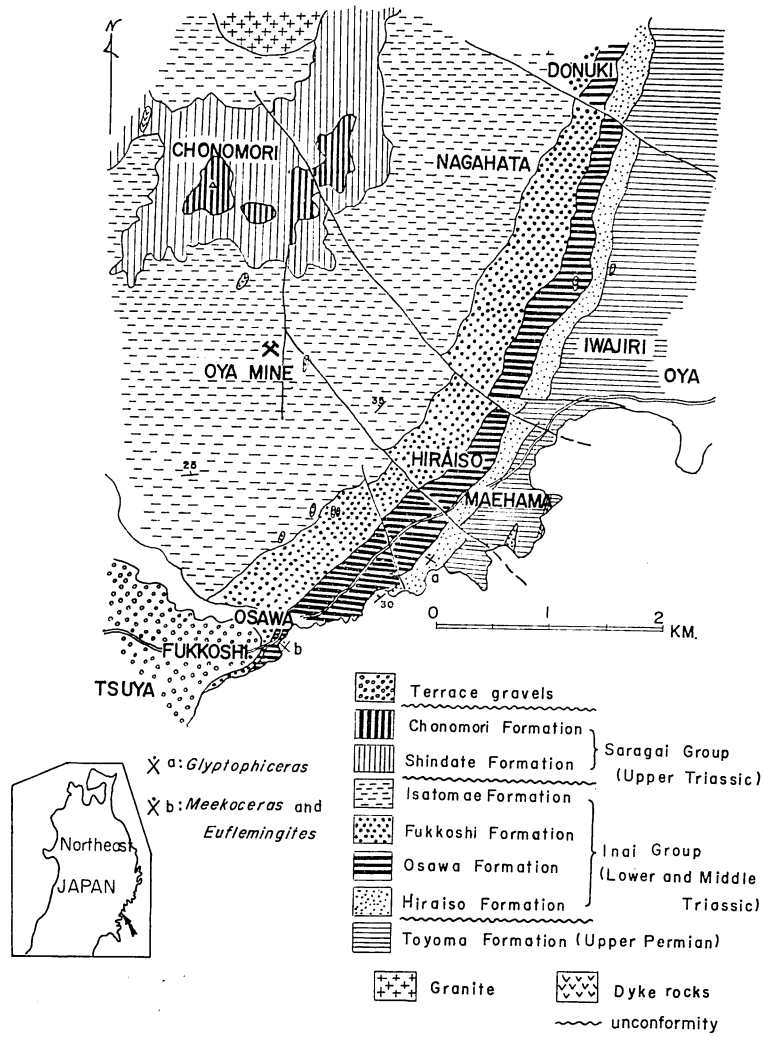


Fig. 1. Geological map of the Hiraiso district, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture, in the Kitakami Massif, with indication of the locality of *Glyptophiceras* and *Meekoceras* faunas. (Geological map after Y. ONUKI and Y. BANDO, 1959)

Triassic formations into some members. Later INAI (1939), ICHIKAWA (1948, 1951), ONUKI and BANDO (1958), and BANDO (1956, 1958) contributed to the stratigraphy of the type area. Especially, ICHIKAWA (1948, 1951) proposed a subdivision of the Triassic System of the type area in the Kitakami Massif, and this became the basis for his time stratigraphic subdivision of Japanese Triassic.

The Hiraiso Formation (ICHIKAWA, 1946) is composed of light greenish calcareous sandstone with arenaceous limestone layers above the basal conglomerate in its lower part, and has yielded many Lower Triassic pelecypods, but ammonoids are very rare. The upper part of this formation comprises a thin

alternation of calcareous light blue sandstone and dark gray fine sandstone, which grades upwards into the calcareous siltstone of the next younger Osawa Formation. The boundary between the Hiraiso and Osawa Formations is places at the upper limit of the dark grey fine grained sandstone.

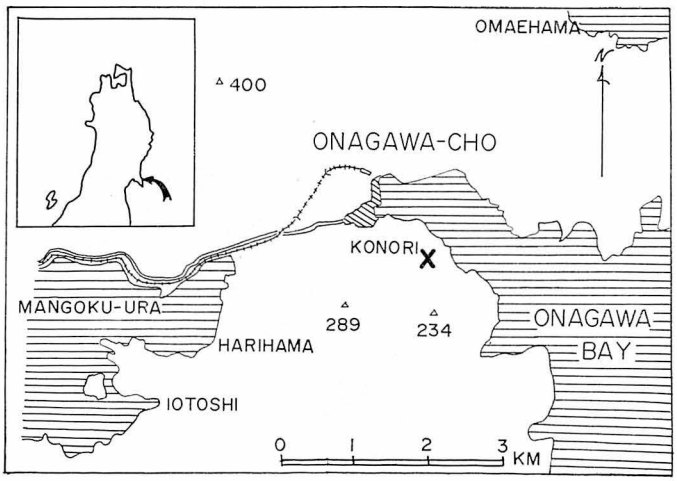
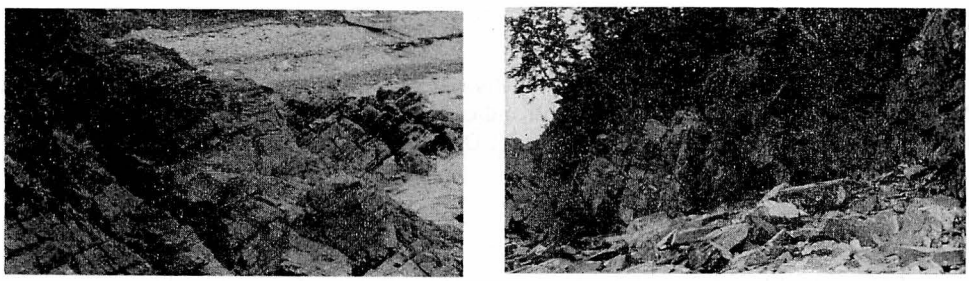


Fig. 2. Map showing the locality of the *Leiophyllites* fauna at Konori near Onagawa-cho, Ojika-gun, Miyagi Prefecture, in the southern Kitakami Massif.

The Osawa Formation (ICHIKAWA, 1948) consists of a banded alternation of well bedded calcareous fine sandstone and siltstone. The upper part of this formation is composed of laminated dark blue calcareous shales which yielded some interesting Upper Scythian ammonoid as *Subcolumbites* cf. *perrinismithi*. This formation gradually change into the Fukkoshi Formation (Middle Triassic) which is composed of light green sandstone, banded sandy shales and



(1) (2)

Fig. 3. (1) Banded calcareous sandstone of the Hiraiso Formation at Hiraiso, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture. *Glyptophiceras* cf. *gracile* SPATH was collected from this formation. (2) The outcrop of black shales of the Osawa Formation at Osawa, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture. The specimens of *Meekoceras* and *Euflemingites* were collected from here by Professor Keiji NAKAZAWA.

conglomerates. In the uppermost part there is a thin alternation of sandstone and sandy shale, and some non-continuous layers of sandstone in the shale.

Up to date, the precise chronological horizon ranging from the Hiraiso Formation below to the middle part of the Osawa Formation above was unknown, but the occurrence of *Glyptophiceras* cf. *gracile* from the Hiraiso Formation and the Owenitan ammonites, i. e. *Meekoceras* and *Euflemingites*, from the Osawa Formation gave an important bright to the solution of this problem. *Glyptophiceras gracile* was first described by SPATH (1930, p. 34) from the *Otoceras* and *Ophiceras* beds of Clavering Island and S. S. W. of Cape Stosch in Eastern Greenland and he placed their horizon in the lower part of Otoceratan. Later, KUMMEL (1957) proposed the two ammonite zones, i. e. *Otoceras woodwardi* in the lower and *Ophiceras commune* in the upper, for the SPATH's Otoceratan stage. The chronological subdivision for the Lower Triassic have also been attempted by KIPARISOVA and POPOV (1956, 1961, 1964) and they proposed the Induan stage for the Lower Scythian as regarding the range from the Otoceratan to the early part of Flemingitan. More recent classification of the Lower Triassic is of TOZER (1965, 1967) and SILBERLING and TOZER (1968). According to the classification of them, the Otoceratan and the early part of Gyronitan stages were regarded as the Griesbachian, and moreover, the Griesbachian was divided into the lower, which consists of the *Otoceras concavum* zone in the lower and the *Otoceras boreale* zone in the upper, and the upper, which consists of the *Ophiceras commune* zone in the lower and the *Pachyproptychites strigatus* zone in the upper. It is difficult to decide the precise horizon of Japanese

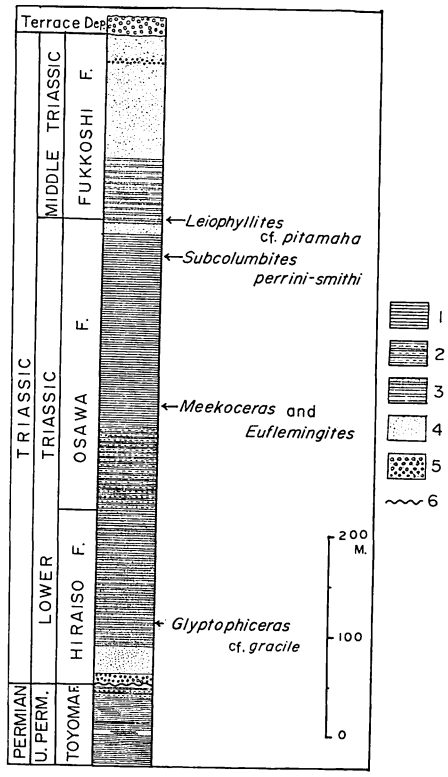


Fig. 4. Compiled columnar section of the Middle and Lower Triassic at Hiraiso, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture, in the southern part of Kitakami Massif, with horizons of the characteristic ammonites. 1: black shale, 2: thin alternation of sandstone and siltstone, 3: banded alternation of sandstone and silty shale, 4: calcareous sandstone, 5: conglomerate, and 6: unconformity.

Glyptophiceras in the above mentioned chronological stages because the occurrence of only single specimen and no ammonite beside this specimen, but judging from the general faunal sequence of the lowest Scythian in Greenland, North America, Himalayas and in Russia the present writer correlated the horizon with the Lower Otoceratan stage.

Table 1. Correlation table for the Lower Triassic Series based upon the characteristic ammonoids. (complied by Y. BANDO, 1970)

LOWER TRIASSIC (Scythian)	Standard ammonite stage	Standard ammonite zone	Arctic Canada		Northeast U.S.S.R	Japan	
	Spath(1930,1934)	Kummel (1957)	Tozer (1965)		Kiparisova & Popow (1964)	Bando (1964)	
Upper Eo-Trias	Prohungaritan	*Prohungarites similis*	Spathian	*Keyserlingites subrobustus*	Olenekian	*Prohungarites* Zone	*Leiophyllites* Zone
	Columbitan	*Columbites parisianus*				*Columbites* Zone	*Subcolumbites* Zone
		Tirolites cassianus		*Nordophiceras pilatum*		*Owenites* Zone	*Anasibirites* Zone
	Owenitan	*Anasibirites multiformis*	Smithian	*Arctoceras*			*Owenites* Zone
		Meekoceras gracilitatus		*blomstrandi*			
				Wasatchites tardus			
				Meekoceras gracilitatus			
Lower Eo-Trias	Flemingitan	*Flemingites flemingianus*	Dienerian	*Paranorites sverdrupi*	Induan	*Gyronites* Zone	(*Eumorphotis* & *Entolium* Zone)
		Koninckites volutus					
	Gyronitan	*Xenodiscoides fallax*		*Proptychites candidus*			
		Prionolobus rotundatus	Griesbachian	Upper			
		Proptychites rosenkrantzi			*Pachyproptychites striatus*		
		Vishnuites decipiens			*Ophiceras commune*		
	Otoceratan	*Ophiceras commune*		Lower	*Otoceras boreale*	*Otoceras* Zone	*Glyptophiceras* Zone
		Otoceras woodwardi			*Otoceras* n.sp.*		

* *Otoceras concavum* TOZER (TOZER, 1967)

Acknowledgments

The writer is indebted to and thanks Professor Kotora HATAI of the Institute of Geology and Paleontology, Tohoku University, Sendai, for his valuable advices and encouragement, and Professor Yoshio ONUKI of the Miyagi University of Education in Sendai for his kind offer of some ammonoids used in the present study and for his information on their occurrences. The writer is also indebted to Professor Keiji NAKAZAWA of the Kyoto University for his kind permission to study the valuable ammonite specimens which he collected from the type locality of the Osawa Formation in the Kitakami Massif. I am also deeply indebted to Mr. Shoichi ONODERA of the Oya Middle School, Miyagi Prefecture, and Mr. Hideo ARAKI of the Kesennuma Library, Miyagi Prefecture, for their kind offer of interesting ammonites.

Systematic Description

Suborder Ceratitina HYATT, 1884

Superfamily Otoceratacea HYATT, 1900

Family Ophiceratidae ARTHABER, 1911

Genus *Glyptophiceras* SPATH, 1930

Glyptophiceras cf. *gracile* SPATH

Pl. 37, fig. 1

Compare:

1930. *Glyptophiceras gracile* SPATH, p. 34, pl. 7, figs. 3-6; pl. 8, figs. 9a, b; 10a, b.
1935. *Glyptophiceras gracile* SPATH, p. 51, pl. 11, fig. 9; pl. 17, figs. 6a, b; pl. 18, figs. 6a, b; pl. 18, figs. 5a, b, 6.
1969. *Glyptophiceras gracile* TRÜMPY, p. 90.

Description: Shell evolute, serpenticones with laterally compressed whorls. The ornamentation of shell surface of the outer whorl is characterized by a coarse, sigmoidal costation, which tending to degenerate into striation on the ventral and umbilical margin. Each costations are irregular in their prominence, but in general, they are most prominent at about 1/3 height of the flank. The umbilicus is about 2/5 diameter of the shell, and the height of the last whorl is about 1/3 diameter of the outer whorl. Suture ceratitic, which consists of entirely rounded saddles and serrated lateral lobes. Of these, the external saddle is broad, the first lateral lobe is deeply serrated, and the secondary lateral lobe is shallow and narrow. The umbilical series of suture is simple and short.

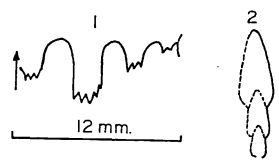


Fig. 5. Suture line (1) and cross section of the whorls (2) of *Glyptophiceras* cf. *gracile* SPATH from the Hiraiso Formation at Monzen, Hiraiso, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture, in the Kitakami Massif.

Remarks: The present material is the first ammonite which occurred from the Hiraiso Formation at type locality. Fortunately, the specimen is well preserved the shell sculpture and septa. The first occurrence of the genus *Glyptophiceras* from Japan was recorded by NAKAZAWA and SHIMIZU (1956) from the black shale at Tomisu, Hyogo Prefecture, southwest Japan, and this ammonite was described by them as the name of *Glyptophiceras japonicum*. In the shell ornamentation and the whorl character the present material is very similar with those of *G. gracile* SPATH from the Otoceratan beds of Greenland. The species of *G. gracile* has a variable shell ornamentation as pointed out by SPATH himself (1935, p. 52) and has a rather weak sculpture in ornamentation than those of *G. aequicostatum* (DIENER) (genotype) from the Himalayas (DIENER, 1913). The species of *Glyptophiceras* were originally described by DIENER (1913) from the *Ophiceras* beds at Pastannah (Pastun) in Kashmir as *Xenodiscus*. Up to date, the most of species of *Glyptophiceras* has been described from East Greenland and Kashmir. Recently, two species of *Glyptophiceras* were

Measurements of Glyptophiceras spp. (*in mm*):

	D	H	W	U	H/D	W/H	U/D
GLKU-402 *Glyptophiceras* cf. *gracile*	62.9(44.8)	19.7	——	38.6(17.4)	0.31	——	0.45
G. gracile (type specimen) by SPATH (1930)	44.8	14.8	11.8	20.9	0.32	0.79	0.47

Measurements of Flemingites sp. (*in mm*):

	D	H	W	U	H/D	U/D
JM 11210	41	20.6	——	10.8	0.50	0.26

(every measurements were measured in the short axis of the whorl)

described from the Induan beds of Primorye in Russia, i.e. *G. tobisiense* KIPARISOVA and *G.* (?) *ignotum* KIPAR. (KIPARISOVA, 1961). And also, POPOV (1961) described *G. pascoei* SPATH from the *Otoceras* zone of Induan stage in Eastern Verkhoyan, northeast Russia.

Occurrence and geological horizon: Calcareous sandy shale at Monzen, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture. Lower Part of the Hiraiso Formation. Lowest Scythian, Otoceratan or Lowest Induan stage.
Reg. No. GLKU*-C402. Coll. S. ONODERA.

Family Flemingitidae HYATT, 1900

Genus *Flemingites* WAAGEN, 1892

Flemingites sp.

Pl. 37, fig. 2

Description: Shell rather evolute, laterally compressed, with shallow umbilicus. Whorl sides almost flat. Umbilical shoulder of the whorl rounded. Sculpture preserved only on the outer whorl and they consists of numerous, faint spiral strigations and weak sigmoidal radial ribs. Suture unfortunately unknown. The height of the outer whorl is about 1/2 of the diameter of the shell and the width of the umbilicus is about 1/4 of the diameter of the shell.

Remarks: The present material is a fragmentary specimen (JM 11210) from the *Meekoceras* bed of the Osawa Formation at the type locality in the Kitakami Massif. Judging from the form of the whorls and the shell sculpture the present material belongs to the genus *Flemingites*, but specifically it is impossible to identify with any species of *Flemingites* because the preservation of the shell is poor. The present specimen was yielded with *Meekoceras*, *Euflemingites* and *Xenoceltites*? from the black shale of the Osawa Formation.

Occurrence and geological horizon: Black shale of the Osawa Formation at Osawa (type locality), Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture, in the southern part of the Kitakami Massif. Upper Scythian, Owenitan.
Reg. No. JM*11210. Coll. K. NAKAZAWA.

Genus *Euflemingites* SPATH, 1934

Euflemingites sp.

Pl. 37, fig. 5

Description: Shell rather involute, laterally compressed, with wide umbilicus. Shell surface ornamented with distinct concentric strigations as in *Euflemingites guyerdetiformis* WELTER (genotype) from Timor (WELTER, 1922, p. 117, pl. 109, figs. 10-12; SPATH, 1934, p. 115, fig. 29). The strigations gradually become strong from the umbilicus to the body whorl. The ventral part

* Abbreviation for the Geological Laboratory, Kagawa University, Takamatsu, Japan.

* Abbreviation for Japanese Mollusca in the Department of Geology and Mineralogy, Kyoto University, Kyoto, Japan.

and septa are unfortunately missing.

Remarks: The shell ornamentation of the present material closely resembles those of *Euflemingites*, but the specific identification seems to be impossible because the ventral part and sutures are missing. The genus *Euflemingites* is distinguished from *Flemingites* by the strong strigations (SPATH, 1934, p. 115), but the sutures resemble each other.

The species of *Euflemingites* have been recorded from Timor (WELTER, 1922; SPATH, 1934), United States of America (SMITH, 1932), Spitsbergen (SPATH, 1951), Arctic Canada (TOZER, 1961), South China (CHAO, 1959), and from the Himalayas (DIENER, 1897). The genus *Euflemingites* predominate in the Owenitan stage of the Lower Triassic, especially in the *Meekoceras* zone. In Japan, the record of the present material is the first and it was found in association with *Meekoceras* and *Xenoceltites*? from the black shale of the Osawa Formation. No other species of *Euflemingites* has been reported from the Lower Triassic beds of Japan.

Occurrence and geological horizon: Black shale of the Osawa Formation at Osawa (type locality), Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture, in the southern part of the Kitakami Massif, northeast Japan. Owenitan, Lower Triassic.

Reg. No. JM 11206. Coll. K. NAKAZAWA.

Family Meekoceratidae WAAGEN, 1895

Subfamily Meekoceratinae WAAGEN, 1895

Genus *Meekoceras* HYATT in C. A. WHITE, 1879

Meekoceras sp. A

Pl. 37, fig. 3

Description: Shell laterally compressed, rather evolute, discoidal whorls with flattened sides and shallow umbilicus. The width of the umbilicus is about 1/5 of the total diameter of the shell. Surface with fine radial folds and fine growth strigation on the umbilical sides of the whorl. Septa ceratitic, with entire saddles and serrated lobes, but the ventral lobe is unknown. The first lateral lobe is large and distinctly serrated, the second lateral lobe is smaller than the first, and following this there is a series of auxiliary lobes. The height of the last whorl is about twice the diameter of the umbilicus. The width and exact diameter of the shell are unfortunately unknown.

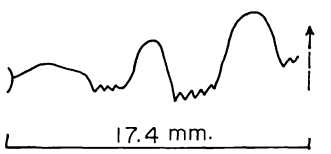


Fig. 6. Suture line of *Meekoceras* sp. from the Osawa Formation at Osawa, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture.

Remarks: The present material is from the black shale of the Lower Triassic Osawa Formation at Osawa (type locality). The preservation is very poor and all of the materials from the locality mentioned above are laterally de-

Measurements of Meekoceras sp. A (*in mm*):

	D	H	W	U	H/D	W/H	U/D
JM 11208	—	17.0	—	10.1	—	—	—

formed and their whorl sections are almost unknown.

The present material is closely related to *Meekoceras gracilitatus* WHITE from North America (WHITE, 1879; SMITH, 1904; HYATT and SMITH, 1905; SMITH, 1934; SPATH, 1934; KUMMEL, 1954; KUMMEL in ARKELL et al., 1957; KUMMEL and STEELE, 1962; TOZER, 1961) in the shell ornamentation, umbilicus and the septa, but the precise identification is impossible because of the state of preservation of the present material. Judging from the septa, especially from the form of the lateral lobes and auxillary series, the present specimen is thought to belong to the genus *Meekoceras*.

Occurrence and geological horizon: Black shale of the Osawa Formation at Osawa, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture, in the Kitakami Massif. Lower Triassic Owenitan ammonite stage.

Reg. No. JM 11208. Coll. K. NAKAZAWA.

Meekoceras sp. B

Pl. 37, fig. 7

Description: Shell involute, laterally compressed, discoidal, with narrow umbilicus and venter. The whorl sides are slightly convex and the width broad. The umbilical shoulders are steep and their walls high angled. The living chamber occupies about 2/3 volution of the outer whorl and the height of whorls is about 1/2 of the total diameter of the shell. The diameter of the umbilicus is very narrow being about 1/10 of the diameter of the shell. The venter is narrow and rather flat, with subangular ventral shoulders. The surface is ornamented with low radial folds and faint radial striae of growth. Septa faint, but unknown precisely, consisting of entire lateral saddles and indistinct lateral lobes, but the serration of the lobes is unknown.

Remarks: The present specimen is probably an immature form, and the preservation of the shell is rather well except for the septa. Considering from the shell characters the material at hand belongs to the genus *Meekoceras*, but specific identification is impossible because the septa are not preserved. In the whorl shape and ornamentation of shell the present material resembles *Meekoceras gracilitatus* WHITE from North America.

Occurrence and geological horizon: Black shale of the Osawa Formation at Osawa, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture, in the Kitakami Massif. Lower Triassic Owenitan stage.

Reg. No. JM 11207. Coll. K. NAKAZAWA.

Family Xenoceltitidae SPATH, 1930

Subfamily Xenoceltitinae SPATH, 1930

Genus *Xenoceltites* SPATH, 1930

Xenoceltites? sp.

Pl. 37, fig. 4

Description: Shell small, evolute, laterally compressed, rather ellipticonic serpenticone with radial week ribs on

Measurements of Meekoceras sp. B (*in mm*):

	D	H	W	U	H/D	U/D
JM 11207	24.6(15.9)	13.8(8.0)	——	3.2(2.0)	0.56(0.50)	0.13(0.12)

Measurements of Xenoceltites? sp. (*in mm*):

	D	H	W	U	H/D	U/D
JM 11209	14.0(10.1)	5.0(3.5)	——	6.5(4.2)	0.35(0.35)	0.46(0.42)

sides. The ribs are irregular and costated and a few weak constrictions are observed on the shell. The depth of the umbilicus is shallow and the width is a little wider than half of the diameter of the shell. The height of the shell is about 1/3 of the total diameter of the conch. The septa are missing.

Remarks: The material at hand is an incomplete specimen, however the general shape of the conch may be identified with the genus *Xenoceltites subevolutus* SPATH (1934, p. 130, pl. 2, fig. 2; pl. 8, fig. 2; pl. 9, fig. 4; pl. 11, fig. 2) from the beds of his upper Eo-Trias of Spitsbergen, but the present material shows a more evolute style. From the shape of the conch the present specimen also resembles *X. evolutus* (WAAGEN) (WAAGEN, 1895, p. 32, pl. 10, fig. 3, as *Dinarites*; FREBOLD, 1930, p. 16-18, pl. 3, fig. 6; SPATH, 1934, p. 127) from Chhidru of the Salt Range of Pakistan, but it is unfortunate that precise identification can not be done because of the poor preservation. The last mentioned allied species has been described from the Tao Formation of Shikoku, Japan, as *X.* aff. *evolutus* (WAAGEN) and is associated with the fauna of *Anasibirites* and *Meekoceras*, thus the present writer places its stratigraphical horizon in the Owenitan ammonite stage of the Lower Triassic (BANDO, 1964, p. 86).

Occurrence and geological horizon: Black shale of the Osawa Formation at Osawa, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture, in the Kitakami Massif. Lower Triassic Owenitan stage. Reg. No. JM 11209. Coll. K. NAKAZAWA.

Family Danubitidae SPATH, 1951

Genus *Danubites* MOJSISOVICS, 1893

Danubites aff. *ambika* DIENER

Pl. 38, fig. 1

1895. *Danubites ambika* DIENER, p. 104, pl. 29, fig. 2.

Description: Evolute, laterally compressed, with wide umbilicus and broadly rounded venter. Conch slowly increasing in height and shallowly embracing the inner whorls. The umbilical shoulders with steep angle and narrow wall. The surface ornamented with many distinct radial ribs which are most prominent at 2/3 height of the flanks and diminishing at the ventral margin. There are about 30 ribs on the flanks of the outer whorl. The septa ceratitic, consisting of broad lateral saddles and rather narrowly denticulated lateral lobes. The second lateral saddle situated on the umbilical shoulders and rather low in height and broad. The external saddle is very high, but the ventral suture is unfortunately missing. The first lateral lobe denticulated with about 3 or 4 points at bottom. The length of the body whorl is equal to about half of the outer whorl.

Remarks: The septal feature of the present material is characterized by higher, elongated ventral saddle, and lower broad lateral saddles, and both show a remarkable contrast. These features are clearly observed on the septa of *D. ambika* DIENER from the Himalayan Muschelkalk, and the shell

Measurements of Danubites aff. *ambika* DIENER (*in mm*):

	D	H	W	U	H/D	W/H	U/D
IGPS coll. cat. no. 91406	57.1(30.0)	17.2(10.4)	——	30.5(15.1)	0.30(0.32)	——	0.53(0.50)
DIENER's type species	43	15	14.5	18	0.30	0.30	0.42

ornamentations of both the present material and the Himalayan species resemble one another. Some differences are observed in the shape of the whorl section, especially the Himalayan species shows greater width of whorls than the present material. *Danubites kansa* DIENER from the Himalayan Muschelkalk also resembles the present specimen in the shell ornamentation, but the suture line differs remarkably. *Danubites japonicus* SHIMIZU (SHIMIZU, 1930, p. 69, pl. 24, fig. 5), from the Isatomae Formation at Inai, Ojika-gun, Miyagi Prefecture, has a wider umbilicus and more abundant radial ribs on the surface of the whorls than those of the present material. From Japan another species of *Danubites* was described by SHIMIZU (1930) as *D.* cf. *kansa* DIENER from the Isatomae Formation at Kudanohama, Utazu-cho, Motoyoshi-gun, Miyagi Prefecture; he regarded the age as Anisian.

Occurrence and geological horizon: Black shale in the alternation of sandstone and shale of the Osawa Formation at Konori-hama, Onagawa-cho, Ojika-gun, Miyagi Prefecture, in the southern Kitakami Massif. Uppermost Scythian, Prohungaritan ammonite stage or *Leiophyllites* zone.

Reg. No. IGPS coll. cat. no. 91406. Coll. Y. ONUKI and K. SASAKI.

Danubites sp.

Pl. 38, fig. 2

Description: Evolute, slightly embracing, slowly increasing in height of whorls; umbilicus very wide; surface ornamented with dense, strong radial ribs which extend straightly from the umbilical to the ventral margin. It is unfortunate that the septa, ventral part and the body whorls are missing in the present material.

Remarks: The material at hand is an incomplete single specimen. Considering from the shell ornamentation the present material may belong to the genus *Danubites*, but specific identification is impossible. The species of *Danubites* have been reported from the Lower Triassic of India, Siberia, Idaho and California in North America, but in Japan, up to the present, *Danubites* has been described from the lower part of the Middle Triassic Inai Group in the Kitakami Massif of Northeast Japan.

Occurrence and geological horizon: Black shale in the alternation of sand-

Measurements of Danubites sp. (*in mm*):

	D	H	W	U	H/D	U/D
IGPS coll. cat. no. 91407	27.0	7.1	——	13.2	0.26	0.50

stone and shale of the Osawa Formation at Konori-hama, Onagawa-cho, Ojika-gun, Miyagi Prefecture, in the southern part of the Kitakami Massif. Uppermost Scythian, Prohungaritan ammonite stage or *Leiophyllites* zone.
Reg. No. IGPS coll. cat. no. 91407. Coll. Y. ONUKI and K. SASAKI.

Family Ussuritidae HYATT, 1900

Genus *Leiophyllites* DIENER, 1915

Leiophyllites cf. *pitamaha* (DIENER)

Pl. 37, fig. 6

Compare:
1895. *Monophyllites pitamaha* DIENER, p. 107, pl. 31, figs. 7a-c, 5 ? and 8 ?
1915. *Leiophyllites pitamaha* DIENER, p. 205.
1934. *Leiophyllites pitamaha* SPATH, p. 297.
1968. *Leiophyllites pitamaha* SHEVYREV, p. 112, pl. 6, fig. 3.

Description: Shell evolute, laterally compressed, slowly increasing in height, with serpenticone coiling whorls. The outer whorl slightly embracing the inner whorls; the umbilicus width very broad and shallow. The surface is ornamented with faint radial fine striations of growth and the sides are smooth and roundly convex. The venter is narrowly rounded and its shoulders indistinctly rounded. The umbilical shoulders gently rounded to the umbilicus. The maximum width is at the middle height of the flanks. Septa unknown.

Remarks: Two specimens were studied. The specimens described here were collected from the lowermost part of the Fukkoshi Formation at the quary of Konori, about 300 m west of Konori and at the boundary between the Lower Triassic Osawa Formation and the Fukkoshi Formation (Uppermost Scythian to Lower Anisian). The genus *Leiophyllites* was first described from Japan by SHIMIZU (1930) from the Isatomae Formation at Kudano-hama, Isatomae, Utazu-cho, Motoyoshi-gun, Miyagi Prefecture, at about 30 km north of Konori. No species of *Leiophyllites* have been recorded from any other localities of the Lower and Middle Triassic formations of the Kitakami Massif. According to the field observations the horizon that yielded the present ammonite may belong to the Fukkoshi Formation (Lowermost Anisian-Uppermost Scythian). The materials at hand are poorly preserved, but the ornamentation of the shell, the umbilicus and the whorl characters are well preserved. The character of the whorl shape, ornamentation and the umbilicus resemble the genus *Leiophyllites*. Specificially, the specimens illustrated here show a close resemblance with *Leiophyllites pitamaha* DIENER (DIENER, 1895, p. 107-108, pl. 31, figs. 5, 7, 8, as *Monophyllites*) in the whorl section, the form of umbilicus and the shell ornamentation. But the striations on the shell of DIENER's Himalayan form are feebler than those on our specimens. Another Himalayan

Measurements of Leiophyllites cf. *pitamaha* (DIENER) (*in mm*):

	D	H	W	U	H/D	U/D
IGPS coll. cat. no. 91403-1	——	9.0(5.7)	——	11.95	——	——
IGPS coll. cat. no. 91403-2	29.1(18.8)	7.8(3.8)	——	15.2(8.0)	0.26(0.20)	0.53(0.42)

species, *Leiophyllites pradyumna* DIENER (DIENER, 1895, p. 106-107, pl. 31, figs. 3-4 as *Monophyllites*) has denser striations of growth or more delicate striae of growth near the umbilical margin compared with *L. pitamaha*.

Occurrence and geological horizon: Black shale in the alternation of sandstone and shale of the Osawa Formation at Konori-hama, Onagawa-cho, Ojika-gun, Miyagi Prefecture, in the southern Kitakami Massif. Uppermost Scythian, Prohungaritan ammonite stage or *Leiophyllites* zone.

Reg. No. IGPS coll. cat. no. 91403. Coll. Y. ONUKI and K. SASAKI.

Leiophyllites aff. *pradyumna* (DIENER)

Pl. 38, fig. 3

Compare:

1895. *Monophyllites pradyumna* DIENER, p. 106, pl. 31, figs. 3-4.
1915. *Leiophyllites pradyumna* DIENER, p. 205.
1934. *Leiophyllites pradyumna* SPATH, p. 306.
1968. *Leiophyllites pradyumna* ZAKHAROV, p. 124, pl. 23, figs. 2, 3.

Description: Evolute, laterally compressed, with wide umbilicus and distinct radial striations of growth. The width of the umbilicus is about half of the total diameter of the shell and the height of the shell is about 1/3 of the total diameter of the shell. The umbilical and ventral shoulders are unknown because of lateral deformation. The septa are also unknown.

Remarks: Judging from the shell ornamentation and umbilical features the present material resembles *L. pradyumna* (DIENER) from the Himalayan Muschelkalk, but comparison of their septa and whorl section is difficult because of the incomplete preservation of our material. As already mentioned by DIENER (1895) and SPATH (1934) the shell surface of *L. pradyumna* is characterized by striations more distinct than the other species of *Leiophyllites* and by the periodical exterior fringed ribs which, however, do not reach the umbilicus. The present material clearly exhibits these features on the surface of the shell. Up to date, *Leiophyllites pradyumna* has been described from the Himalayas and Timor. Most recently, ZAKHAROV (1968) described *L. pradyumna* from the Lower Triassic in the southern Primorye. In Japan, this is the first occurrence of this species. *L.* cf. *pseudopradyumna* WELTER related to the present species has been already reported by SHIMIZU (1930) from the Isatomae Formation at Kudano-hama, Utazu-cho, Motoyoshi-gun, Miyagi Prefecture, in the Kitakami Massif.

Occurrence and geological horizon: Black shale in the alternation of sandstone and shale of the Osawa Formation at Konori-hama, Onagawa-cho, Ojika-gun, Miyagi Prefecture, in the southern Kitakami Massif. Uppermost Scythian,

Measurements of Leiophyllites aff. *pradyumna* (DIENER) (*in mm*):

	D	H	W	U	H/D	W/H	U/D
IGPS coll. cat. no. 91404	54.3(25.0)	17.6(7.8)	——	25.7(12.9)	0.32(0.31)	——	0.47(0.52)
L. pradyumna	42	12.5	10	21	0.29	0.8	0.5
by DIENER (1895)	26	9	9	12	0.34	1.0	0.47

Prohungaritan ammonite stage or *Leiophyllites* zone.
Reg. No. IGPS coll. cat. no. 91404. Coll. Y. ONUKI and K. SASAKI.

References

BANDO, Y. (1964): The Triassic stratigraphy and ammonite fauna of Japan. *Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.)*, vol. 36, p. 1-137, pls. 1-15.

—— (1968): Stratigraphic problems concerning the newly occurred Lower Triassic ammonites from the Kitakami Massif and Maizuru Zone. *Mem. Fac. Educ., Kagawa Univ.*, pt. 2, no. 174, p. 1-7, pls. 1-3.

CHAO, K.C. (1959): Lower Triassic ammonoids from Western Kwangsi, China. *Palaeont. Sinica, N.S. B*, no. 9, p. 1-355, pls. 1-45.

DIENER, C. (1895): Himalayan Fossils. The Cephalopoda of the Muschelkalk. *Pal. Indica*, 15th Ser., 2, pt. 2, p. 1-118, pls. 1-31.

—— (1913): Himalayan Fossils. Triassic faunae of Kashimir. *Ibid., N.S.*, 5, p. 1-133, pls. 1-13.

—— (1915): Fossilium Catalogue. 1, pt. 8. Cephalopoda Triadica, p. 1-369, Berlin.

—— (1916): Japanische Triasfaunen. *Akad. Wiss. Wien, Denkschr.*, vol. 92, p. 405-549, pl. 1.

FREBOLD, H. (1930): Die Altersstellung des Fischhorizontes, des Grippianiveaus und des unteren Saurierhorizontes in Spitsbergen. *Skr. Svalb. og. Ishavet*, vol. 28, p. 1-36, pls. 1-6.

HYATT, A. and SMITH, J.P. (1905): The Triassic cephalopod genera of North America. *U.S.G.S. Prof. Paper* 40, p. 1-394, pls. 1-85.

ICHIKAWA, K. (1948): Stratigraphy of the Lower and Middle Triassic in the Tsuya-Isatomae districts in the southern Kitakami Massif. *J. Geol. Soc. Japan*, vol. 53, p. 79 (in Japanese).

—— (1951): Triassic system in the southern part of the Kitakami Massif, in the Triassic stratigraphy of Japan. *Geol. Surv. Japan, Rep. Spec.* No., p. 7-26 (in Japanese).

INAI, Y. (1939): Geology of Shizukawa and its environs in Miyagi Prefecture. *J. Geol. Soc. Japan.*, vol. 46, p. 231-242 (in Japanese).

KIPARISOVA, L.D. (1961): Paleontological foundation for the stratigraphy of the Triassic deposits of the Primorye region. Part 1, Cephalopoda. *Vsesoiuzuyi Nautsuno-Issledovatelskii Geol. Inst.* (VSEGEI), n. ser. 48, p. 1-278, pls. 1-38 (in Russian).

KIPARISOVA, L.D. and POPOV, Yu. N. (1956): Subdivision for the Lower Triassic system into stages. *Dokl. Akad. Nauk. S.S.S.R.*, vol. 109, no. 4, p. 842-845 (in Russian).

—— and —— (1961): On the subdivision of the Lower Triassic into two stages. *Bull. Interdept. Stratigr. Comm.*, vol. 3, p. 24-37 (in Russian).

—— and —— (1964): The project of subdivision of the Lower Triassic into stages. Internat. Geol. Congr., 22nd Session. Dokl. Soviet Geol., Problema 16a, *Acad. Nauk. S.S.S.R.*, p. 91-99 (in Russian with English summary).

KUMMEL, B. (1954): Triassic stratigraphy of southeastern Idaho and adjacent areas. *U.S.G.S. Prof. Paper* 254, p. 165-194.

—— (1957): In "Treatise on Invertebrate Palaeontology", Part L. Mollusca 4, Cephalopoda, Ammonoidea. Geol. Soc. Amer. and Univ. Kansas Press, p. 1-490.

—— (1969): Ammonoids of the Late Scythian (Lower Triassic). *Bull. Museum of Comp. Zool., Harvard Univ.*, vol. 137, no. 3, p. 311-559, pls. 1-71.

KUMMEL, B. and STEELE, C. (1962): Ammonites from the *Meekoceras gracilitatis* Zone at Crittenden Spring, Elko County, Nevada. *J. Paleont.*, vol. 36, no. 4, p. 638-703, pls. 99-104.

KUROSAWA, M. (1929): Geology of Maiya-Shizugawa area in the Kitakami Massif (Graduation Thesis, MS, in Japanese).

MABUTI, S. (1932): Stratigraphy of the Tatsukane Mass in southern Kitakami

Massif (Graduation Thesis, MS, in Japanese).

NAKAZAWA, K. (1958): The Triassic system in the Maizuru Zone, southwest Japan. *Mem. Coll. Sci., Univ. Kyoto, Ser. B,* vol. 24, p. 265–313.

NAKAZAWA, K. and BANDO, Y. (1968): Lower and Middle Triassic ammonites from Portuguese Timor (Palaeontological study of Portuguese Timor, 4). *Mem. Fac. Sci., Kyoto Univ., Ser. Geol. & Min.,* vol. 34, p. 83–114, pls. 4–7.

ONUKI, Y. (1959): Geology of the Kitakami Massif. *Geological explanation of Iwate Prefecture* II, p. 1–189 (in Japanese).

—— (1969): Geology of the Kitakami Massif, Northeast Japan. *Contr. Inst. Geol. Pal., Tohoku Uhiv.,* no. 69, p. 1–239, pls. 1–4.

POPOV, Yu. N. (1961): Triassic ammonoids of northwestern U.S.S.R. *Nautsuno-Issledovatelskii Inst. Geol. Arckt., Trudy,* vol. 79, p. 1–124, pls. 1–25 (in Russian).

SHEVYREV, A.A. (1968): Triassic ammonoids of southern U.S.S.R. *Akad. Nauk SSSR, Pal. Inst., Trudy,* vol. 119, p. 1–252, pls. 1–21 (in Russian).

SILBERLING, N.J. and TOZER, E.T. (1968): Biostratigraphic classification of the Marine Triassic in North America. *Geol.*

Explanation of Plate 37

Fig. 1. *Glyptophiceras* cf. *gracile* SPATH
GLKU-C402 ×1, from the calcareous sandy shale at Monzen, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture. Lower part of the Hiraiso Formation. Lowest Scythian, Otoceratan or Lowest Induan stage.

Fig. 2. *Flemingites* sp.
JM 11210 ×1.2, from the black shale of the Osawa Formation at Osawa, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture. Upper Scythian, Owenitan stage.

Fig. 3. *Meekoceras* sp. A
JM 11208 ×1.5, Loc. ibid. Upper Scythian, Owenitan stage.

Fig. 4. *Xenoceltites* ? sp.
JM 11209 ×1.3, Loc. ibid. Upper Scythian, Owenitan stage.

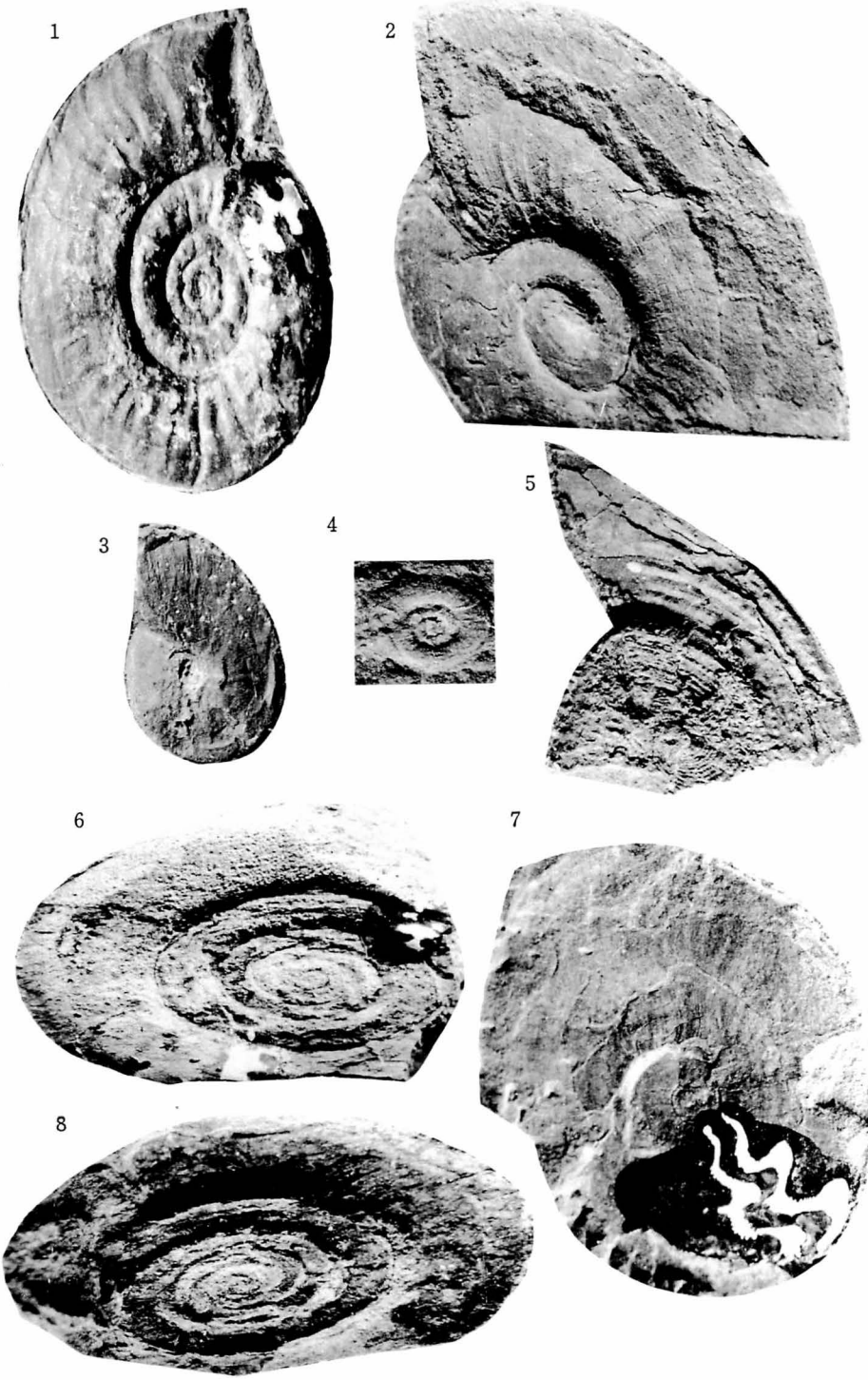
Fig. 5. *Euflemingites* sp.
JM 11206 ×1.4, Loc. ibid. Upper Scythian, Owenitan stage.

Fig. 6. *Leiophyllites* cf. *pitamaha* (DIENER)
IGPS, coll. cat. no. 91403 ×2, from the Osawa Formation at Konori, Onagawa-cho, Ojika-gun, Miyagi Prefecture. Uppermost Scythian, Prohungaritan or *Leiophyllites* zone.

Fig. 7. *Meekoceras* sp. B
JM 11207 ×1.4, from the calcareous sandy shale of the Osawa Formation at Osawa, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture. Upper Scythian, Owenitan stage.

Fig. 8. *Leiophyllites* sp.
IGPS, coll. cat. no. 91405 ×1.3, from the Osawa Formation at Konori, Onagawa-cho, Ojika-gun, Miyagi Prefecture. Uppermost Scythian, Prohungaritan or *Leiophyllites* zone.

The specimens of Figs. 2, 3, 4, 5 and 7 are preserved in the Department of Geology and Mineralogy, Kyoto University, Kyoto; and the specimens of Figs. 6 and 8 are preserved in the Institute of Geology and Paleontology, Tohoku University, Sendai. The first specimen, Fig. 1, being preserved in the Department of Geology, University of Kagawa, Takamatsu.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Soc. Amer., Spec. Paper 110, p. 1-63.

SHIMIZU, S. (1930): On some Anisic ammonites from the *Hollandites* Beds of the Kitakami Mountainland. *Sci. Rep. Tohoku Imp. Univ., 2nd Ser. (Geol.)*, vol. 14, p. 63-74, pl. 24.

SHIIDA, I. (1939): On the Geology of Kesennuma-cho and its environs in Miyagi Prefecture. *Contr. Inst. Geol. Pal., Tohoku Univ.*, no. 33, p. 1-72.

SMITH, J.P. (1914): The Middle Triassic invertebrate fauna of North America. *U.S.G.S. Prof. Paper* 83, p. 1-254, pls. 1-99,

—— (1932): Lower Triassic ammonoids of North America. *Ibid.*, 167, p. 1-199, pls. 1-81.

SPATH, L.F. (1930): The Eotriassic invertebrate fauna of East Greenland. *Med. om Grφnland*, vol. 83, p. 1-90, pls. 1-12.

—— (1934): The Ammonoidea of the Trias (1); *Catalogue of the Fossil Cephalopoda in the British Museum (Nat. Hist.)*, pt. 4, p. 1-521, pls. 1-18.

—— (1951): The Ammonoidea of the Trias (II); *Ibid.*, pt. 5, p. 1-228.

TOZER, E.T. (1961): Triassic stratigraphy and faunas, Queen Elizabeth Island, Arctic Archipellago. *Geol. Surv. Canada, Mem.* 316, p. 1-116, pls. 2-30.

—— (1965): Lower Triassic stages and ammonoid zones of Arctic Canada. *Geol. Surv. Canada, Paper* 65-12, p. 1-14.

—— (1967): A standard for Triassic time. *Gelol. Surv. Canada, Bull.* 156, p. 103, pls. 1-10.

TOZER, E.T. and PARKER, J.R. (1968): Notes on the Triassic biostratigraphy of Svalbard. *Geol. Mag.*, vol. 105, no. 6, p. 526-542, pls. 25-27.

TRÜMPY, R. (1969): Lower Triassic ammonites from Jameson Land (East Greenland), in Notes on Triassic Stratigraphy and Paleontology of North-Eastern Jameson Land (East Greenland). *Med. om Grφnland*, Bd. 168, no. 2, p. 81-116, pls. 1-2.

WAAGEN, W. (1895): Fossils from the Ceratite Formation. *Pal. Indica, 13th Ser. Salt Range Fossils*, 2, p. 1-323, pls. 1-40.

WELTER, O.A. (1922): Die Ammoniten der unteren Trias von Timor. *Pal. von Timor*, vol. 11, p. 83-154, pls. 155-171.

YEHARA, S. (1927): The Lower Triassic cephalopod and bivalve fauna of Shikoku. *Japan. J. Geol. Geogr.*, vol. 5, p. 135-172, pls. 13-17.

ZAKHAROV, Yu. D. (1968): Lower Triassic biostratigraphy and ammonoids in southern Primorye Region. *Akad. Nauk SSSR, Siberian Branch, Far East Geol. Inst.*, p. 1-172, pls. 1-31 (in Russian).

Fukkoshi	風越
Hiraiso	平磯
Inai	井内
Isatomae	伊里前
Ishinomaki	石巻
Konori	小乗
Kudano-hama	管ノ浜
Monzen	門前
Motoyoshi	本吉
Ojika	牡鹿
Onagawa	女川
Osawa	大沢
Tao (Taho)	田穂
Tate	舘
Tomisu	富栖
Toyoma	登米
Utazu	歌津

Explanation of Plate 38

Fig. 1. *Danubites* aff. *ambika* DIENER
IGPS, coll. cat. no. 91406. ×2.
Fig. 2. *Danubites* sp.
IGPS, coll. cat. no. 91407. ×2.
Fig. 3. *Leiophyllites* aff. *pradyumna* (DIENER)
IGPS, coll. cat. no. 91404. ×2.

All illustrated specimens here are from the Osawa Formation at Konori, Onagawa-cho, Oshika-gun, Miyagi Prefecture, southern Kitakami Massif. Uppermost Scythian, Prohungaritan stage of *Leiophyllites* zone. All specimens are preserved in the Institute of Geology and Paleontology, Tohoku University, Sendai. Coll. Prof. Y. ONUKI and Mr. K. SASAKI.

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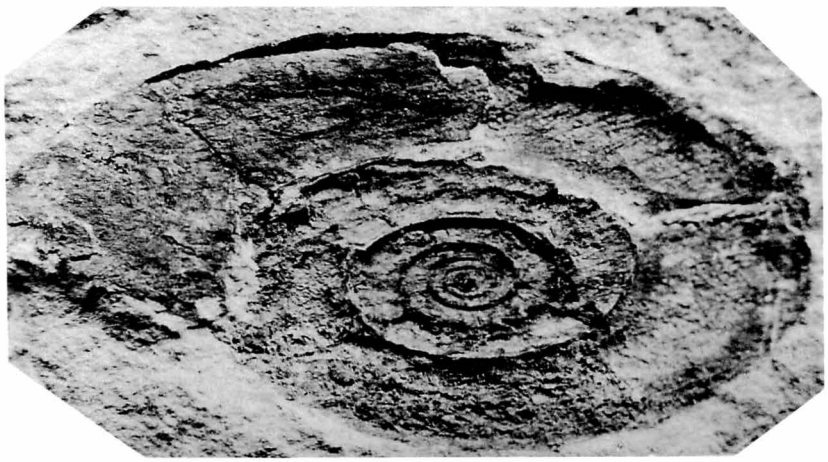

例　会　通　知

	開　催　地	開　催　日	講演申込締切日
106回例　会	広　島　大　学	1970年11月22日	1970年10月10日
1971年 総会・年会	東　京　大　学	1971年1月23・24日	1970年12月10日
107回例　会	関　西　地　区	1971年6月	
108回例　会	九　州　大　学	1971年10月中　旬	

◎ 106回例会（広島大学）：シンポジウム，中国地方新生界の化石群（世話人：中野光雄）。
◎ 108回例会（九州大学）：5学会連合学術大会（予定）。

学　会　記　事

◎ 1970年6月26日の評議員会において，下記の諸君の入会が承認された。（敬称略）
斉藤　実・清水照夫・岡村長之助・植村和彦・崔　東龍・Daniel HABIB

News

◎ 「化石」の19・20号合併号が，昭和45年8月31日に出版された。植物の分布と進化のシンポジウム特集号である。
◎ 「日本古生物学の回想」（A5版59頁）が本会より出版された。矢部長克先生80才の祝賀会（昭和33年）の際に拠金された方に配布した。残部は実費（300円）で頒布する。

◎ 本会誌の出版費の一部は文部省研究成果刊行費による。

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