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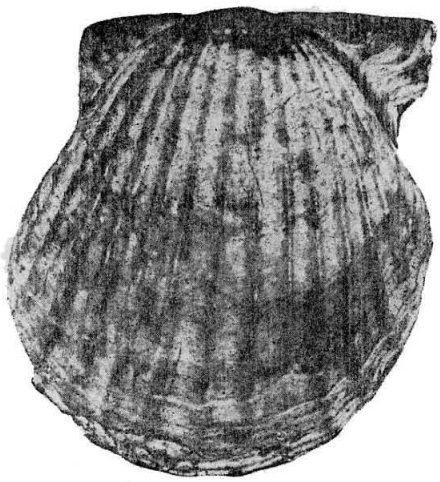

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TRANSACTIONS

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512. MOLLUSCAN FAUNA OF THE HIGASHI-INNAI FORMATION OF NOTO PENINSULA, JAPAN-II: REMARKS ON MOLLUSCAN ASSEMBLAGE AND DESCRIPTION OF SPECIES

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能登半島東印内層の軟体動物化石群—II；貝化石群集と種の記載： 本編では各産出層準の古環境，古地理の変遷を考察した。 また貝化石群の時代が中新世初期を示すことを明らかにした。 さらに17新種を記載した他，若干の既知種の再検討を行なつた。 増田孝一郎

Concluding Remarks on Molluscan Assemblage

The stratigraphical and geographical distributions of the molluscan shells and the other fossils from the Higashi-Innai Formation are shown in Tables 1-4. For the sake of convenience the stratigraphical and geographical changes of the molluscan assemblages will be described from the lower to the upper horizon.

(a) First horizon

During this stage the environmental conditions may not have been favourable to the molluscs because of the rapid deposition of the sediments and unstable sedimentary basin. However, gradually the conditions changed and the environment became favourable to the molluscs. The molluscan assemblages are generally characterized by the few number of species and individuals and by such brackish water genera as *Ostrea*, *Vicarya*, *Vicaryella*, *Cerithidea*, *Batillaria*, *Nassarius*, etc.

From the little change in the assemblages from the different localities and their rather uniform and extensive distributions in the present field it is inferred that the molluscs were able to survive the environmental conditions involving variable and extreme salinities and temperatures. The environmental conditions of the first horizon may have been a shallow embayment (Fig. 1).

(b) Second horizon

With the opening of this stage the seas continued to transgress towards the south from the north.

The faunal assemblage of this stage is varied, being composed of besides the molluscs, corals, echinoids, larger foraminifera and others. The molluscan species become very numerous in both species and individuals compared with the first horizon. The distributions of the molluscs are shown in Figs. 2 and 3. The distributions of the hard bottom dwelling molluscs coincide with the distributions of such fossils as corals, bryozoans, calcareous algae, etc.

From the figures and tables it is noticed that the molluscan species show wide variation in the assemblage geo-

* Received February 10, 1966; read Sept. 25, 1965 at Nagasaki.

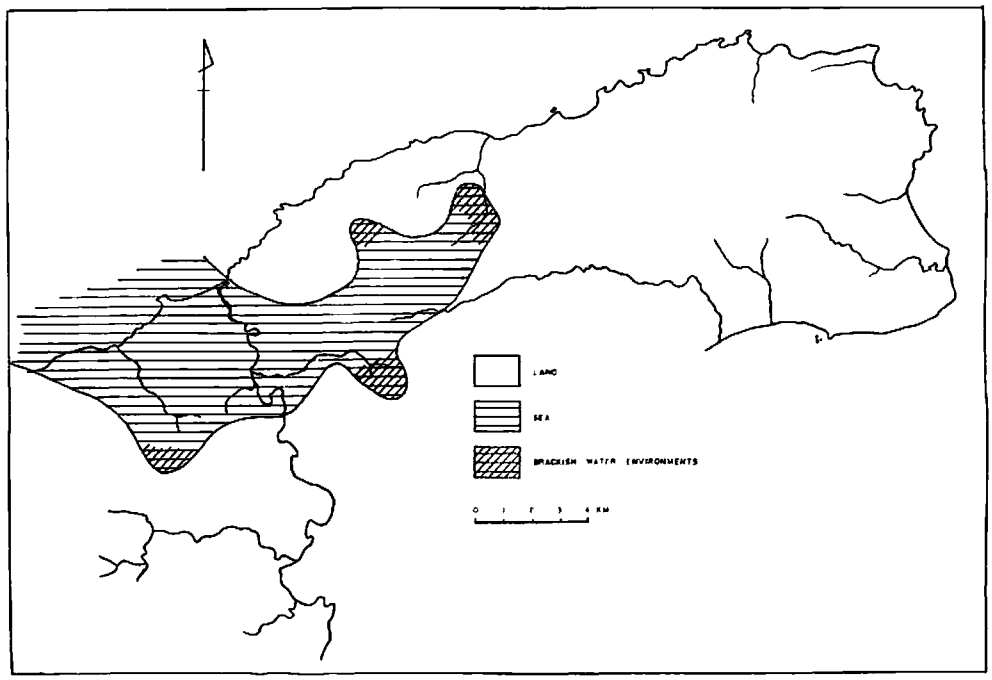

Fig. 1. Paleogeographical map of the First horizon.

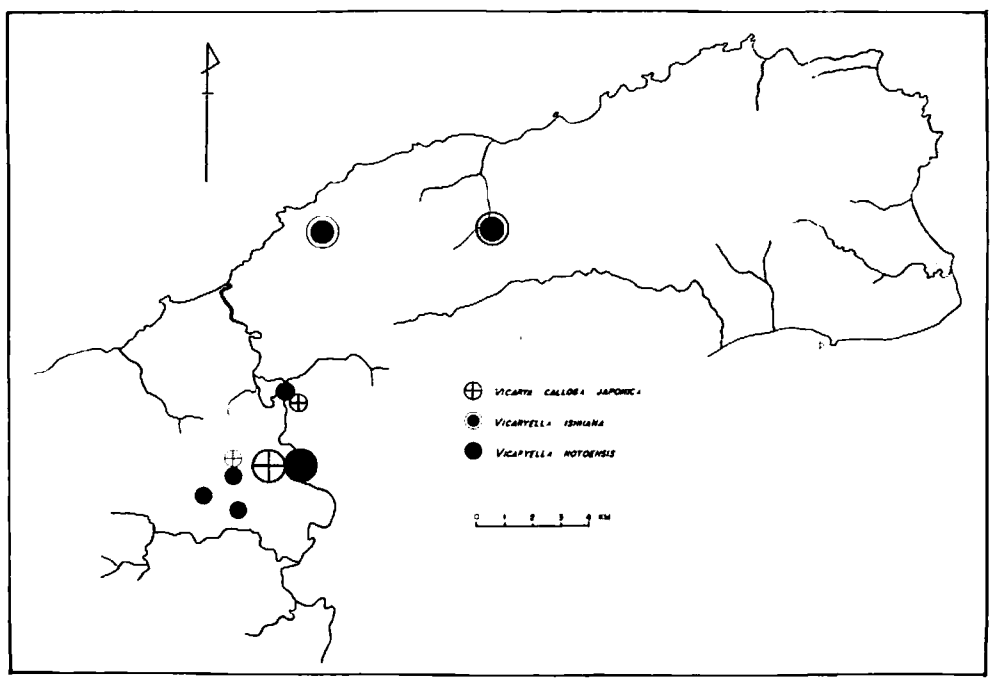

Fig. 2. Distributions of *Vicarya callosa japonica* YABE and HATAI, *Vicaryella ishiiana* (YOKOYAMA) and *Vicaryella notoensis* MASUDA (large circle: abundant to common occurrence of that species; small circle: few to rare occurrence of that species).

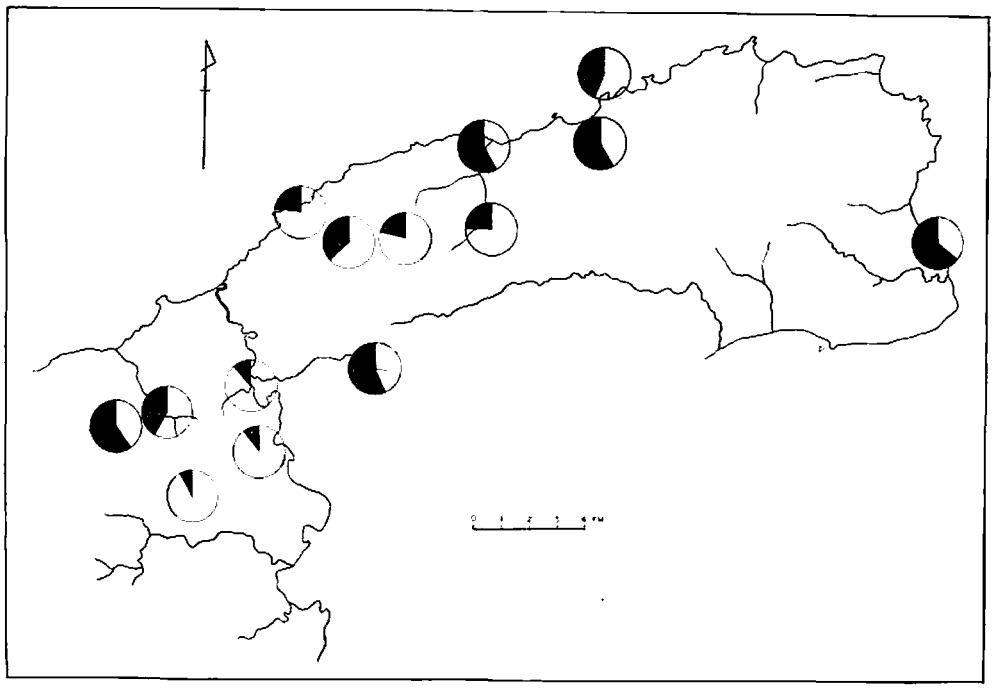

Fig. 3. Relative abundancy of hard bottom dwelling molluscs (dark colored).

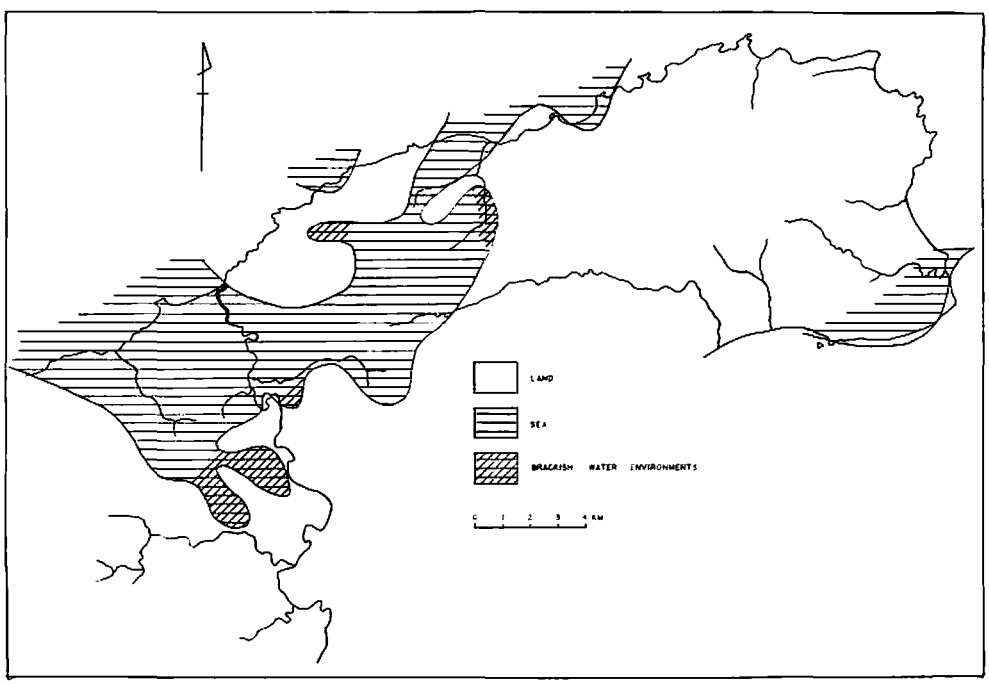

Fig. 4. Paleogeographical map of the Second horizon.

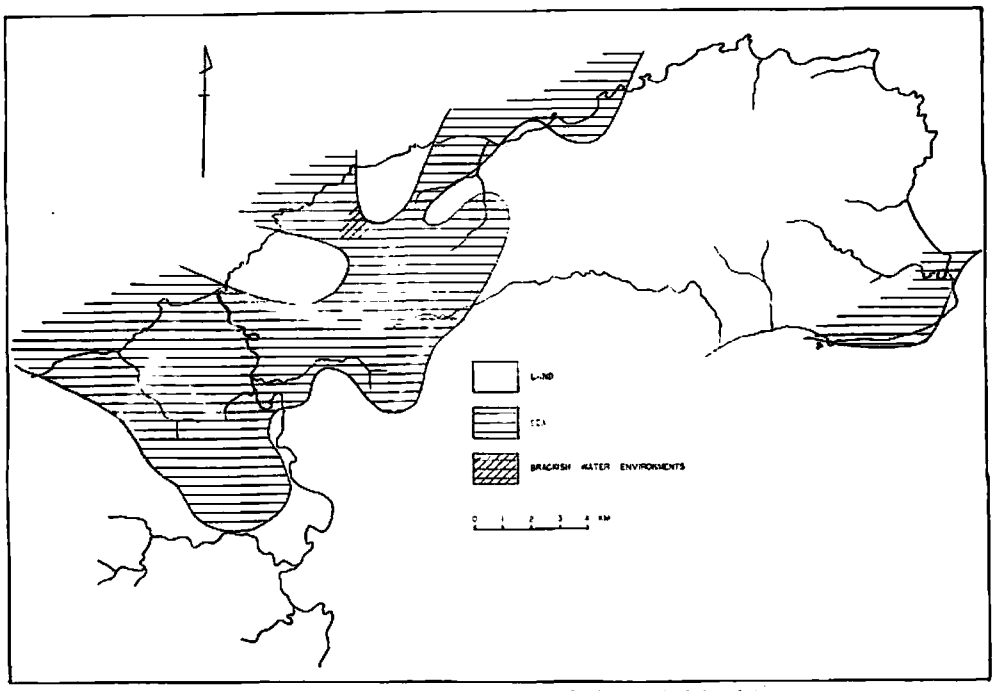

Fig. 5. Paleogeographical map of the Third horizon.

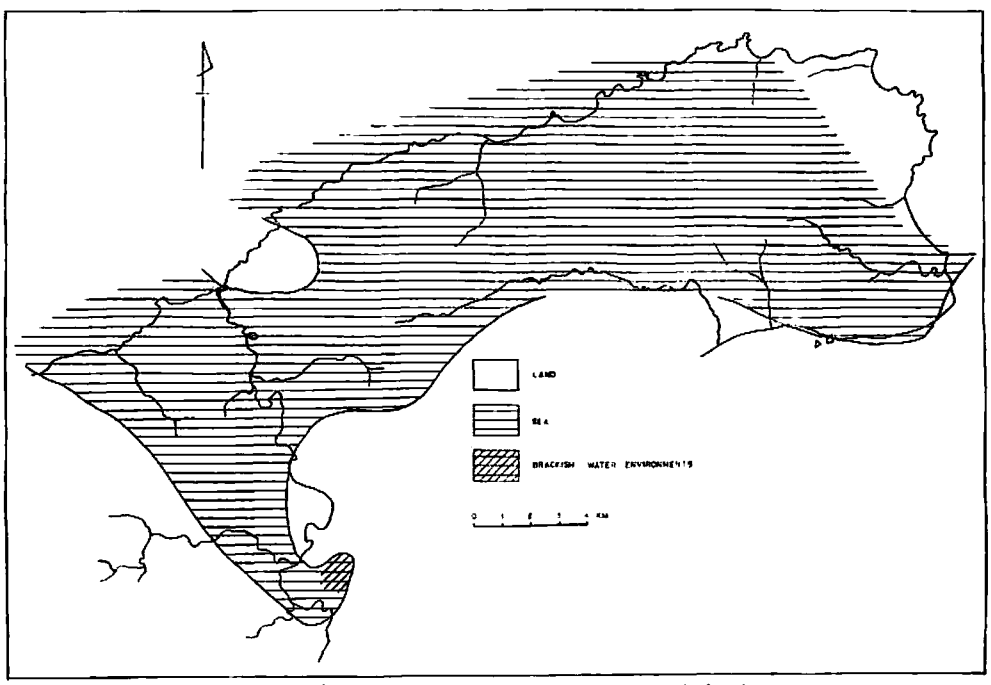

Fig. 6. Paleogeographical map of the Fourth horizon.

graphically. Among the molluscs there are some good ecologic indicators as *Vicarya callosa japonica* YABE and HATAI, *Vicaryella notoensis* MASUDA, *Nassarius notoensis* MASUDA, *Raeta* sp., *Cyclina japonica* KAMADA, etc. These are good indicators of brackish water ecological conditions. The occurrence of allopatric forms as *Vicaryella notoensis* MASUDA, *V. ishiiana* (YOKOYAMA), *Nassarius notoensis* MASUDA, *N. minoensis* ITOIGAWA, *Cyclina japonica* KAMADA and *C. lunulata* MAKIYAMA are important for consideration of the paleoenvironmental conditions during deposition.

From the fossils, it is inferred that the brackish environmental conditions existed in the southern area near Kanagura, in the vicinity of Awagura and in the vicinities of Kobunayama and Fujio. Elsewhere the conditions are inferred to have been marine. From the lithologic characters and the thickness variation in the vicinity of Kakuma there may have existed a channel extending from Ôtani to near Fujio through Kakuma (Fig. 4).

(c) Third horizon

This stage is represented by only a few fossil localities. The molluscan species from the uppermost part of Loc. No. 24 comprise brackish water forms as *Vicarya callosa japonica* YABE and HATAI, *Vicaryella notoensis* MASUDA, etc. Those from other localities are few in species and individuals but consist of a marine assemblage.

Judging from the lithological characteristics, fauna and distribution it is thought that there was some fluctuation during the marine transgression of this stage or at least some differential movements. The map of this stage is shown in Fig. 5.

(d) Fourth horizon

The seas of this stage extended to the southern area and the carbonaceous sandy siltstone near Kyûden yielded many molluscan shells but the fossil molluscs are contained in the glauconite bearing coarse-grained sandstone at other localities. The molluscan fauna from Kyûden (Loc. No. 22) consists of *Raeta* sp., *Saxolucina k-hataii* (OTUKA), *Cerithidea* sp., etc. It seems that there may have been a small embayment in the vicinity of Kyûden opened towards the northwest. The paleogeographical map of this stage is shown in Fig. 6.

(e) Conclusion

From the faunal elements and the paleogeography it is considered that the Higashi-Innai Formation was deposited under the influence of a warm and shallow sea as shown by the occurrence of tropical to subtropical molluscs as *Ctena, Katelysia, Euchelus, Monilea, Turbo, Nerita, Littorinopsis, Rissoina, Architectonica, Vicarya, Vicaryella, Pachycrommium, Cypraea, Apollon, Oliva, Vexillum, Mitra, Philbertia, Cythara, Conus*, etc. This view is upheld by the associated occurrence of reef building corals and by the assemblages of the smaller foraminifera as pointed out by ASANO (1953).

Geological Age and Correlation

The Higashi-Innai Formation is characterized with such fossil molluscs as *Anadara makiyamai* HATAI and NISIYAMA, *A. kurosedaniensis* HATAI and NISIYAMA, *Chlamys ishidae* MASUDA, *C. iwamurensis* ITOIGAWA, *Crassatellites suyamensis* OINOMIKADO, *Felaniella ferruginata* (MAKIYAMA), *Joannisiella meisensis* MAKIYAMA, *Saxolucina k-hataii* (OTUKA), *Pillucina yokoyamai* (OTUKA), *Clinocardium ogurai* (OTUKA), *Cyclina japonica* KAMADA, *C. lunulata* MAKIYAMA, *Dosinia akaisiana* NOMURA, *D. tugaruana* NOMURA, *Protothaca tateiwai* (MAKIYAMA), *Pitar itoi* (MAKIYAMA),

Katelysia nakamurai IKEBE, *Soletellina minoensis* YOKOYAMA, *Cultellus izumoensis* YOKOYAMA, *Turbo ozawai* OTUKA, *Littorinopsis miodelicatula* OYAMA, *Architectonica kurodae* TSUDA, *Cerithidea kanpokuensis* MAKIYAMA, *Vicarya callosa japonica* YABE and HATAI, *Vicaryella ishiiana* (YOKOYAMA), *V. notoensis* MASUDA, *Cerithium ancisum* (YOKOYAMA), *Calyptraea tubura* OTUKA, *Polinices meisensis* MAKIYAMA, *Neverita coticazae* (MAKIYAMA), *Pachycrommium japonicum* KANNO, *Sinum ineptum* (YOKOYAMA), *Apollon osawanoensis* TSUDA, *Chicoreus asanoi* MASUDA, *Conus tokunagai* OTUKA, etc. Among the molluscan species the Recent species or the ones referable to the Recent species are only nine such as *Lima* cf. *goliath* SOWERBY, *Ostrea* cf. *denselamellosa* LISCHKE, *Phylyctiderma* cf. *japonica* (PILSBRY), *Lucinoma acutilineatum* (CONRAD), *Cryptomya busoensis* YOKOYAMA, *Joannetia* cf. *cumingi* (SOWERBY), *Solen* cf. *gouldi* DUNKER, *Dentalium* cf. *hexagonum* GOULD and *D. weinkauffi* DUNKER.

This formation is also characterized with larger foraminifers as *Miogypsina kotoi* HANZAWA and *Operculina complanata japonica* HANZAWA and with the Orito Flora (ISHIDA, 1964) which corresponds to the Daijima Flora (HUZIOKA, 1949).

From the above mentioned accounts the geological age of the Higashi-Innai fauna is considered to be Early Miocene (MASUDA, 1962a, 1963).

From the molluscan species given in the faunal lists the Higashi-Innai Formation is considered to be a correlative of the faunas of the Heirokudô, Meisen and Ennichi Formations in Korea, the Kurosedani Formation of Toyama Prefecture, the Uchiura and Kunimi of Fukui, the Kawai of Shimane, the Orito and Tsugawa of Niigata, the Nishikurosawa of Akita, the Ainaigawa and Tanosawa of Aomori, the Takinoue of Hokkaido, the Mizunami of Gifu, the Tsuzuki of Kyoto, the Fujishima of Wakayama, the Tsuyama of Okayama, the Shôbara of Hiroshima, the Kaisekizan of Mie, the Shiratori of Iwate, the Kunugidaira of Fukushima and the Ajiri of Miyagi Prefectures.

Description of New Species and Remarks on Some Species

Family Nuculanidae

Genus *Saccella* WOODRING, 1925

Saccella saikaiensis MASUDA, n. sp.

Pl. 35, figs. 1a-b, 2, 3

Holotype:—DGS*, Reg. No. 4494.

Description:—Shell small, moderately thick, moderately inflated, transversely elongated, longer than high; antero-dorsal side slightly convex, passing gradually into rounded anterior margin; postero-dorsal side nearly straight, descending abruptly into broadly rounded ventral margin; posterior margin bluntly pointed. Beak somewhat curved, pointed, situated at nearly half of disc length. Surface with much curved ridge extending from beak to posterior end, sculptured with conspicuous, coarse, smooth concentric lines nearly equal to their interspaces in width. Escutcheon narrow, oblong, lanceolated, defined by ridge; lunule narrow, sharply defined by ridge from beak to near anterior end; interior character unknown.

* Abbreviation for the Department of Geology, Faculty of Education, Tohoku University, Sendai.

Dimensions (in mm):—

Height	7.8*	7.8	—	7.4	6.3	6.0	5.8
Length	12.9	13.4	13.2	12.0	12.0	ca. 9.5	10.2
Depth	5**	3.0	ca. 3.0	2.8	2.2	2.2	2.5

*—holotype; **—breadth

Remarks:—The present species resembles *Saccella minoensis* ITOIGAWA (1960, p. 263, pl. 1, fig. 1) from the Mizunami Group, Gifu Prefecture, but is distinguishable therefrom by its smaller shell, coarse concentric lines on surface, beak at nearly central part of disc, one radiating ridge extending from beak to posterior end and sharply defined lunule. *Saccella gordonis* (YOKOYAMA) (1920, p. 177, pl. 19, figs. 4, 5) from the Pliocene Naganuma Formation, Kanagawa Prefecture is distinguished from the present one by its sharply pointed posterior end, two radiating ridges and fine concentric lines. Also distinguishable from *Saccella confusa toyomaensis* KAMADA (1962, p. 50, pl. 2, figs. 1-5) from the Miocene Numanouchi Formation, Fukushima Prefecture by its rather large and short shell.

Type locality:—Loc. No. 23.

Occurrence:—Type loc.—C; Loc. No. 3—C; Loc. No. 4—F.

Family Pectinidae

Genus *Aequipecten* FISCHER, 1887

Aequipecten matsunagiensis
MASUDA, n. sp.

Pl. 35, figs. 4-6

Holotype:—DGS, Reg. No. 4506.

Description:—Shell small, moderately inflated, higher than long, nearly equilateral except for auricles, nearly equivalve; valves radiately ribbed, apical angle about 90°. Right valve with about 19, elevated, rather squarish, round-topped radial ribs and fine concentric growth lines; radial ribs nearly equal or a little narrower than their interspaces, sometimes with faint, fine, shallow furrows on surface near ventral margin; interspaces flat-bottomed; auricles medium in size; anterior auricle larger than posterior one, with prominent byssal notch, sculptured with a few radial threads and concentric lines; posterior one truncated behind at about right angle, with sculpture similar to anterior one; hinge with distinct cardinal crura, shallow and narrow resilial pit with short, distinct lateral ridges, widely open and distinct ctenolium. Left valve with sculpture nearly equal to right valve. Interior surface rather distinctly folded, with flutings near ventral margin.

Dimensions (in mm):—

Valve	Right*	Right	Right	Left
Height	21.0	14.0	8.5	10.0
Length	18.5	12.0	7.8	9.0
Depth	5.0	—	—	2.5

*—holotype

Remarks:—This species is distinguished from *Aequipecten yanagawaensis* (NOMURA and ZINBO) (1936, p. 337, pl. 20, figs. 2a-b) from the Miocene Yanagawa Formation, Fukushima Prefecture by its subequilateral shell, smaller apical angle, fewer roundtopped radial ribs and no intercalary threads. *Chlamys ishidae* MASUDA (1962a, p. 171, pl. 18, figs. 21-24) from the Miocene Kurosedani Formation, Toyama Prefecture is distinguished from the present one by its larger number of

rounded radial ribs, intercalary threads and characters of marginal serration.

Type locality:—Loc. No. 32.

Occurrence:—Type loc.—R; Loc. No. 3—R; Loc. No. 36—C.

Family Mytilidae

Genus *Modiolus* LAMARCK, 1799

Modiolus wanizakiensis MASUDA, n. sp.

Pl. 35, figs. 8a-b, 9

Holotype:—DGS, Reg. No. 4510.

Description:—Shell rather small, very thin, elongated, expanded posteriorly, moderately inflated; antero-dorsal side short, concave, rather abruptly passing into bluntly pointed anterior end; postero-dorsal side long, nearly straight near beak, rounded near posterior end, passing gradually into rounded posterior margin; ventral margin nearly straight except for rounded antero- and postero-ventral margins. Beak rather low, situated near anterior end. Surface with very faint, fine concentric growth lines slightly folded near margin. Interior characters unknown.

Dimensions (in mm):—

Height	18*	21	25
Length	30.5	35	—
Breadth	10.5	ca. 11.0	15.8

*—holotype

Remarks:—This species resembles *Modiolus yasuhiroi* KAMADA (1962, p. 72, pl. 3, figs. 13, 14) from the Numanouchi Miocene, Fukushima Prefecture but differs by its small, protruded anterior end and rounded posterior corner.

Type locality:—Loc. No. 33.

Occurrence:—Type loc.—C.

Family Myochamidae

Genus *Myadora* GRAY, 1840

Myadora suzuensis MASUDA, n. sp.

Pl. 35, figs. 10, 11

Holotype:—DGS, Reg. No. 4513.

Description:—Shell medium in size, rather thin, triangularly elongate oval in shape, longer than high; apical angle about 120°; antero-dorsal margin nearly straight, passing gradually into broadly rounded ventral margin; postero-dorsal margin gently curved downwards, passing abruptly into posterior margin and truncated behind; ventral margin broadly rounded. Right valve somewhat inflated; sculptured with very coarse, rather irregular, smooth concentric lines which are narrower than their interspaces and rather well-developed keel extending from beak to posterior corner, making elongated posterior border which is sculptured with broad, smooth concentric lines. Beak situated at nearly half of disc length. Left valve nearly flat, with sculpture nearly equal to right valve. Interior margin smooth; hinge with elongated, rather wide excavation bounded by distinct ridge; other interior characters unknown.

Dimensions (in mm):—

Valve	Right*	Right	Left
Height	10.0	10.2	6.2
Length	13.2	—	7.5
Depth	3.2	ca. 3.5	—

*—holotype

Remarks:—The present new species is distinguished from *Myadora okadae* HATAI and MASUDA (1960, p. 33, figs. 1, 2) from the Miocene Moniwa Member of the Hatatate Formation, Miyagi Prefecture by its elongated shell, broad, smooth

concentric lines and rather well developed keel. *Myadora ikebei* HABE (1950, p. 27, pl. 4, figs. 4-6), a Pleistocene and Recent species of Japan, can be distinguished by its ill-developed keel on the surface and regularly spaced coarse concentric lines.

Type locality:—Loc. No. 24.

Occurrence:—Type loc.—F; Loc. 33—F.

Family Carditidae

Genus *Glans* MEGERLE, 1811

Glans naomiae MASUDA, n. sp.

Pl. 36, figs. 13a, b, 14

Holotype:—DGS, Reg. No. 4517.

Description:—Shell small, moderately thick, subovate, moderately inflated; antero-dorsal side short, concave in front of beak, passing gradually into rounded ventral margin; postero-dorsal side long, rounded, passing gradually into ventral margin; beak pointed, curved forwards, situated anteriorly at about 2/3 of shell length; lunule small, sharply defined. Surface with about 22, elevated, conspicuously imbricated radial ribs and fine concentric growth lines; radial ribs somewhat broader than their interspaces; scales on radial ribs disc-like, rather flat, becoming closely packed and imbricated towards ventral margin and inclined apically. Interior margin with distinct coarse dentation; muscle scars faintly impressed; anterior cardinal and posterior cardinal teeth of left valve somewhat developed; hinge characters of right valve unknown.

Dimensions (in mm):— Height 9.6, length 10.1, breadth 6.0 (holotype); height 7.0, length 7.6 (paratype).

Remarks:—The present genus is rather rare in the Tertiary strata of Japan and may be the first record.

Glans hirasei (DALL) (KIRA, 1960, p. 130, pl. 52, fig. 20), a Recent species of Japan, can be distinguished from the present one by the large and subquadrate shell. *Glans sagamiensis* KURODA and HABE (HABE, 1961, p. 122, app. 37, pl. 55, fig. 14), a Recent species of Japan, also can be distinguished from the present one by its larger and subquadrate shell, nearly equal radial ribs and interspaces.

The description of the present species is based upon a single cojoined shell and a single small, isolated shell; they may represent rather young shells. The new name is taken after the name of my daughter, Naomi MASUDA.

Type locality:—Loc. No. 35.

Occurrence:—Type loc.—R; Loc. No. 23—R.

Family Lucinidae

Genus *Ctena* MÖRCH, 1861

Ctena hataii MASUDA, n. sp.

Pl. 35, figs. 15-20

Holotype:—DGS, Reg. No. 4521.

Description:—Shell rather small, moderate in thickness, inequilateral, longer than high, slightly inflated; antero-dorsal side rather long, somewhat concave in front of beak, passing gradually into broadly rounded ventral margin; postero-dorsal side short, rounded, merging into ventral margin; beak pointed, somewhat curved forwards, situated posteriorly at about one-third of shell length; lunule small, oblong, rather distinct. Surface with radial ribs, intercalary threads and concentric growth lines; radial ribs ten or a little more, somewhat broader than their interspaces, divided into two parts near beak and further bifurcate at about half of disc height; intercalary threads between radial ribs

usually appear at upper half of disc and sometimes bifurcate ventrally; secondary intercalary threads between radial ribs and primary intercalary threads appear near ventral margin; concentric growth lines distinct. Lateral teeth rather large and distinct; inner margin finely crenulated.

Dimensions (in mm) :—

Height	9.8*	11.2	9.6	9.0	9.0	7.5	6.0
Length	11.1	12.4	10.4	10.0	10.0	8.2	6.2
Depth	3.0	3.5	3.0	2.5	—	2.0	—

*—holotype

Remarks:—This new species is named in honor of Professor Kotora HATAI of the Tohoku University.

The present species resembles *Ctena minoensis* ITOIGAWA (1960, p. 269, pl. 2, fig. 6) from the Miocene Mizunami group of Gifu Prefecture and *Ctena delicatula* (PILSBRY) (1904, p. 555, pl. 41, figs. 15, 16), a Recent species of Southern Japan. But the former is distinguished from *hataii* by its small shell, coarse radial ribs and no intercalary threads, and the latter by its large shell and rather simple surface sculpture.

Type locality:—Loc. No. 30.

Occurrence:—Type loc.—C; Loc. No. 25—F; Loc. No. 32—R; Loc. No. 35—F; Loc. No. 36—R.

Family Veneridae

Genus *Cyclina* DESHAYES, 1849

Subgenus *Cyclinorbis* MAKIYAMA, 1926

Cyclina (*Cyclinorbis*) *lunulata* MAKIYAMA, 1926

Pl. 35, fig. 33

1926. *Cyclina* (*Cyclinorbis*) *lunulata* MAKIYAMA, *Jour. Coll. Sci., Imp. Univ. Kyoto, Ser. B. Vol. 2, No. 3*, p. 158, pl. 13, fig. 1.
1952. *Cyclina* (*Cyclinorbis*) *lunulata* MAKIYAMA, KAMADA, *Trans. Proc. Palaeont. Soc. Japan, N.S., No. 6*, p. 170, pl. 15, figs. 5, 6.

Holotype:—Geological Survey of Chôsen (Korea), Reg. No. 32.

Remarks:—In 1952 KAMADA described *Cyclina japonica*, n. sp. based upon the specimens from the Higashi-Innai Formation at Tokunari (Loc. No. 12) in the present field and discussed on the Recent and fossil species of the genus *Cyclina* of Japan and Korea.

Among the specimens from the Higashi-Innai Formation, the ones referable to *Cyclina japonica* KAMADA occur only at Tokunari (Loc. No. 12), the type locality of *Cyclina japonica*. The specimens from the localities other than just mentioned are referred to *Cyclina lunulata* MAKIYAMA.

From the morphological characters it is evident that *Cyclina japonica* KAMADA is closely related to *Cyclina lunulata* MAKIYAMA.

Type locality:—Nanseki, Meisen District, North Korea.

Occurrence:—Loc. No. 23—F; Loc. No. 24—F; Loc. No. 3—F.

Genus *Paphia* RÖDING, 1798

Subgenus *Paphia* s. s.

Paphia (s. s.) *euglypta ohiroi* MASUDA, n. subsp.

Pl. 35, figs. 22, 23

Holotype:—DGS, Reg. No. 4527.

Description:—Shell rather large, transversely elongated, moderately inflated; antero-dorsal side short, broadly concave, passing gradually into rounded antero-ventral margin; postero-dorsal side long, slightly convex but rounded near posterior end and merging into rounded postero-ventral margin; ventral margin nearly straight; beak situated anteriorly at about 2/3 of shell length. Surface with very coarse, round-topped concentric lines; concentric lines rather fine near beak but tend to become coarse and to strengthen with growth. Interior characters unknown.

Dimensions (in mm):—

Height	29.0*	29.5	27.5	23.5	23.5	20.5
Length	53.0	52.0	ca. 48.0	48.0	43.0	ca. 36.0
Depth	9.0	—	—	—	7.5	7.0

*—holotype

Remarks:—This new subspecies is much related to *Paphia euglypta* (PHILIPPI) (1848, p. 76, pl. 7, fig. 3), a Recent species of Southern Japan, but it is distinguishable therefrom by its oblong shell, broadly concaved antero-dorsal side and very coarse concentric lines. This species can be distinguished from *Paphia exillis takaokaensis* SHUTO (1957, p. 145, pl. 2, figs. 5-7, 21-22) from the Miocene Miyazaki group of Miyazaki Prefecture by its large shell and very coarse concentric lines. *Paphia pseudoliratus* VREDENBURG (1928, p. 457, pl. 31, figs. 2-5) from the Miocene Mekran Series of India is distinguished from the present one by its concentric folds which are broader than their intercalary furrows.

This new subspecies is named in honor of Mr. Sûyû ÔHIRO who helped the writer in the field.

Type locality:—Loc. No. 38.

Occurrence:—Type loc.—F; Loc. No. 37—C; Loc. No. 39—R.

Paphia (s. s.) *suzuensis* MASUDA, n. sp.

Pl. 35, figs. 24, 25

Holotype:—DGS, Reg. No. 1530.

Description:—Shell of medium size, moderately inflated, transversely elongated; antero-dorsal side short, slightly concave, passing gradually into rather acutely rounded anterior margin; postero-dorsal side long, nearly straight, passing gradually into rather acutely rounded posterior margin; ventral margin broadly rounded; beak pointed, situated anteriorly about one-third of shell length; escutcheon narrow, rather sharply defined. Surface with rather low, irregular, somewhat lamellated, close-set, coarse concentric lines; concentric lines at postero-dorsal side somewhat more prominent than those of other parts, broader than their interspaces. Interior characters

Dimensions (in mm):—

Height	25.3*	21.2	18.0	14.0	12.5	8.5
Length	43.0	34.5	29.0	22.5	20.0	12.5
Depth	8.5	7.5	—	5.5	3.5	3.0

*—holotype

unknown.

Remarks:—The present species can be distinguished from *Paphia hirabayashii* OTUKA (1938, p. 12, pl. 1, fig. 9, pl. 2, figs. 16, 19) from the Miocene Shiroyama Formation, Shizuoka Prefecture by its much elongated shell and finely lamellated coarse concentric lines. *Paphia grata tsumaensis* SHUTO (1957, p. 153, pl. 12, figs. 9-11) from the Miyazaki Miocene, Miyazaki Prefecture resembles the present species, but SHUTO's species is distinguishable from *suzuensis* by its fine concentric lines. This species can be distinguished from *Paphia pseudoliratus* VREDENBURG (Op. cit.) by the shell form and surface sculpture.

Type locality:—Loc. No. 30.

Occurrence:—Type loc.—F; Loc. No. 23—F.

Genus *Venerupis* LAMARCK, 1818

Subgenus *Amygdala* RÖMER, 1857

Venerupis (*Amygdala*) *takagii*

(MASUDA), 1955

Pl. 35, figs. 28a, b, 29

1955. *Callista chinensis takagii* MASUDA, *Trans. Proc. Palaeont. Soc. Japan, N. S., No. 20*, p. 121, pl. 19, fig. 7.

Holotype:—DGS, Reg. No. 2501.

Remarks:—*Callista chinensis takagii* was described by the writer from the Higashi-Innai Formation at Tokunari (Loc. No. 12) based upon two, small, unfavourably preserved specimens. Numerous rather well preserved specimens referable to *takagii* were collected from the Higashi-Innai Formation at different localities. These specimens show that *takagii* should be refered to the genus *Venerupis* and subgenus *Amygdala* and that the type specimens may be young shells.

The newly collected specimens take the following description: Shell medium to small, rather thin, moderately inflated, transversely elongated; antero-dorsal side short, slightly rounded, passing gradually into rounded anterior margin; postero-dorsal side long, nearly straight, grading into rounded posterior margin; ventral margin nearly straight to slightly rounded at central part of shell but tend to become rounded at both antero- and posterior ends; beak pointed, situated anteriorly at about 3/5 of shell length, escutcheon narrow, rather distinctly defined. Surface sculptured with numerous, close-set, rater low, fine radial threads and fine concentric growth lines; radial threads nearly equal to their interspaces; concentric lines rather more distinct at anterior part than at posterior part and appear somewhat decussated. Pallial sinus large, deep, nearly horizontal; upper line subparallel with lower, broadly rounded at end; interior margin smooth; hinge characters unknown.

The present species resembles *Venerupis* (*Amygdala*) *japonica* (DESHAYES) (KIRA, 1960, p. 144, pl. 56, fig. 23), a Recent species of Japan, but it is distinguishable therefrom by its rather small, oblong shell, nearly straight ventral margin, rather low, close-set radial threads, faint, fine concentric growth lines and large pallial sinus. Another closely related species is *Venerupis* (*Amygdala*) *variegata* (HANLEY) (SOWERBY, 1855, p. 696, pl. 151, figs. 133-138), a Recent species of Southern Japan, but *variegata* has a rather large shell, somewhat rounded postero-dorsal side and shallow pallial sinus.

Dimensions (in mm):—

Height	11.5*	18.5	16.8	13.5	13.4	6.5
Length	19.2	27.8	25.3	21.0	21.3	11.2
Depth	—	9.8**	5.0	4.0	—	2.3

*—holotype; **—breadth

Type locality:—Loc. No. 12.

Occurrence:—Type Loc.—F; Loc. No. 33—R; Loc. No. 35—C.

Family Erodonidae

Genus *Anisocorbula* IREDALE, 1930

Anisocorbula ohiroi MASUDA, n. sp.

Pl. 35, figs. 35a-b, 36a-b

Holotype:—DGS. Reg. No. 4546.

Description:—Shell rather small, moderately inflated, oblong, inequilateral; right valve slightly larger than left valve at ventral margin; antero-dorsal side shorter than postero-dorsal side; slightly rounded but somewhat concave in front of beak, passing gradually into broadly rounded ventral margin; postero-dorsal side somewhat rounded, passing abruptly into ventral margin. Beak small, pointed, situated somewhat anteriorly. Right valve with numerous, subequal, rather coarse, low, smooth concentric lines which are narrower than their interspaces, well developed keel extending from beak to postero-ventral corner, posterior border elongated with coarse concentric lines and ill developed keel from beak to postero-dorsal end. Left valve smaller than right, with surface sculpture equal to right valve except for obsolete keel from beak to postero-dorsal end. Interior surface smooth; hinge with small but somewhat distinct resilial pit; muscle scars rather distinct.

Dimensions (in mm):—

Height	6.5*	7.5	5.2	4.5	2.1	2.0
Length	9.5	10.2	8.2	6.2	3.6	3.5
Depth	4.5**	3.0	2.0	—	—	—

*—holotype; **—breadth

Remarks:—This species is distinguishable from *Anisocorbula peregrina* (YOKOYAMA) (1923, p. 55, pl. 6, figs. 14, 14a) from the Miocene Fujishima Formation, Wakayama Prefecture and *Anisocorbula osawanoensis* TSUDA (1960, p. 79, pl. 3, figs. 10a-c) from the Kurosedani Miocene, Toyama Prefecture, in having small, rather thin shell, numerous, rather coarse but low, smooth concentric lines and less distinct and small resilial pit.

Type locality:—Loc. No. 36.

Occurrence:—Type Loc.—F; Loc. No. 24—F; Loc. No. 30—F; Loc. No. 32—F; Loc. No. 33—R.

Family Haliotidae

Genus *Haliotis* LINNAEUS, 1758

Haliotis notoensis MASUDA, n. sp.

Pl. 36, fig. 1

Holotype:—DGS, Reg. No. 4551,

Description:—Shell small, thin, auriform, low; whorls low, about four in number, separated by rather indistinct sutures; about two younger whorls

smooth. Body whorl very large, low, somewhat shouldered, with a little more than ten small openings on shoulder and with somewhat elevated, curved, coarse longitudinal threads and numerous, unequal, rather fine spiral threads; longitudinal threads narrower than their interspaces, more elevated than spiral threads and somewhat granulated; spiral threads at periphery under shoulder nearly equal, smooth, much more distinct than those on surface, about five in number, narrower than interspaces.

Dimensions (in mm):—Height ca. 4.8, width 14.0×19.5 (holotype); height 5.0, width 29.0×20.0; width 22.0×17.0 (paratype).

Remarks:—From *Haliotis diversicolor* REEVE (1846, pl. 12, sp. 39), a Recent species of Southern Japan, the present new species can be distinguished by its strong longitudinal threads, fewer spiral threads on periphery and fine spiral threads on surface.

Type locality:—Loc. No. 24.

Occurrence:—Type loc.—R; Loc. No. 10—F; Loc. No. 30—F; Loc. No. 32—R.

Family Fissurellidae

Genus *Tugali* GRAY, 1843

Tugali notoensis MASUDA, n. sp.

Pl. 36, figs. 2a-b

Holotype:—DGS, Reg. No. 4552.

Description:—Shell rather small, low-conic; apex prominent, directed posteriorly, situated at about 3/4 of shell length; anterior surface somewhat concave; posterior surface broadly rounded. Surface with numerous longitudinal riblets and concentric lines, making reticulation; riblets rather low, unequal, somewhat broader than their interspaces; concentric lines rathr conspicuous at anterior margin; slit fasciole a little elevated. Aperture elongate oval, tapering posteriorly; interior margin finely denticulated.

Dimensions (in mm):—Height 7.5, length of aperture ca. 22.0, breadth of aperture 13.5.

Remarks:—This new species is distinguished from *Tugali decussatoides* (NOMURA and HATAI) (1936b, p. 148, pl. 17, fig. 11) from the Miocene Kubota Formation, Fukushima Prefecture by the position of its apex, broadly rounded posterior surface and more riblets.

Type locality:—Loc. No. 24.

Occurrence:—Type loc.—R; Loc. No. 30—R.

Family Trochidae

Genus *Euchelus* PHILIPPI, 1847

Euchelus notoensis MASUDA, n. sp.

Pl. 36, figs. 4a-c, 5a-c, 6a-c

Holotype:—DGS, Reg. No. 4554.

Description:—Shell rather small to medium in size, turbinate conical, with four post nuclear whorls and one and a half nuclear whorls; spiral angle about 90°. Whorls rounded, shouldered, separated by distinctly channeled sutures; nuclear whorls smooth, rounded; surface with several, conspicuous, fine granulated, unequal spiral threads and somewhat oblique, fine longitudinal threads; two spiral threads on first post nuclear whorl, tend to increase their number by intercalation downwards, nearly equal to their interspaces; interspaces with oblique, fine threads. Base of body whorl with fine, distinct, finely granulated, nearly equal spiral cords which are subequal to their interspaces. Aperture rather wide, suboval; outer lip rather thick, denticulated within; inner

lip sharply defined; umbilicus rather narrow, deep, crack-like; columela nearly straight, subvertical.

Dimensions (in mm):—

Height	5.8*	ca. 9.6	5.0	4.3	4.0	3.4
Diameter	7.0	ca. 10.0	6.0	5.4	4.8	4.0

*—holotype

Remarks:—The present species is distinguished from *Euchelus ornatissimus* YOKOYAMA (1926b, p. 374, pl. 43, figs. 7, 8) a Pleistocene species of Atsumi Peninsula, Aichi Prefecture by its rather low whorl and distinct, deep umbilicus. *Euchelus minoensis* ITOIGAWA (1960, p. 275, pl. 3, fig. 10) from the Miocene Mizunami Group, Gifu Prefecture resembles the present new species but differs in having rather higher whorls sculptured with rather less prominent granulated spirals, three post nuclear whorls and no dentation within the outer lip.

Type locality:—Loc. No. 24.

Occurrence:—Type loc.—F; Loc. No. 30—F; Loc. No. 35—R.

Genus *Calliostoma* SWAINSON, 1840

Calliostoma otaniensis MASUDA, n. sp.

Pl. 36, figs. 7a-b

Holotype:—DGS, Reg. No. 1406.

Description:—Shell small, conical, with about six whorls of which one and a half are nuclear whorls; spiral angle about 55°. Whorls shouldered, separated by distinct, impressed sutures; sculptured with rather strong, granulated spiral threads which are broader than their interspaces; three primary and one secondary spiral threads in penultimate whorl and three primary and two secondary spiral threads on body whorl. Base of body whorl with about nine, fine, smooth spiral threads. Aperture subquadrate; outer lip simple; inner lip thin; columella oblique.

Dimensions (in mm):—Height 4.6, diameter 3 (holotype).

Remarks:—This new species resembles *Calliostoma kurodai* IKEBE (1942, p. 275, pl. 28 figs. 13a-c), a species living in Toyama Bay, Japan, but *kurodai* is distinguishable from *otaniensis* in having larger shell, a little more spiral angle and less distinct shoulders.

Type locality:—Loc. No. 30.

Occurrence:—Type loc.—R.

Genus *Monilea* SWAINSON, 1840

Monilea yoshioi MASUDA, n. sp.

Pl. 36, figs. 8a-c, 9a-c, 10a-b

Holotype:—DGS, Reg. No. 4556.

Description:—Shell medium in size, conical, with two nuclear and four post nuclear whorls; spiral angle about 90°. Whorls moderately high, rounded, separated by somewhat channeled sutures; nuclear whorls low, smooth, rounded; surface with several, unequal, rather low, more or less lamellated, smooth spiral threads and oblique, faint, fine incremental lines; spiral threads three on first post nuclear whorl and increase their number by intercalation towards base. Base of body whorl moderately rounded, with several (about seven), low, flat-topped, smooth spiral cords which are much broader than their interspaces. Aperture subovate, oblique; outer lip thin, simple; inner lip rather thick with weak denticles; umbilicus medium,

rather deep; columella oblique.

Dimensions (in mm):—

Height	9.0*	9.5	9.0	8.0	7.5	7.2	7.0
Diameter	11.5	10.5	10.5	10.0	9.0	7.6	8.4

*—holotype

Remarks:—*Monilea cingulata* MAKIYAMA (1927, p. 60, pl. 3, figs. 3, 4) from the Pliocene Dainichi Formation, Shizuoka Prefecture resembles the present new species, but it can be distinguished from *yoshioi* by its larger shell, larger number of post nuclear whorls and larger number of spiral threads. *Homalopoma hidaensis* ITOIGAWA (1960, p. 277, pl. 3, figs. 12a-b) and *Homalopoma tukiyosiensis* OYAMA and SAKA (1944, p. 138, pl. 14, figs. 1a-c), both from the Miocene Mizunami Group, Gifu Prefecture also resemble the present species, but both differ by the shape and height of the spire, strength of spiral threads and aspect of the umbilicus.

The specific name is given to the name of my son, Yoshio MASUDA who was born recently.

Type locality:—Loc. No. 39.

Occurrence:—Type loc.—A; Loc. No. 30—C.

Monilea hamadae MASUDA n. sp.

Pl. 36, figs. 11a-c, 12a-c, 13a-b, 14a-c

Holotype:—DGS, Reg. No. 4558.

Description:—Shell rather small, rather thin, conical, with two nuclear and four post nuclear whorls; spiral angle a little less than right angle. Whorls shouldered, somewhat rounded, separated by distinctly channeled sutures; nuclear whorls low, smooth, rounded; surface with two, strong, elevated spiral threads, one rather weak subsutural thread and faint, fine, oblique longitudinal threads, rarely with a few, fine intercalary threads; spiral threads much narrower than their interspaces. Base of body whorl rounded, with about seven, rather low, smooth spiral cords which are nearly equal to their interspaces. Aperture subovate; outer lip thin; umbilicus very wide, deep, with fine spiral cords.

Dimensions (in mm):—

Height	5.0*	5.8	5.2	4.8	4.5	4.0
Diameter	5.2	5.8	5.4	4.8	4.8	4.2

*—holotype

Remarks:—The present new species is distinguished from *Monilea yoshioi* MASUDA described in this article by its smaller and somewhat higher shell, shouldered whorls, two conspicuous spiral threads and very wide umbilicus. *Homalopoma tukiyosiensis* OYAMA and SAKA (Op. cit.) resembles the present one, but differs from the present one by its larger and higher shell, flattish whorls, shallow sutures and larger number of spiral threads. *Monilea (Rossiteria) osawanoensis* TSUDA (1959, p. 81, pl. 3, figs. 15a-b) from the Kurosedani Miocene of Toyama Prefecture also resembles the present one, but it is distinguishable from *hamadae* by its higher shell, slightly shouldered whorls, surface sculpture and characters of inner lip.

Type locality:— Loc. No. 23.

Occurrence:—Type loc.—C; Loc. No. 3—C; Loc. No. 30—R.

Family Turbinidae

Genus *Turbo* LINNAEUS, 1758

Subgenus *Marmorostoma* SWAINSON, 1829

Turbo (*Marmorostoma*) *ozawai* OTUKA, 1938

1938. *Turbo* (*Lunella*) *ozawai* OTUKA. *Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2, Vol. 5, Pt. 2*, p. 36, pl. 3, figs. 22-24.

1959. *Turbo* (*Marmorostoma*) cf. *ticaonica* REEVE, HORIKOSHI in KOBAYASHI and HORIKOSHI. *Japan. Jour. Geol. Geogr., Vol. 29, Nos. 1-3*, p. 49, pl. 4, figs. 1a, b, text-fig. b.

Syntype:—GT*, Reg. No. 10018.

Remarks:—This species was first described by OTUKA from the Miocene Shôbara Formation, Hiroshima Prefecture based upon two opercula, thus the shell characters remained unknown. In 1958 HORIKOSHI illustrated *Turbo* (*Marmorostoma*) cf. *ticaonica* REEVE, a Recent species of the Philippine, from the Miocene Uchiura Formation, Fukui Prefecture based upon a single shell without the operculum. At that time he stated that from the characters of the operculum OTUKA's *ozawai* should be referred to the subgenus *Marmorostoma* and "if *ozawai* is found together with a shell of *Turbo* cf. *ticaonica* at any fossil locality, OTUKA's denomination is validated for *Turbo* cf. *ticaonica*".

The abundant shells and opercula from various localities in the present field show that the former can be referred to the HORIKOSHI's *Turbo* cf. *ticaonica* REEVE and the latter to OTUKA's *ozawai*.

The shells and opercula from the Higashi-Innai Formation take the following description: Shell medium, thick, ovate-conical; whorls six of which two are nuclear ones; spiral angle about 70°. Nuclear whorls smooth, rounded; post nuclear whorls moderately rounded, more or less shouldered, separated by impressed sutures; surface with several, elevated, strong, unequal, more or less rounded spiral cords, fine interstitial threads and fine but rather distinct incremental lines; first post nuclear whorl with three, unequal, strong spiral cords which are much narrower than their interspaces and three, weak, fine spiral threads. Body whorl with six, strong, unequal spiral cords, a fine interstitial spiral thread between strong spiral cords and rather distinct oblique incremental lines; spiral cords forming shoulder and occasionally more or less granulated at upper part of whorl; base rounded, with seven to eight, strong, more or less granulated, unequal revolving threads and rather distinct incremental lines. Aperture subovate; outer lip rather thin; inner lip rather sharply defined by thin callus; columella somewhat concave. Operculum slightly elongate-oval, much inflated, asymmetrical in profile; base slightly inflated. Surface rounded, with numerous, fine, unequal, rounded tubercles; fine tubercles sometimes connected with each other and with irregularly granulated lines subparallel with base. Base more or less undulated by rather distinct coiling, with faint, fine incremental lines and very faint, fine radial threads which can be observed only by lens.

Turbo (*Marmorostoma*) *ticaonica* REEVE (1848, pl. 5, sp. 23) is distinguished from the present one by its larger, umbilicated shell and larger number of spiral threads.

* Abbreviation for the Geological Institute, University of Tokyo.

The present species also resembles *Turbo parvuloides* NOMURA (1940, p. 35, pl. 3, figs. 2a-b) from the Miocene Moniwa Member of the Hatatate Formation, Miyagi Prefecture and also *Turbo* (*Marmorostoma*) *minoensis* ITOIGAWA (1960, p. 278, pl. 4, figs. 2, 3) from the Miocene Mizunami Group of Gifu Prefecture. However, it differs therefrom in having larger shell and fewer coarse spiral threads.

The shells from the Higashi-Innai Formation show considerable variaton in morphological features, though the opercula are similar with one another except for the surface tubercles. That is to say, the specimens from Loc. Nos. 24, 30 and 32 have somewhat higher shell, somewhat fewer interstitial spiral threads and coarse, smooth spiral cords but with

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Explanation of Plate 35

(All figures in natural size, unless otherwise stated)

Figs. 1a-b, 2, 3. *Saccella saikaiensis* MASUDA, n. sp. 1a-b, holotype, DGS, Reg. No. 4494; Loc. No. 23. ×2. 2, 3, paratype, DGS, Reg. No. 4495; Loc. No. 3. ×2. ..... p. 322

Figs. 4, 5, 6. *Aequipecten matsunagiensis* MASUDA, n. sp. 4, holotype, DGS, Reg. No. 4506; Loc. No. 32. 5, paratype, DGS, Reg. No. 4655; Loc. No. 3. 6, paratype, DGS, Reg. No. 4507; Loc. No. 32. ..... p. 323

Fig. 7. *Placopecten protomollitus* (NOMURA). DGS, Reg. No. 4509; Loc. No. 32.

Figs. 8a-b, 9. *Modiolus iwanizakiensis* MASUDA, n. sp. 8a-b, holotype, DGS, Reg. No. 4510; Loc. No. 31. 9, paratype, DGS, Reg. No. 4511; Loc. No. 31. ..... p. 324

Figs. 10, 11. *Myadora suzuensis* MASUDA, n. sp. 10, paratype, DGS, Reg. No. 4514; Loc. No. 24. ×2. 11, holotype, DGS, Reg. No. 4513; Loc. No. 24. ×2. ..... p. 324

Fig. 12. *Crassatellites suyamensis* OINOMIKADO. DGS, Reg. No. 1415; Loc. No. 30.

Figs. 13a-b, 14. *Glans naomiae* MASUDA, n. sp. 13a-b, holotype, DGS, Reg. No. 4517; Loc. No. 35. ×2. 14, paratype, DGS, Reg. No. 4518; Loc. No. 23. ×2. ..... p. 325

Figs. 15-20. *Ctena hataii* MASUDA, n. sp. 15, holotype, DGS, Reg. No. 4521; Loc. No. 30. ×2. 16, 17, 19, paratype, DGS, Reg. No. 4523; Loc. No. 30. ×2. 18, 20, paratype, DGS, Reg. No. 4525; Loc. No. 24. ×2. ..... p. 325

Fig. 21. *Siratoria siratoriensis* (OTUKA). DGS, Reg. No. 4535; Loc. No. 3.

Figs. 22, 23. *Paphia euglypta ohiroi* MASUDA, n. subsp. 22, holotype, DGS, Reg. No. 4527; Loc. No. 38. 23, paratype, DGS, Reg. No. 4528; Loc. No. 39. ..... p. 326

Figs. 24, 25. *Paphia suzuensis* MASUDA, n. sp. 24, paratype, DGS, Reg. No. 4529; Loc. No. 30. 25, holotype, DGS, Reg. No. 4530; Loc. No. 30. ..... p. 327

Figs. 26, 27a-b. *Leukoma itoigawae* TSUDA. DGS, Reg. No. 4532; Loc. No. 30. ×2.

Figs. 28a-b, 29. *Venerupis* (*Amygdala*) *takagii* (MASUDA). DGS, Reg. No. 4537; Loc. No. 35. ..... p. 328

Fig. 30. *Clementia japonica* MASUDA. DGS, Reg. No. 4540; Loc. No. 23.

Fig. 31. *Pitar itoi* (MAKIYAMA). DGS, Reg. No. 4536; Loc. No. 23.

Figs. 32. "*Venus*" sp. DGS, Reg. No. 4545; Loc. No. 24.

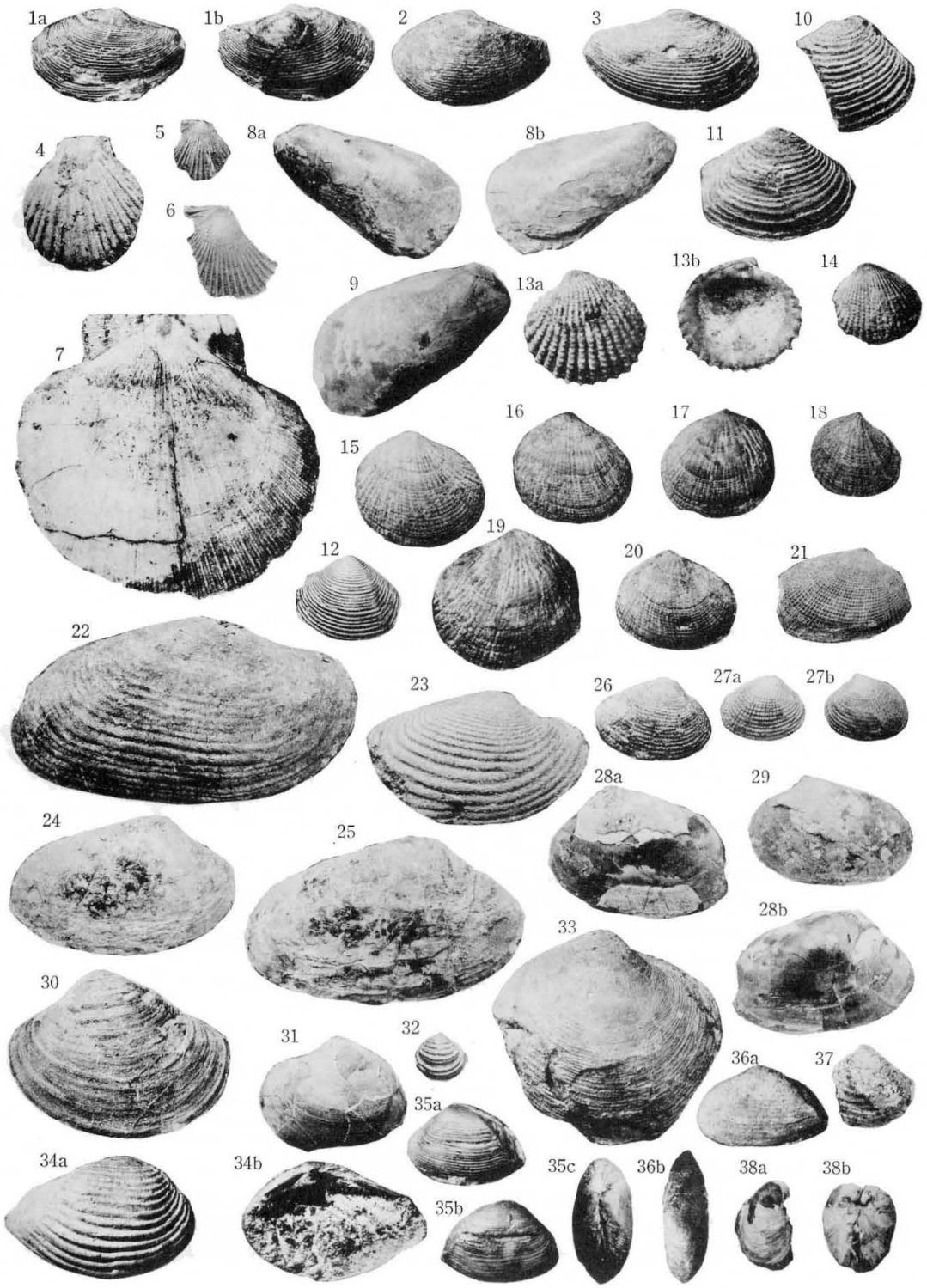
Fig. 33. *Cyclina* (*Cyclinorbis*) *lunulata* MAKIYAMA. DGS, Reg. No. 4538; Loc. No. 23. .. p. 326

Figs. 34a-b. *Anisocorbula peregrina* (YOKOYAMA). DGS, Reg. No. 4549; Loc. No. 24. ×2.

Figs. 35a-c, 36a-b. *Anisocorbula ohiroi* MASUDA, n. sp. 35a-c, holotype, DGS, Reg. No. 4546; Loc. No. 24. ×2. 36a-b, paratype, DGS, Reg. No. 4547; Loc. No. 30. ×2. .... p. 329

Fig. 37. *Raeta* sp. DGS, Reg. No. 4541; Loc. No. 12.

Figs. 38a-b. *Cardilia toyamaensis* TSUDA. DGS, Reg. No. 4543; Loc. No. 35.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28b
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36a
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35a
34a
34b
35c
36b
38a
38b
35b

no distinct tubercles compared with the individuals from Loc. No. 35. INO and KAMETAKA (1943) state that the development of tubercles or spines in *Turbo* is related with the environmental conditions, that is to say, the shells with ill-developed spines are usually found in rather calm water and those with well developed spines in the influence of rough water conditions. Therefore, it seems that from the development of the tubercles in *ozawai* from the Higashi-Innai Formation the environmental conditions in the vicinity of Loc. No. 35 may have been of rocky bottom influenced by strong waves and currents. This view is supported by the hard bottom dwelling molluscan assemblage, reef building corals, calcareous algae, etc. and also by the lithologic facies.

Dimensions (in mm):—

Shell:

Height	36.5	35.0	34.0	32.0	30.0	13.0
Diameter	31.0	32.0	32.0	26.0	24.5	10.5

Operculum:

Height	7.6	7.0	6.5	7.2	5.0	3.6
Maximum diameter	17.3	18.3	16.4	16.0	12.8	9.2

Type locality:—Suketó, Shôbara-machi, Higa-gun, Hiroshima Prefecture.

Occurrence:—Loc. No. 1—F (shell); Loc. No. 3—F (shell); Loc. No. 10—F (shell and operculum); Loc. No. 24, operculum—A, shell—F; Loc. No. 30—F (shell and operculum); Loc. No. 32, shell—C, operculum—A; Loc. No. 33—F (operculum); Loc. No. 35—A (shell and operculum).

Family Neritidae

Genus *Nerita* LINNAEUS, 1758

Nerita ishidae MASUDA, n. sp.

Pl. 36, figs. 23a, b, 24a–c, 25

Holotype:—DGS, Reg. No. 4564.

Description:—Shell of medium size, thick, semi-globose; whorls minute; surface smooth but with faint, fine incremental lines. Body whorl very large, ventricose, with regularly rounded periphery. Aperture crescent form; outer lip sharply angulated, regularly rounded anteriorly, somewhat projected below, rather thin, thickened inwards and denticulated on inner margin; inner lip distinct, finely denticulated; callus thick, makes wide, flat smooth platform and inclined inwards.

Dimensions (in mm):—

Height	10.5*	18.5	13.5	9.0	8.5	4.5
Diameter	14.0	21.0	17.5	11.0	10.5	5.5

*—holotype

Remarks:—*Nerita kamigiriensis* ITOIGAWA (1960, p. 140, pl. 6, figs. 14, 15) from the Mizunami Miocene of Gifu Prefecture is distinguished from the present new species by its several, small, irregular granules on the columella area. *Nerita subgranulosa* NAGAO (1928, p. 117, pl. 12, figs. 4, 4a, pl. 19, figs. 14, 14a) from

the Eocene Shirataka Formation of Northern Kyushu, Kumamoto Prefecture differs from the present one by its surface sculpture, angulated shoulder and small granules on the flattened inner lip.

The denticulation of the inner margin of the outer lip can be seen in rather large specimens but not in the younger specimens.

This species is named in honor of Dr. Shirô ISHIDA of the Geological and Mineralogical Institute of Kyoto University, who collaborated with the writer in the field.

Type locality:—Loc. No. 30.

Occurrence:—Type loc.—A; Loc. No. 1—F; Loc. No. 10—F; Loc. No. 23—R; Loc. No. 24—R; Loc. No. 32—F; Loc. No. 33—F; Loc. No. 35—R; Loc. No. 39—F.

Family Lacunidae

Genus *Lacuna* TURTON, 1827

Lacuna japonica MASUDA, n. sp.

Pl. 36, figs. 26a-b, 27

Explanation of Plate 36

Fig. 1. *Haliotis notoensis* MASUDA, n. sp. Holotype, DGS, Reg. No. 4551; Loc. No. 24. ×2...p. 329

Figs. 2a-b. *Tugali notoensis* MASUDA, n. sp. Holotype, DGS, Reg. No. 4552; Loc. No. 24. ×1. ....p. 330

Fig. 3. *Collisella* sp. DGS, Reg. No. 4553; Loc. No. 3. ×2.

Figs. 4a-c, 5a-c, 6a-c. *Euchelus notoensis* MASUDA, n. sp. 4a-c, 6a-c, paratype, DGS, Reg. No. 4555; Loc. No. 24. ×2.5. 5a-c, holotype, DGS, Reg. No. 4554; Loc. No. 24. ×2.5. ....p. 330

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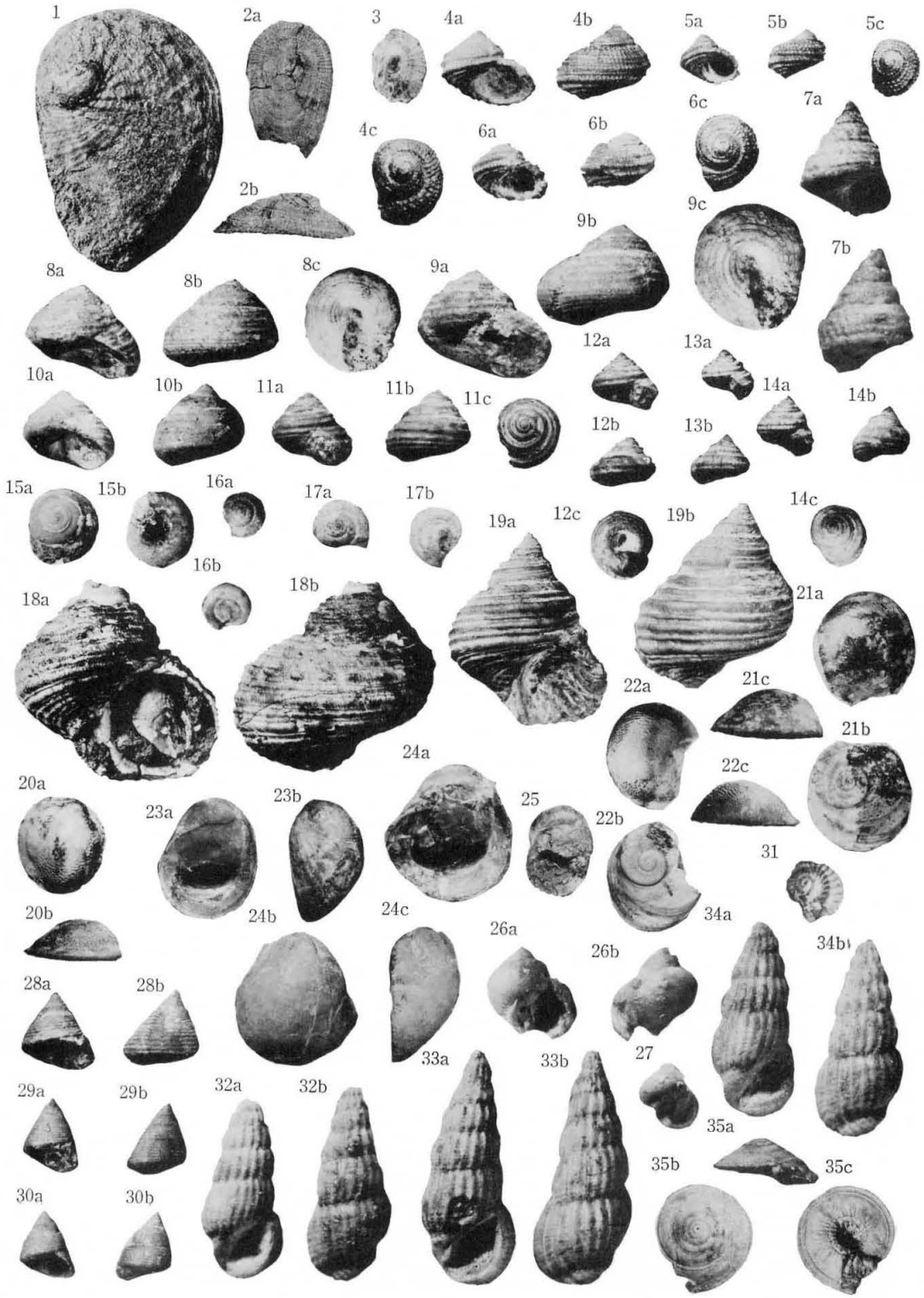
Figs. 35a-c. *Architectonica kurodae* TSUDA. DGS, Reg. No. 4572; Loc. No. 24. ×1.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Holotype:—DGS, Reg. No. 4566.

Description:—Shell very small, moderately thick, globose, with about five whorls; spiral angle about 90°. Whorls roundly shouldered, separated by rather distinct sutures; surface smooth. Aperture wide, ovate; outer lip thick, rounded; inner lip with thin callus; umbilicus rather wide, deep and oblong.

Dimensions (in mm):—Height 3.2, diameter 3.0 (holotype); height 2.2, diameter 2.0 (paratype).

Remarks:—This new species is distinguished from *Lacuna i-hayasakai* NOMURA (1938, p. 272, pl. 33, figs. 4a-b) from the Pliocene Tatsunokuchi Formation, Miyagi Prefecture by its larger spiral angle and rounded, thick outer lip.

Type locality:—Loc. No. 30.

Occurrence:—Type loc.—F.

Family Rissoidae

Genus *Rissoina* D'ORBIGNY, 1840

Rissoina naomiae MASUDA, n. sp.

Pl. 36, fig. 32a, b, 33a, b, 34a, b

Holotype:—DGS, Reg. No. 4571.

Description:—Shell small, rather thick, elongate-conical, imperforate, with seven whorls, two nuclear whorls lacking; spiral angle about 30°. Whorls moderately inflated, separated by somewhat channeled sutures; sculptured with distinct longitudinal ribs and numerous spiral threads; longitudinal ribs subvertical, rather strong, more or less rounded, extending from summit to lower suture, about 25 on body whorl, about 21 on penultimate whorl and tend to decrease their number towards upper whorls; last longitudinal rib makes a prominent, rounded varix on back of outer lip; interspaces between longitudinal ribs broader than ribs themselves; spiral threads usually faint and fine but tend to become distinct towards lower part of body whorl. Body whorl contracted below; base rounded, with a strong, rounded, longitudinal costellated spiral cord. Aperture subovate, with rather acute angle posteriorly; outer lip prominent, marginate, anteriorly tortile; inner lip smooth, with rather thick callus, slightly concave.

Dimensions (in mm):—

Height	6.0*	7.5	6.8	6.5	5.2	5.0
Diameter	2.6	3.0	2.5	3.0	2.3	2.2

*—holotype

Remarks:—The present new species resembles *Rissoina rosea* (DESHAYES) (SOWERBY, 1878, pl. 5, sp. 42), a Recent species of Southern Japan and *Rissoina submerculialis* YOKOYAMA (1920, p. 73, pl. 4, fig. 15), a Pleistocene species of Central Japan, but it differs from the former by its numerous spiral threads and no columella plait and from the latter by its large and long shell, larger number of subvertical longitudinal ribs and rather thick callus.

Type locality:—Loc. No. 30.

Occurrence:—Type loc.—A; Loc. No. 1—F; Loc. No. 10—C; Loc. No. 24—F; Loc. No. 35—F.

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 64, pp. 338-350, pl. 37, Dec. 15, 1966

513. FUSULINIDS FROM THE FUNAFUSEYAMA LIMESTONE IN YAMAGATA-GUN, GIFU PREFECTURE, JAPAN

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岐阜県山県郡舟伏山石灰岩からの紡錘虫：舟伏山石灰岩から産出する紡錘虫化石は12属43種が鑑定され，そのうち1種が新種である。これらの紡錘虫化石は下位の *Paraschwagerina* (*Acervoschwagerina*) 亜帯から上位の *Yabeina igoi* 亜帯まで識別される。本地域の紡錘虫化石と青海，赤坂，伊吹山のそれとの対比を試みた。　松丸国照

Introduction

Mt. Funafuseyama (1043.3 m) and its adjacent area has been studied by many geologists and palentologists, namely IISAKA (1932), KOBAYASHI (1951) IGO and OGAWA (1958), ISHII and his collaborators (1963, 1964), NAKAMURA (1965), and others. However, most of the studies on the fusulinids from this area were the descriptions of new and interesting species from only several restricted localities. The Funafuseyama Limestone is distributed about 12 km in east-west and about 9 km in north-south direction in Yamagata-Gun, Gifu Prefecture. From the extensive distribution and good development as well as yield of fusulinids, the limestone of this area is considered important for establishment of a standard biostratigraphic sequence of the fusulinids and for a basic column for interregional correlation.

Fortunately the writer at the advice of NAKAMURA who worked out the geology of the limestone was able to collect to abundant fusulinids. Based upon the fusulinids and the geology of the limestone, which may serve as a standard, the writer in this article attempts interregional correlation.

* Received March 19, 1966; Read June 18, 1966.

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The writer takes this opportunity to express his hearty thanks to; Professor Kiyoshi ASANO of the Institute of Geology and Paleontology, Faculty of Science, Tohoku University, for his encouragement, Professor Kotora HATAI of the same Institute, for his encouragement and reading of the manuscript, Professor Rokuro MORIKAWA of the Department of Earth Science, Saitama University, for his suggestion on the classification and zoning of the fusulinids, Drs. Masafumi MURATA and Kunihiro ISHIZAKI, both of the Institute of Geology and Paleontology, Tohoku University, for their kind discussions on the fusulinids, Dr. Manjiro NAKAMURA of the Kokan Mining Co. Ltd., for his kind offer of the limestone blocks from

the Funafuseyama area and valuable information on the stratigraphy.

Stratigraphic notes

According to NAKAMURA (1965), the rocks of the Funafuseyama area can be classified into two major units. One is the non-calcareous group and the other is the calcareous group. The former is subdivided into the Kanzaki and Tsubaki lithogenetic units. The Kanzaki Formation is composed mainly of chert intercalated with schalstein and limestone lenses. The Tsubaki Formation is composed mainly of sandstone, shale and chert intercalated with schalstein and limestone lenses.

The Funafuseyama Limestone is composed mainly of grayish white, gray, dark gray and black limestones and dolomite intercalated with schalstein. The Kanzaki Formation of the non-calcareous group overlies the Tsubaki Formation in the western part of the area with conformity but is superposed on the formation in the eastern part, in other words, they interfinger with one another. The Funafuseyama Limestone of the calcareous group lies upon the Kanzaki Formation with conformity.

The succession of the strata from the older to the younger in the non-calcareous group is from sandstone and shale to chert in the western part and from sandstone to shale in the eastern part. In the calcareous group the lowest observable strata is sandstone, and this grades upwards into shale through chert to limestone. The non-calcareous group and the calcareous group are stratigraphically contemporaneous but in different lithofacies according to NAKAMURA (1965). The relation can also be upheld by paleontological evidence of the mutual occurrence of fusulinids as, *Neoschwagerina margaritae*, *N.* sp. and *Yabeina igoi*, from the limestones of both groups. On the other hand, IGO and OGAWA (1958) once stated that the stratigraphic relationship between the Funafuseyama Limestone and the Kanzaki Formation is doubtful, but the larger part of the formations are contemporaneous with one another and the lower part of the latter may be older than that of the former.

Paleontological remarks

1. Zoning of the Funafuseyama Limestone

The Funafuseyama Limestone can be classified into four zones and five subzones based upon the respective chronological ranges of the fusulinids collected from the limestones of the present area. The zones and subzones recognized in upward sequence in the Funafuseyama Limestone are:

Pseudoschwagerina zone
  Paraschwagerina (*Acervoschwagerina*) subzone
Parafusulina zone
Neoschwagerina zone
  Neoschwagerina fuwensis subzone
  Neoschwagerina colaniae-rotunda subzone
  Neoschwagerina margaritae-craticulifera subzone
Yabeina zone
  Yabeina igoi subzone

In spite of the occurrence of fusulinid species from most of the localities of ths Funafuseyama Limestone, particular species characterizing the *Parafusulina* zone were not recognized. It is, however, expected that the *Parafusulina japonica* subzone can be separated from the *Parafusulina* zone by future detailed stratigraphic work and refined study of the *Parafusulina* species in this area.

From the above cited fusulinid zones of the Funafuseyama Limestone, the time range of this limestone is considered to be longer than hitherto believed as once suggested by IGO and OGAWA (1958).

2. Description of each zones

1) *Paraschwagerina* (*Acervoschwagerina*) subzone

This subzone is distributed mainly in the Hatsushikadani area (refer to locality map for all localities and locality numbers) and is characterized by the occurrences of *Paraschwagarina* (*Acervoschwagerina**) sp., *Pseudofusulina krafti*, *Psf.* sp., *Yangchienia* sp., *Codonofusiella* sp., and *Schubertella* sp.

This assemblage referrs them to the *Pseudoschwagerina* zone. This fossil zone is relatively poor in fossil yield just as the *Paraschwagerina* (*Acervoschwagerina*) subzone of the Ibukiyama Limestone, Gifu Prefecture, according to KOBAYASHI (1957). The locality numbers are indicated in the locality map, together with the geographical or local names of the area in which they occur.

Locality names	Locality numbers
Hatsushikadani	401, 185, 391, 395
Kanzaki	71

2) *Parafusulina* zone

This fossil zone includes the Kanzaki and Tsubaki Formations of the non-calcareous group and the Funafuseyama Limestone of the calcareous group. The outstanding species of this zone are *Parafusulina japonica*, *P. mizutanii*, *Pseudodoliolina ozawai* and *Neoschwagerina nipponica*.

This fusulinid fauna is similar to the fusulinids of the *Parafusulina japonica*, *Pseudodoliolina ozawai* and *Neoschwagerina nipponica* zones of the Akasaka Limestone, Gifu Prefecture. Those zones are characterized by the occurrences of *Parafusulina japonica*, *Pseudodoliolina ozawai* and *Neoschwagerina nipponica*, respectively, as already pointed out by MORIKAWA (1958). The following species were discriminated from the *Parafusulina* zone of the Funafuseyama Limestone:

Yangchienia sp., *Codonofusiella* sp., *Schubertella* sp., *Parafusulina exilis*, *P. gifuensis*, *P. funafusensis*, *P. japonica*, *P. gigantojaponica*, *P. kinosakii*, *P. takeyamai*, *P. okuboensis*, *P. taniyashikiensis*, *P. mizutanii*, *P. truncata*, *P. tomeganensis*, *P. ozawai*, *P. yabei*, *P. kinshoensis*, *P. parakinosakii*, *P. undata*, *P. neoensis*, *P. takeii*, *P. gumbeli*, *P.* sp., *Chusenella douvillei*, *Verbeekina* sp., *Misellina claudiae*, *Pseudodoliolina ozawai*, *Neoschwagerina nipponica*, *N. paranipponica*.

The fusulinids from the *Parafusulina* zone are abundant both in individuals and number of species. *Chusenella douvillei* from this zone of the Funafuseyama Limestone closely resembles the same species recorded from the Maokou Limestone, Kwangsi, China by SHENG (1963). *Chusenella douvillei* from the Maokou Limestone is stated to occur in association with *Schwagerina pseudocompacta*, *S. quasibrevipola*, *S. quasiregularis*, *S. pingdingensis*, *Chusenella conicocylindrica*, *Pseudodoliolina pulchra* and *Neoschwagerina kwangsiana*. This fusulinid assemblage belongs to the *Neoschwagerina* zone of SHENG. Therefore, it is very interesting that *Chusenella douvillei* from the Funafuseyama Limestone occurred from the *Parafusulina* zone and not from the *Neoschwagerina* zone as in China. From the occurrence from the *Parafusulina* zone *Chusenella* must be considered to range from the *Para-*

* The writer considers the *Acervoschwagerina* subzone of KOBAYASHI (1957) to be equivalent to the *Paraschwagerina* (*Acervoschwagerina*) subzone.

fusulina zone up to the *Neoschwagerina* zone.

The localities are as follows.

Locality names	Locality numbers
Funafuseyama	10, 14, 15
Nakagoshi	416, 173, 420, 415, 88, 91, 92
Mizude	93, 410, 413, 56, 60, 57
Fukase	45, 52, 118, 110, 1
Kashibaradani	69, 68, 121, 107, 189, 191, 192, 193, 414
Iwatani	126, 164, 162, 92, 156, 98, 136
Nakagashi	132, 142
Shiraiwa	139
Oiwake	30, 104, 6, 3, 26, 5, 25, 29
Mahira	220, 221, 222, 21
Takaradani	381
Enbara	197, 82
Kanzaki	322
Akadaru	297, 351

3) *Neoschwagerina fuwensis* subzone

Neoschwageaina fuwensis is the characteristic species of this subzone and is associated with *Yangchienia* sp., *Codonofusiella* sp., *Parafusulina exilis*, *P. japonica*, *P. kinosakii*, *P. taniyashikiensis*, *Pseudodoliolina ozawai*, *Neoschwagerina nipponica* and other fusulinids. These fusulinids first appear in the upper part of the *Parafusulina* zone and extend into the lower part of the *Neoschwagerina* zone. For such reason this subzone may better be placed in the *Parafusulina-Neoschwagerina* zone as already pointed out by MORIKAWA (1960). However, in order to emphasize the importance of *Neoschwagerina fuwensis* as a stratigraphic key and paleontological horizon, the writer proposes this subzone.

The localities are as follows.

Locality names	Locality numbers
Nakagashi	421, 90, 91
Oiwake	27
Enbara	326, 22

4) *Neoschwagerina colaniae-rotunda* subzone

This subzone is characterized by *Neoschwagerina* as *Neoschwagerina colaniae* and *N. rotunda*. Those two characteristic species were collected in association with *Yangchienia* sp., *Parafusulina exilis*, *P. japonica*, *P. gigantojaponica*, *P. gifuensis*, *P. kinosakii*, *P. takeyamai*, *P. taniyashikiensis*, *P. kinshoensis*, *Verbeekina* sp., *Pseudodoliolina ozawai*, *Neoschwagerina nipponica*, *N. akasakensis*, *N. tuwensis*, *N. colaniae*, *N. rotunda*, and *N.* sp. from the Localities given below.

Neoschwagerina colaniae and *N. rotunda* are restricted in chronological distribution to this subzone and occurred only from the Limestone. However, KAMMERA (1961) reported that *Neoschwagerina rotunda* is a member of the *Neoschwagerina craticulifera* zone, which occurs in the Kozaki Formation at Shimofukami, in the Kuma massif, Kumamoto Prefecture.

The localities are as follows.

Locality names	Locality numbers
Mizude	409, 405, 404
Fukase	51, 119, 40
Oiwake	27
Enbara	22, 328, 80

5) *Neoschwagerina margaritae-craticulifera* subzone

In this subzone, *Neoschwagerina margaritae*, *N. craticulifera*, and *N. larga* are the conspicuous species, and they are associated with *Parafusulina japonica*, *P. kinshoensis*, *Verbeekina vebveeki*, *V.* sp., *Pseudodoliolina ozawai* and *Neoschwagerina* sp. The subzone is situated in the upper part of the Funafuseyama Limestone.

The localities are as follows.

Locality names	Locality numbers
Nakagoshi	87
Mizude	43, 47
Fukase	53
Nakagashi	287

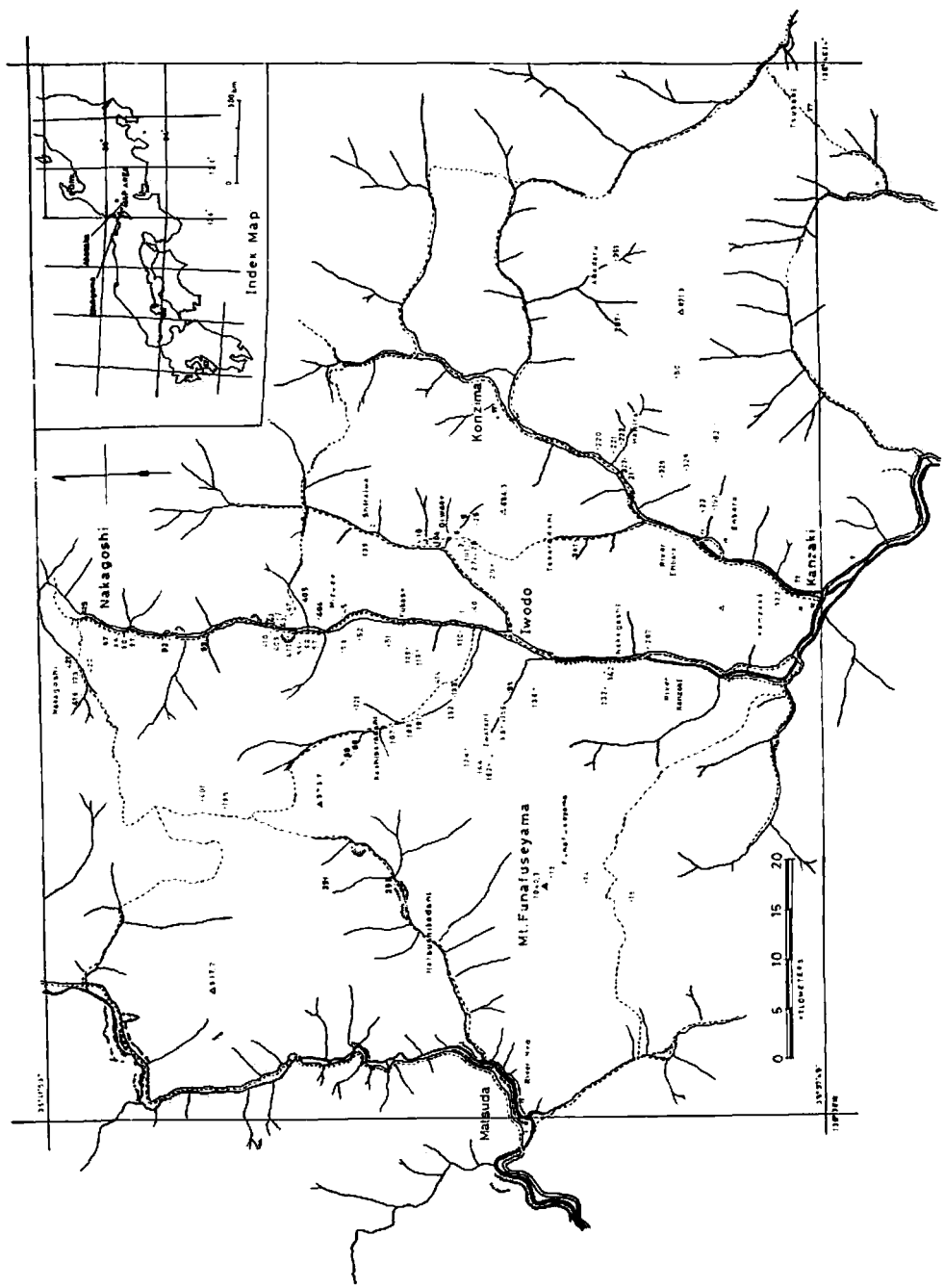


Fig. 1. Map showing fossil localities

Shiraiwa 2
Oiwake 101
Mahira 323

6) *Yabeina igoi* subzone

This subzone is the uppermost fusulinid bearing horizon in the Funafuseyama Limestone, and is characterized by the occurrence of *Neoschwagerina margaritae*, *N.* sp., and *Yabeina igoi*. *Yabeina igoi*, from its structure, seems to be the most primitive form of the genus *Yabeina*.

The Akasaka Limestone yielded such fusulinids as *Yabeina globosa*, *Y. katoi*, *Y. inouyei* and *Neoschwagerina minoensis*. This fauna is thought to represent a horizon higher than the *Yabeina igoi* subzone above mentioned.

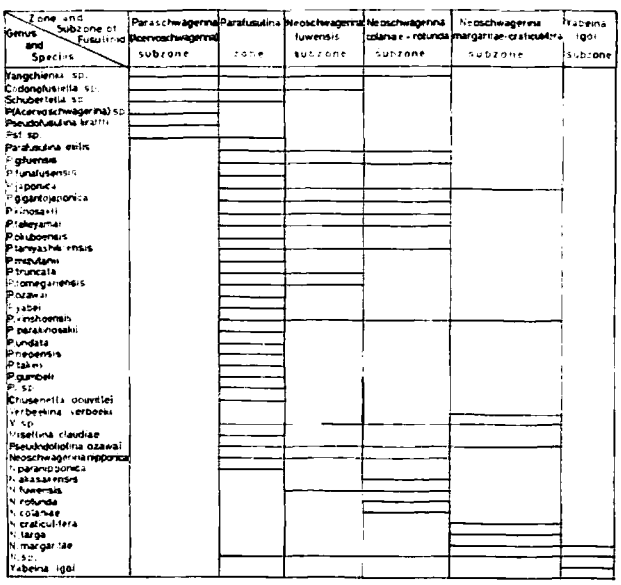
The fusulinids characterizing this subzone of the Funafuseyama Limestone were collected from the following localities.

Mizude.....42
Tsubaki 77

3. Range chart of the fusulinid fossils from the Funafuseyama Limestone

The fusulinid fossils discriminated from the abundant rock samples collected from the Funafuseyama area are listed in the Range chart, which shows the respective ranges of the different species are their relationship with the established zones and subzones.

Table 1. Range chart of the fusulinid fossils from the Funafuseyama Limestone.



4. Correlation

From the paleontological evidence of the fusulinids, the writer attempted to correlate the zones and subzones recognized in the Funafuseyama Limestone with some well known areas in Central Japan, where paleontological and geological studies have been undertaken and published.

1) Correlation with the Omi Limestone

According to KAWADA (1954), the Omi Limestone, Niigata Prefecture ranges in

geological age from the early Carboniferous (Viséan-Tournaisian) to the middle Permian (Kungrian) based upon the paleontological evidence of the fusulinid fossils. The fossil zones of the Permian System of the Omi Limestone are the *Pseudoschwagerina-Pseudofusulina* zone of the P_1 Formation and the *Neoschwagerina* zone of the P_2 Formation. The P_1 Formation is overlain by the P_2 Formation with conformity. The *Pseudoschwagerina-Pseudofusulina* zone is characterized by *Pseudoschwagerina* and *Paraschwagerina* in the lower part of this zone and of *Pseudofusulina* in the upper part. The time range of *Pseudofusulina* is apparently longer than that of *Pseudoschwagerina* and *Paraschwagerina*, and *Pseudofusulina* is also superior in numbers and species in comparison with the latter two genera. Therefore, *Pseudofusulina* is considered to characterize this zone.

The limestone of the P_1 Formation has yielded *Pseudofusulina kraffti*, a species which also occurred from the *Paraschwagerina* (*Acervoschwagerina*) subzone of the Funafuseyama Limestone. However, *Pseudofusulina vulgaris*, which occurred from the upper part of the P_1 Formation was not found in the materials from the *Paraschwagerina* (*Acervoschwagerina*) subzone of the Funafuseyama Limestone, although IGO and OGAWA (1958) recognized it in the lower part of the Funafuseyama Limestone, which probably corresponds to the *Paraschwagerina* (*Acervoschwagerina*) subzone of the writer.

Accordingly, the *Paraschwagerina* (*Acervoschwagerina*) subzone of the Funafuseyama Limestone may be correlated with this zone of the P_1 Formation of the Omi Limestone.

On the other hand, the *Neoschwagerina* zone of the P_2 Formation can be subdivided into three fossil assemblages based upon the outstanding species, namely, the lower is the *Schwagerina* (=*Parafusulina*) *japonica* assemblage; the middle is the *Neoschwagerina douvillei* and *N. craticulifera* assemblage; and the upper is the *Neoschwagerina margaritae* assemblage.

Thus, a part of the P_2 Formation may correspond to the *Neoschwagerina margaritae-craticulifera* subzone of the Funafuseyama Limestone from the mutual occurrence of *Neoschwagerina craticulifera* and *N. margaritae*.

The fusulinids discriminated from the rolling limestone blocks of the Omi Limestone are *Sumatrina cfr. annae*, *Yabeina cfr. globosa* and others. These fusulinids belong to the *Yabeina* zone, and are thought to have been derived from the uppermost part of the *Neoschwagerina* part of the *Neoschwagerina* zone of the P_2 Formation. If the *Yabeina* zone is actualy developed in the uppermost part of the *Neoschwagerina* zone of the P_2 Formation, the *Yabeina igoi* subzone of the Funafuseyana Limestone may be correlated with the part between the lower part of the *Yabeina* zone and the uppermost part of the *Neoschwagerina* zone of the Omi Limestone.

2) Correlation with the Akasaka Limestone

MORIKAWA (1958) recognized 15 fusulinid zones in the Akasaka Limestone. This limestone is situated at about 29 km west from the present area. The 15 fusulinid zones, in ascending order, are as follows:

Pseudoschwagerina zone
  Pseudofusulina grunum-avenae zone
Parafusulina zone
  Parafusulina japonica zone
  Pseudodoliolina ozawai zone
  Neoschwagerina nipponica zone

Neoschwagerina zone
Neoschwagerina fuxensis zone
Neoschwagerina rotunda zone
Neoschwagerina colaniae zone
Neoschwagerina craticulifera zone
Neoschwagerina margaritae zone
Neoschwagerina larga zone
Yabeina zone
Yabeina igoi zone
Yabeina globosa zone
Yabeina katoi zone
Yabeina inouyei zone
Neoschwagerina minoensis zone

The *Pseudofusulina grunum-avenae* zone which is the lowest fusulinid zone of the Akasaka Limestone is characterized by *Pseudofusulina grunum-avenae*, and *Parafusulina truncata* besides other fusulinids. This zone is equivalent to the horizon Np? (Benijima) described by OZAWA (1927), and is considered by KOBAYASHI (1957) to correspond to the *Paraschwagerina* (*Acervoschwagerina*) subzone of the Ibukiyama Limestone, and also by the writer to the *Paraschwagerina* (*Acervoschwagerina*) subzone of the Funafuseyama Limestone, because of the occurrence of mutual species.

Therefore, the *Pseudofusulina grunum-avenae* zone of the Akasaka Limestone can be correlated with the *Paraschwagerina* (*Acervoschwagersna*) subzone of the Funafuseyama Limestone.

According to the correlation table of MIKAMI (1965), the Akasaka Limestone and the Ibukiyama Limestone do not always correspond to limestones of the same names mentioned by KOBAYASHI. There may be confusion in stratigraphic terminology, subdivision of the limestone and other problems. Thus, it seems evident that there still remains more room for study concerning the correlation of those limestones.

The characteristic species discriminated from the *Parafusulina japonica* zone to the *Neoschwagerina larga* zone of the Akasaka Limestone, point to that they can be correlated with the *Parafusulina* zone to the *Neoshwagerina margaritae-craticulifera* subzone of the Funafuseyama Limestone.

The *Yabeina igoi* zone of the Akasaka Limestone which is characterized by *Yabeina igoi* is associated with *Neoschwagerina margaritae*, *Verbeekina* sp., *Yabeina cfr. multiseptata* and other fusulinids.

The *Yabeina igoi* zone of the Akasaka Limestone can be correlated with the *Yabeina igoi* subzone of the Funafuseyama Limestone, from the mutual occurrence of the short-ranged species, *Yabeina igoi*.

3) Correlation with the Ibukiyama Limestone

The Ibukiyama Limestone was subdivided by KOBAYASHI (1957) into the following subzones; (in ascending order)
Paraschwagerina (*Acervoschwagerina*) subzone
Pseudofusulina ambigua subzone
Parafusulina sapperi subzone
Neoschwagerina craticulifera subzone
Neoschwagerina margaritae subzone
Yabeina subzone

The *Paraschwagerina* (*Acervoschwagerina*) and *Pseudofusulina ambigua* subzones which is in the lower part of the Ibukiyama Limestone has yielded *Paraschwagerina* (*Acervoschwagerina*) *cfr. kagemoriensis*, *Paraschwagerina* (*Acervoschwagerina*) sp., *Schwagerina hawkinsi*, *Pseudofusulina ambigua*. *Psf.* cfr. *vulgaris*, *Psf.* sp., *Minojapanella* sp., *Schubertella* sp. and other fusulinids.

This fusulinid fauna from the Ibukiyama Limestone is quite similar to that of the Funafuseyama Limestone, and show that the two can be correlated with each other.

The *Parafusulina sapperi* subzone to the *Neoschwagerina margaritae* subzone

of the Ibukiyama Limestone can be correlated with the *Parafusulina* zone to the *Neoschwagerina mragaritae-craticulifera* subzone of the Funafuseyama Limestone, based upon the occurrence of many important mutual species as *Parafusulina japonica*, *P. gigantojaponica*, *Pseudodoliolina ozawai*, *Neoschwagerina nipponica*, *N. craticulifera*, *N. margaritae* and others.

Although the correlation between the limestones mentioned above seems to be reasonable, it should be noted that *Neoschwagerina fuwensis*, *N. rotunda*, and *N. colaniae* from the lower part of the *Neoschwagerina* zone of the Funafuseyama and Akasaka Limestones have not been found from the lower part of the *Neoschwagerina* zone of Ibukiyama Limestone, and *Neoschwagerina larga* from the upper part of the *Neoschwagerina* zone of the Funafuseyama and Akasaka Limestones has not been recorded from the upper part of the *Neoschwagerina* zone of the Ibukiyama Limestone.

The *Yabeina* subzone of the uppermost part of the Ibukiyama Limestone which overlies with conformity the *Neoschwagerina margaritae* subzone has yielded no definitely determined species of *Yabeina*, although the following ones have been found, namely, *Yabeina cfr. katoi*, *Y. cfr. cascadensis*, *Y.* sp., *Neoschwagerina craticulifera*, *N. margaritae*, *Verbeekina*, *verbeeki*, and *Pseudodoliolina ozawai*.

Moreover, from the phylogenetic relation of the subfamily *Neoschwagerina* from the Akasaka Limestone, according to MORIKAWA and SUZUKI (1961), the

Table 2. Correlation between the Funafuseyama Limestone and other areas.

Fossil Zone \ Area	Funafuseyama L. Present Paper	Ibukiyama L. Kobayashi(1957)	Akasaka Limestone Morikawa(1958)	Ozawa(1927)	O... (1954)
Yabeina zone		?	N.minoensis zone		
			Y.inouyei zone		
			Y.katoi zone	Ng-N(Y)globosa zone	?
		Yabeina subzone	Y.globosa zone		
	Y.igoi subzone		Y.igoi zone		
Neoschwagerina zone	N.margaritae-craticulifera subzone	N.margaritae subzone	N.larga zone	Nm-N.margaritae zone	Neoschwagerina zone (P₁ Formation)
			N.margaritae zone		
	N.colaniae-rotunda subzone	N.craticulifera subzone	N.craticulifera zone	Nc-N.craticulifera zone	
			N.colaniae zone		
			N.rotunda zone		
	N.fuwensis subzone		N.fuwensis zone		
Parafusulina zone	Parafusulina zone	P.sapperi subzone	N.nipponica zone	Nn-N.(Cancellina) nipponica zone	
			Psdd.ozawai zone		
			P.japonica zone		
Pseudoschwagerina zone	Paraschwagerina (Acervoschwagerina) subzone	Psf.ambigua subzone	Psf.grunum-avenae zone	Np? (Benijima)	Pseudoschwagerina-Pseudofusulina zone (P₁ Formation)
		P.(Acervoschw.) subzone			

range of *Yabeina katoi* represents the time range of the *Yabeina globosa* to *Y. inouyei* zone of the Akasaka Limestone, and also associated with *Neoschwagerina*.

Though the *Yabeina* species from the *Yabeina* subzone of the Ibukiyama Limestone is not identical with *Yabeina katoi* but rather nearer to *Yabeina cfr. katoi*, the uppermost *Yabeina* subzone of the Ibukiyama Limestone can probably be correlated with the *Yabeina katoi* zone of the Akasaka Limestone.

From the reasons given above, the writer considers that the *Yabeina igoi* subzone of the Funafuseyama Limestone may be correlated with the lower part of the *Yabeina* subzone of the Ibukiyama Limestone.

Systematic Description

Genus *Parafusulina* DUNBER and SKINNER, 1931

Parafusulina funafusensis MATSUMARU, n. sp.

Pl. 37, figs. 1-14

Description: Shell small, fusiform, with nearly straight to slightly convex axis of coiling, polar ends bluntly pointed. Mature specimens of 4 to 5 volutions, measure 3.5 to 4.3 mm in length and 1.9 to 2.3 mm in width, giving form ratios of 1.8 to 2.0, shell gradually expands from first volution outwards, fusiform throughout shell growth.

Proloculus large, usually irregular, with outside diameter of 0.37 to 0.50 mm, averaging 0.42 mm. Chambers expand slowly, nearly uniform in height in central part of shell but become higher nearer to poles. Average height of chambers from first to fifth volution in adult specimens about 0.12, 0.13, 0.22, 0.25, 0.23 mm, respectively.

Spirotheca thin, composed of tectum and coarse keriotheca in outer volutions and fine keriotheca in inner volutions. Average thickness of spirotheca from first to fifth volution in adult specimens about 0.034, 0.035, 0.054, 0.068, 0.068 mm, respectively.

Septa thin, closely, and regularly fluted throughout shell. Fluting reach outer spirotheca near polar regions. Chamberlets small and low.

Chomata and tunnel indistinct. Axial deposits fill all volutions except central portions.

Measurements (in mm):

Pl.	Fig.	L.	W.	F. R.	N. V.	D. P.
37	1	4.3	2.3	1.9	5	0.40
37	2	3.6	1.8	2.0	4	0.50
37	3	3.5	1.9	1.8	4	0.40
37	4	?	1.8	?	5	0.27
37	5	3.5	1.9	1.8	4	0.43
		?	2.3	?	4	0.37

Height of Volutions					Thickness of Spirotheca				
1	2	3	4	5	1	2	3	4	5
0.10	0.09	0.21	0.20	0.18	0.030	0.033	0.063	0.063	0.050
0.15	0.11	0.23	0.34		0.053	0.037	0.073	0.093	
0.08	0.17	0.25	0.20		0.017	0.030	0.050	0.050	
0.07	0.11	0.17	0.23	0.29	0.027	0.027	0.053	0.077	0.087
0.14	0.14	0.23	0.19		0.033	0.040	0.050	0.057	
0.15	0.19	0.22	0.37		0.047	0.043	0.036	0.067	

Pl.	Fig.	L.	W.	F. R.	N. V.	D. P.
1	6		?		3½?	0.53
1	7		2.5		3½	0.60

Height of Volutions				Thickness of Spirotheca			
1	2	3	4	1	2	3	4
0.11	0.18	0.24	0.37	0.037	0.040	0.050	0.090
0.17	0.33	0.40	0.37	0.030	0.060	0.067	0.067

Septal count			
1	2	3	3½
8	12	16	—
7	12	20	12?

Remarks: The present form resembles *Pseudofusulina houziguanica* SHENG in general shape but is distinguished by its highly and strongly fluting thicker septa. This species also can be distinguished by its influted form and larger proloculus from *Parafusulina okuboensis* OZAWA emend (MORIKAWA) *Parafusulina cayeuxi* (DEPRAT) resembles this species, but differs in the more elongate form and irregularly fluting of septa.

Occurrence: The species occurs commonly in the Funafuseyama locality and is associated with *Parafusulina okuboensis*, *P. kinosakii*, and *P.* sp..

Locality: Funafuseyama Loc. No. 10, 14, 15.

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Hatsushikadani	初鹿谷	Iwodo	伊往戸
Nakagoshi	仲越	Takaradani	宝谷
Mizude	水出	Nakagashi	中樫
Kashibaradahi	樫原谷	Mahira	真平
Fukase	深瀬	Akadaru	赤樽
Shiraiwa	白岩	Enbara	円原
Oiwake	追分	Kanzaki	神崎
Konzima	今島	Tsubaki	椿
Iwatani	岩谷	Matsuda	松田

Explanation of Plate 37

Figs. 1–14. *Parafusulina funafusensis* MATSUMARU, n. sp.

1–Axial section, holotype, ×12. IGPS coll. cat. no. 86620-a.

2–Axial section, paratype, ×12. IGPS coll. cat. nn. 86620-b.

5–Axial section, ×12.

3, 4, 8, 9–Oblique sections. ×12.

6, 7–Sagittal sections, ×12.

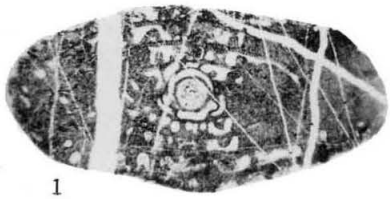
10–Fig. 6. enlarged 60 times, to show the proloculus pore and spirothecal structure of the tectum and coarse keriotheca.

11–Fig. 1. enlarged 56 times, to show the spirothecal structure of first to fifth volutions.

12–Fig. 7. enlarged 52 times, to show the proloculus spur.

13–Fig. 4. enlarged 51 times, to show the proloculus pore and the circum-proloculus chamber.

14–Fig. 3. enlarged 55 times, to show the spirothecal structure in oblique section.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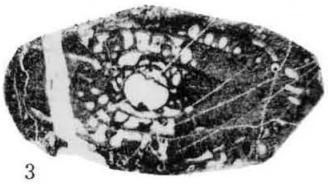
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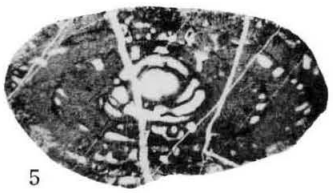
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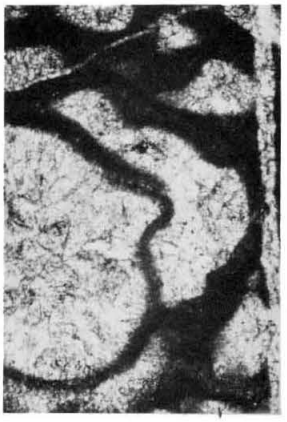
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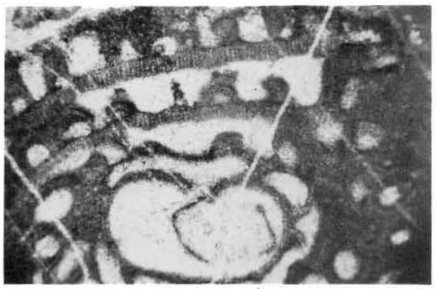
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KUMAGAI and MATSUMARU photo.

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 64, pp. 351-358, pls. 38, 39, Dec. 15, 1966

514. ON A REPTILIAN SKELETON FROM THE PALAEOZOIC FORMATION OF SAN PAULO, BRAZIL*

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ブラジル，サンパウロの古生界産爬虫類骨格：Brazil, San Paulo 近郊 Tatui の花山伊之助氏の農場で発見された爬虫類骨格を新属新種とみとめ，*Brazilosaurus sanpauloensis* と命名，記載した。この骨格は，下部二畳系の Irati 層の灰色石灰岩中から発見され，福井市の斎木重一氏によつて著者らにもたらされたものである。　　鹿間時夫・尾崎　博

In Autumn of 1964, Mr. Zyuichi SAIKI in Fukui City, formerly a member of the Imperial Diet, submitted the writers a reptilian skeleton for study, which was donated to him by Mr. Inosuke HANAYAMA in Tatui, San Paulo, Brazil, during his journey there in April of 1964. HANAYAMA found the fossil in his farm in Tatui during the clearing of land. His farm is situated 16 km NW of Tatui City and the area is composed of late Palaeozoic formations. From the lower Permian Irati formation, *Mesosaurus brasiliensis* MCGREGOR was reported in 1908, and generally speaking *Mesosaurus* is rather common in the Brazilian Permian. The fossil now on hand is preserved in a light creamy to grey limestone of fine lamination. The bed which yielded the fossil may belong to the Irati formation.

* Received April 19, 1966; read January, 1965.

Here the writers extend their cordial thanks to Mr. SAIKI for his generous offer of the specimen for study. Also they express their hearty gratitude to Prof. F. HUENE in Tübingen, Prof. A. ROMER of the Harvard University, Dr. L. I. PRICE in Rio De Janeiro, Miss R. FUSEJIMA of the National Science Museum, Tokyo for their valuable suggestions and kind help during the course of this study.

Brazilosaurus sanpauloensis gen. & sp. nov.

Pls. 38, 39

Holotype: A skeleton belongs to Z. SAIKI and is preserved at the National Science Museum in Tokyo.

Locality: HANAYAMA's farm, 16 km NW of Tatui, San Paulo, Brazil.

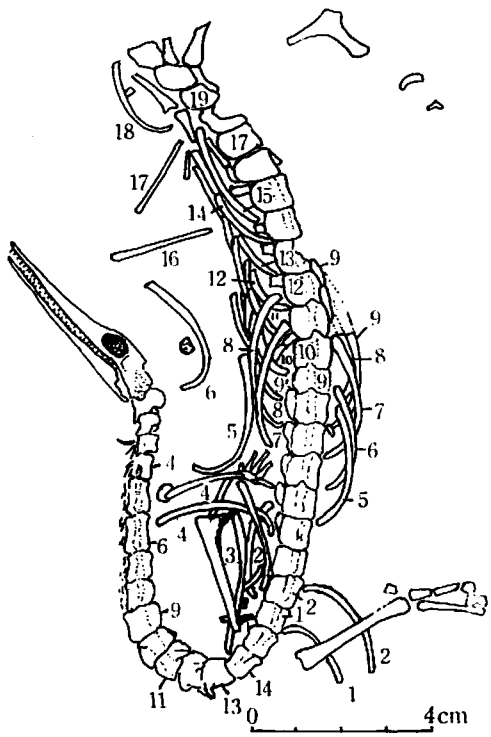
Formation: Irati formation (?); lower Permian.

Description: Skull, vertebrae and costae of presacral region and fore limb largely preserved; skull and cervic vertebrae preserved on their left lateral side, while thoracic- and lumbar regions on their dorsal side, and a torsion is found on posterior part of cervic vertebrae, by which the animal much bent its neck backward. Caudal region and hind limb almost unknown.

Animal slender, elongate and small-sized like *Mesosaurus*. Cervic region very long and longer than skull. Animal 272 mm long as preserved; skull, vertebrate column of cervic region and that of thoracic-lumbar region 46, 86 and 136 mm long respectively. Body very narrow, about 25 mm wide at ninth thoracic vertebra. Fifteen cervic-, nineteen thoracic-lumbar-, one sacral- and one caudal vertebrae are retained. Detailed precise characteristics of each bone, especially of skull and jaw, almost invisible because surface of bone detached.

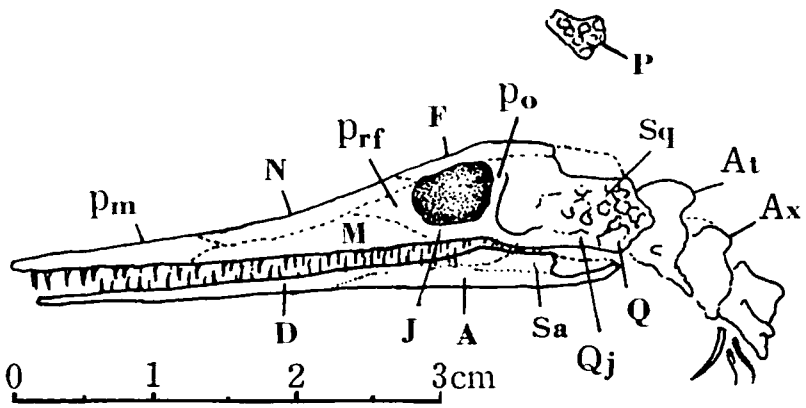
Skull and teeth.

General outline of skull rather like that of *Mesosaurus*. It is very long, low and with strongly projected snout and small cranium. Characteristic of this animals, teeth short and not so much developed as in *Mesosaurus*. Orbit relatively large, 6×4 mm in diameters, subquadrate and situated above the thickest portion of lower jaw. Premaxilla long, narrow and acutely projected forward. Nasal also long and narrow, but maxilla relatively thick and high compared with that of *Mesosaurus*. Preorbital and postorbital foramens as seen in *Mesosaurus* unclear in preservation. Jugal and prefrontal probably same as that of *Mesosaurus*. Dorsal margin of cranium gently curved and its posterior dorsal corner broken. Parietal detached from skull preserved apart from it, irregurllay quadrate and has corrugated surface. Postorbital runs vertically, narrow, forming a posterior margin of orbit and with relatively distinct posterior margin. Quadratojugal relatively thick and supratemporal broad and developed. Surface of posterior portion of cranium corrugated. Cranium relatively larger than that of *Mesosaurus*.



Text-fig. 1. Skeleton of *Brasiliosaurus sanpauloensis* sp. nov.

Lower jaw long, narrow and straight, its ventral margin not recurved as in *Mesosaurus*; it is highest at a point just below posterior margin of orbit. Posterior dorsal corner of jaw broken. Dentary large, long and very straight. Suprangular and angular relatively short and high. There are many homoeodont teeth which are short, acutely pointed, a little curved backward, probably conical and seem te be pleurodont.



Text-fig. 2. Skull of *Brasilosaurus sanpauloensis* sp. nov.

M: Maxilla, Pm: Premaxilla, N: Nasal, F: Frontal, P: Parietal, Prf: Prefrontal, J: Jugal, Po: Postorbital, Qj: Quadratojugal, Q: Quadrate, Sq: Supraquadrate, D: Dentary, A: Angular, Sq: Supraangular, At: Atlas, Ax: Axis.

	Longitudinal width	Maximum height
Premaxilla	12.2±	1.7± (mm)
Maxilla	19.1±	2.4±
Nasal	14.4±	1.3±
Frontal	12.4±	1.0±
Parietal as preserved	4.0	3.2
Postorbital	1.7±	4.3±
Quadratojugal	8.1±	0.8±
Supratemporal	6.9±	—
Lower jaw	41.9	3.2
Dentary	33.9±	1.9
Angular	16.3±	1.3±
Supraangular	12.2±	1.5±

Vertebrae

As first costa as preserved being attached to sixteenth vertebrae, there seems to be fifteen cervic vertebrae, stout and relatively broad transversally. Four vertebrae from fifth to eighth, longer than broad and fifth vertebrae longest of them. Atlas relatively short and with well developed neural spine, dorsal margin of which much convex upward and posterior dorsal corner distinctly projected aftward. Transverse process running postero-laterally. Axis slightly longer than atlas and has vaulted neural spine. Third cervic vertebrae relatively short, quadrate in transverse view, with recurved dorsal and aft margins; transverse process relatively thick. Fourth cervic vertebra longer than third one with relatively straight dorsal margin. Fifth and sixth vertebrae elongate quadrate in lateral view, with straight dorsal margin and thick transverse process. Four vertebrae from seventh to tenth ones quadrate in lateral view. Eleventh and twelfth cervic vertebrae relatively short and fifteenth vertebrae wider than long.

Dorsal side of thoracic-lumbar vertebrae preserved and centrum of them becomes wider posteriorly from first to eleventh vertebrae. Left lateral borders of centrum from twelfth to ninteenth vertebrae broken, especially eighteenth one. Centrum of thoracic-lumbar vertebrae generally wider than long, although third one almost as wide as long; they are quadrate in general outline and their right lateral margins gently convex outward. Neural spine relatively thick and projected posteriorly as seen in fifth, eighth — eleventh vertebrae. Left transverse process preserved on vertebrae from fourth to eighth, flat, longer than wide and its free margin irregularly curved. Spine-like short transverse process is found on left posterior side of vertebrae from twelfth to fourteenth. This may indicate that vertebrae posterior of eleventh belong to lumbar region. Transverse process of eleventh and twelfth cervic vertebrae also spiny and much pointed. Pelvic girdle seems to be jointed with the twentieth vertebra as preserved, it may be a sacral vertebra. Only one caudal vertebra preserved, which is small sized, quadrate and a little wider than long.

	C1	C2	C3	C4	C5	C6
Median longitudinal length of centrum	4.1+	4.3+	5.3+	5.7	7.5	6.7
Transverse width of ditto at middle	—	—	—	—	—	—
Maximum height	7.3	4.5	4.3	4.5	5.3	5.2

C7	C8	C9	C10	C11	C12	C13	C14	C15	T1	T2	T3	T4
6.9	6.1	6.4	4.5	4.5	4.3	5.1	5.6	5.7	5.8	6.5	6.8	5.7
—	—	—	—	—	—	—	6.6	6.9	6.9	6.8	6.8	6.8
6.6	7.4	8.3	10.0	9.6	8.3	6.1	—	—	—	—	—	—

T5	T6	T7	T8	T9	T10	T11	TL12	TL13
6.5	6.4±	6.7±	7.9±	7.6±	6.7±	6.0±	6.6±	6.3±
7.0-8.3	7.0-9.1	7.5-9.7	8.2-9.8	8.6	8.6	8.8	8.1±	7.5±
—	—	—	—	—	—	—	—	—

TL14	TL15	TL16	TL17	TL18	TL19	S1	CA1
7.0±	6.8±	6.5±	6.7±	6.1±	4.4±	5.5	5.8 (mm)
8.7±	8.4+	8.6	8.4+	7.2+	6.6	6.5	6.6
—	—	—	—	—	—	—	—

Costae

There are preserved above twenty costae on right side and seven costae on left side of the skeleton. First costa of both sides jointed with first thoracic- or sixteenth vertebra from first cervic one. Both right and left costae jointed with vertebrae on first, second, seventh, eighth and ninth ones, while right costa jointed with vertebrae on fourth, tenth-seventeenth ones; left costa jointed with fifth and sixth vertebrae. Isolated costae of right and left third, left fourth, left fifth, right sixth, sixteenth, seventeenth and eighteenth are preserved on right side of the skeleton. Right sixth costa preserved in a position nearest to skull, and sixteenth, seventeenth and eighteenth costae arranged in distant positions.

Costa gently curved although its proximal portion strongly curved. Distal portion of two-third of total length be-

comes thicker gradually distalward. It is not pachyostosed as seen in *Mesosaurus*.

First right, first and second left costae preserved turning forward; first costae as preserved relatively short and first left one preserved only proximally. Second left costa also turned forward. Right and left third costae preserved appressed to each other and parallel with vertebrate column. Right fourth costa as preserved running between fourth thoracic-lumbar- and sixth cervic vertebrae; left fourth costa lies posteriorly of right fourth costa in parallel situation. Right fifth costa as preserved concave outward, lies posterior side of left fourth costa and right eighth costa. Left fifth to ninth costae preserved in their natural position. Right sixth costa preserved between skull and right eighth costa, concave outward and retaining an entire outline of costa. Left seventh—seventeenth costae preserved in their natural position. Distal portion of ninth—thirteenth costae closely appressed to each other. Sixteenth and seventeenth costae of probably right side run straight and detached from their natural position. Right eighteenth costa also detached from eighteenth thoracic-lumbar vertebra and concave inward. There are seen many fine small sized ventral costae on ventral side of third to eighth cervic vertebrae.

	1		2		3	
	R	L	R	L	R	L
Length as preserved along the anterior border	6.4	24.0	28.0	28.6	31.2	16.1
Width at distal end as preserved	—	1.5	1.0	1.4	1.8	1.8

4		5		6		7		8		9	
R	L	R	L	R	L	R	L	R	L	R	L
31.4	27.1	35.8	30.2	32.9	30.4	30.0	31.7	37.7	34.1	21.4	35.7
1.4	1.5	1.8	1.6	1.8	1.5±	2.1	1.9	1.8	1.9	1.8±	2.0

10	11	12	13	14	15	16	17		18	
R	R	R	R	R	R	R	R	L	R	
35.1±	20.0±	14.2	23.0	28.2	25.6	22.6	8.0	18.5	24.6	(mm)
1.8±	1.7	1.5	1.5	1.7	1.6	2.1	1.2	—	1.7	

Girdle and limbs

Scapula and coracoid unknown. There is a suboval bone of small size, attached to the distal end of left fourth costa, 3.4×1.8 mm, and has a corrugated surface; it may be a part of pectoral girdle but details unknown.

Humerus rodlike, straight, becoming slightly wider distally in right one and shows distinct expansion of distal end. Proximal margin of head slightly recurved as seen in left humerus. On left humerus, head trigonal in lateral view and shaft narrowest at middle. Distal end wider in right humerus as preserved than in left one and posterior margin of right one much concave backward while its anterior margin almost straight; its distal margin also straight. Distal end of left humerus convex distally and not so much expanded as in right one. Right humerus probably indicates its outer side and left one its anterior or posterior side. Head of right humerus broken off.

	Right	Left
Maximum length as preserved	27.4	29.2 (mm)
Width of proximal margin as preserved	2.2	5.2
Ditto of distal margin	8.8	4.6

Ulna and radius of left side preserved but ulna broken on its middle of shaft. They are straight, slender and narrow; both proximal and distal ends not so much expanded.

	Ulna	Radius
Maximum length as preserved	10.5+	13.1 (mm)
Width of proximal end as preserved	2.1	1.9

Three carpal bones of left side preserved attached to distal ends of ulna and radius. They are subcircular and anterodistal one situated near distal end of radius smallest. They may correspond to ulnare, intermedium and radiale as seen in *Mesosaurus*. Their dimensions as follows from anterior to posterior ones; 1.6×2.5, 3.4×1.9, and 2.4×2.0 mm. Small bones of centrale unpreserved except one preserved beside right fifth metacarpus; it is suboval and 1.7×1.3 mm in dimensions.

Right metacarpi of three bones from third to fifth preserved between left fourth and right fifth costae. They are elongate trigonal, slender, straight and narrow; proximal margin gently curved and distal end broken off; middle bone as preserved longest.

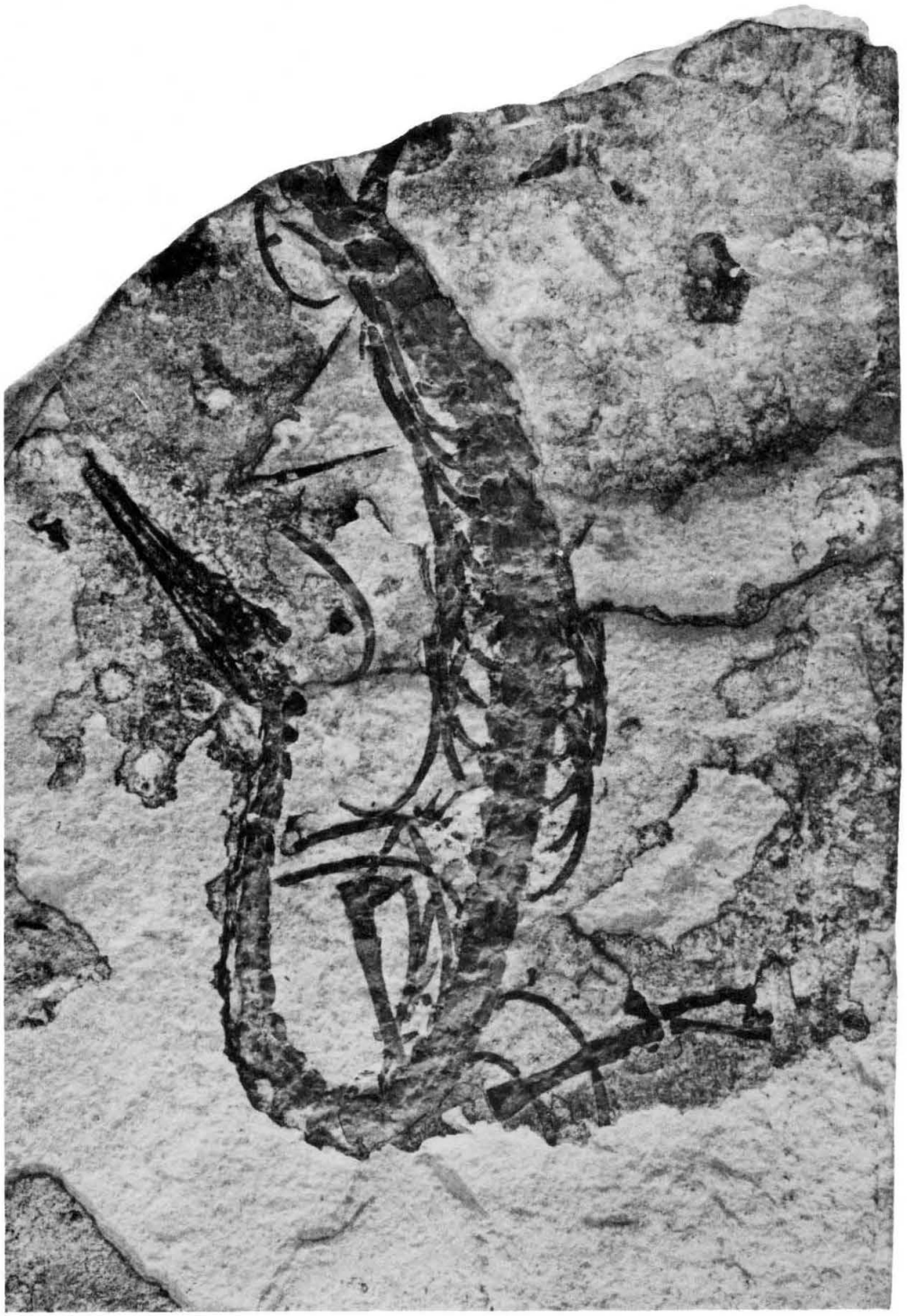
	III	IV	V
Maximum length as preserved	3.9	5.9	5.3 mm
Maximum width of proximal end	1.2	1.2	1.3

Right ilium preserved detached from skeleton and in a position apart from left posterior side of it. The bone large sized, subtrigonal and with recurved and long three margins, the upper one of which being longest. Anterior margin straight and short while posterior one concave aftward. Proximal margin gently curved and concave upward. Acromion border convex downward.

Distance between both ends of upper border	15.4 mm
Width of acromion border	5.2
Length along fore margin	10.5
Median height as preserved	6.4

Explanation of Plate 38

Brazilosaurus sanpauloensis SHIKAMA and OZAKI, gen. & sp. nov. Holotype, natural size.



Two fragments of bone preserved scattered in a position posterior of ilium but whether it belongs to ischium or to pubis is unknown. At left side of ninth thoracic-lumbar- and sacral vertebrae, there are preserved rodlike bones, and at right side of them two rodlike bones. Largest bone of left side may be proximal portion of left femur. It is 14.6 mm long as preserved, gently curved, concave forward and head not so much expanded with straight proximal margin of 4.1 mm length. The other two bones of both sides may be proximal portions of tibia and fibula respectively. Tibia slender, straight and with head not so much expanded; right one is 8.0 and left one 8.5 mm long as preserved. Fibula larger and stouter than tibia with stout subtrigonal head; it is much expanded, 4.0 and 4.5 mm in maximum width on right and left ones respectively. Right and left fibula 12.1 and 8.7 mm long respectively.

Diagnosis: Skull elongate, narrow and low, with developed snout. Orbit large and supratemporal-parietal region developed with corrugated surface. Teeth short, many, conical, a little curved backward and may be pleurodont. Fifteen cervic, nineteen thoracic-lumbar (probably ten thoracic and nine lumbar), one sacral vertebrae are divided. Transverse process lanceolate on fourth to eighth thoracic-lumbar vertebrae and short spiny on twelfth to fourteenth one. Neural spine thick and developed. Cervic region very long, longer than skull and with spiny transverse process. There are many fine spiny ventral costae on ventral side of cervic column. On all thoracic-lumbar vertebrae there are jointed costae of slender shape and gentle curvature; costae not pachyostosed. Humerus slender, relatively long and its distal portion much expanded. Ulna, radius and fibula slender and rodlike. Ulnare, intermedium and radiale as in *Mesosaurus*. Ilium relatively large and its three margins moderately recurved.

Considerations: In general outline this species is rather like *Mesosaurus*, but is clearly different from it by shorter teeth, more cervic vertebrae, longer neck, unpachyostosed costae and by more strongly developed cranium with corrugated surface etc. In *Mesosurus* there are ten cervic vertebrae. Many skulls of *M. brasiliensis* McGREGOR described by J. H. McGREGOR and F. v. HUENE have extremely long teeth which are more extended than dorsal margin of upper snout or ventral margin of lower jaw when upper and lower jaws are closely set to each other as seen in this specimen. In this specimen there is seen no trace of long teeth. We can not accept these differences as owing to growth stages or sexual dimorphism. They are fundamental and anatomical characteristics. *M. brasiliensis* is reported from the lower Permian Irati formation of Southeastern Brazil and Urguay. *M. tenuidens* GERVAIS, the type species of the genus *Mesosaurus* GERVAIS, reported from the lower Permian bed between the Dwyka and Ecca formations in South Africa, has also relatively large sized skull and twenty-nine presacral vertebrae. Hence *Mesosaurus* is safely excluded from comparison with this species. *Noteosaurus africanus* BROOM, regarded by HUENE as same as *Mesosaurus tenuidens*, is out of comparison owing lack of specimens compared.

Stereosternum tumidium COPE known from the Permian of San Paulo, Brazil is about 80 cm long and has thirty-four presacral (eleven cervic and twenty-three thoracic-lumbar) vertebrae, and rather allied outline of skeleton. But it is also distinguished by relatively short neck,

less number of cervic vertebrae and pachyostosed costae. Both *Mesosaurus* and *Stereosternum* carry a very long tail, and perhaps this species also has a long tail as long as presacral region, hence it might be more or less 540 mm in body length, generally corresponding to the size of *Mesosaurus*. *Brazilosaurus* stands rather apart from the stock of *Mesosaurus* and *Stereosternum* from taxonomical points of view. In long neck it may be nearer Sauropterygia than Ichtyosauria.

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Explanation of Plate 39

Brazilosaurus sanpauloensis SHIKAMA and OZAKI, gen. & sp. nov. Holotype, ×2.

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 64, pp. 359-365, pl. 40, Dec. 15, 1966

515. NOTES ON *AMMONITES BRAVAISIANUS* D'ORBIGNY FROM THE CRETACEOUS OF FRANCE*

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フランスの白亜系産 *Ammonites bravaisianus* D'ORBIGNY について：本種はフランス南東部の Uchaux 盆地白亜系産のいくつかのシンタイプスを基に，D'ORBIGNY により設立されたが，特性の記載と図示に疑問点があり，かつ今なおその分類系統上の帰属について見解がまちまちである．そこでパリーの国立自然史博物館所蔵の原標本を再検討して，その写真図版を掲げ，レクトタイプを指定して，種の特性，変異のはんいなどを明確に記載した。ROMAN & MAZERAN (1913) が同じ Uchaux 盆地産の後の採集品に基づき，本種を記載しているが，それは今回の定義にかなりよく合い，かつ同様の変異が認められている。本種は *Subprionocyclus neptuni* や *S. branneri* などと類似し，明らかに *Subprionocyclus* (Collignoniceratidae) に属する。

本種に多分同定できる化石が九州の大野川層群下部の *Inoceramus teshioensis* 帯（チューロニアン上部）から発見されたことが動機となって，フランス産の原標本を検討した次第であるが，九州産のものについては，今回は2標本を図版中にあわせて掲載するに止め，くわしい記述は別な機会にゆずる。本種はフランスではチューロニアン上部の *Coilopoceras requienianum-Romaniceras deverianum* 帯から特徴的に産し，示準化石の1つとすることができる．

松本達郎・野田雅之

Introduction

Ammonites bravaisianus was established by D'ORBIGNY (1841, p. 308, pl. 91, figs. 3-4) for several specimens from the Cretaceous of Uchaux and Mondragon, Vaucluse, France. On the basis of subsequent collections from the Turonian of the Uchaux basin, ROMAN and MAZERAN (1913, p. 22, pl. 1, figs. 13-17) redescribed the same species under the generic name *Prionotropis*. It is noticed that the illustration of D'ORBIGNY by drawing is not quite identical with that of ROMAN and MAZERAN by photographs. Furthermore, we have obtained a number of specimens, from the zone of *Inoceramus teshioensis*, approximately Upper Turonian, in the Cretaceous deposits of the Onogawa basin, eastern Kyushu, Japan, which are referable to the species in question.

This species was referred to *Schloenbachia* by LEONHARDT (1897, p. 58, pl. 6, fig. 3), to *Gauthiericeras* by GROSSOUVRE (1894, p. 93; 1901, p. 124), to *Collignoniceras*? by WRIGHT and WRIGHT (1951, p. 38), and to *Prionocyclus* by BASSE and SORNAY (1959, p. 16, 18).

It is, thus, obviously necessary to settle the question of types, to make clear the diagnosis and extent of variation and to know the taxonomic position of this species. One of us (T. M.) have recently had an opportunity to study D'ORBIGNY's syntypes at the Institut de

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Paléontologie, Muséum National d'Histoire Naturelle, Paris. We have, furthermore, studied more carefully the specimens on loan. This paper presents results of our study. The specimens from Japan are taken into consideration, too, but their full description will be given in a separate paper.

Before going further, we wish to thank Dr. Jacques SORNAY, Paris, for his kind help to this study, and Mr. C.W. WRIGHT, London, for critical reading of the typescript. Dr. Itaru HAYAMI, Fukuoka, has assisted us in various ways.

Types

Twelve specimens from Uchaux (Vaucluse) of *Ammonites bravaisianus* in the Collection of D'ORBIGNY, Muséum National d'Histoire Naturelle, Paris, are available for study. They are presumed to be syntypes. They are all small, more or less incomplete, and represented by internal moulds whose matrix is calcareous sandstone, weathered to brownish. None of them agrees with D'ORBIGNY's illustration (1841, pl. 91, figs. 3-4), which must have been much restored, perhaps synthesised from several specimens and magnified (probably about twice as large as the natural size). Although D'ORBIGNY (1841, p. 309) indicated the dimensions of a representative specimen, they do not agree with those of his illustration nor with those of any syntypes before us. This measured syntype, if it ever existed, seems to be missing. If we temporarily put numbers from left to right and from bottom to top on the twelve surviving specimens which are fixed on one tablet (figured here in Pl. 40, Fig. 6), No. 1 specimen (Pl. 40, Fig. 2) is most similar to the original illustration. It is, however, incompletely preserved, without its nucleus, and seems to represent an extreme end of the variation of the species (see *Variation*).

No. 2 specimen (Pl. 40, Fig. 1) is the largest of the twelve, comparatively better preserved, very close to what ROMAN and MAZERAN (1913) called a typical form. It is accordingly designated here as the **lectotype** of *Ammonites bravaisianus* D'ORBIGNY. The other syntypes (of the twelve) are identified as probably of the same species, except for No. 5 specimen, which has constrictions and no keel and obviously belongs to a different species, probably of the Puzosiinae.

Although the other specimens figured by ROMAN and MAZERAN (1913, p. 22, pl. 1, figs. 13-17) in the collection of the University of Lyon are not at our disposal, they are so clearly described and so finely illustrated that we can be sure of their specific identity with the lectotype. The largest of them (ROMAN and MAZERAN, 1913, pl. 1, fig. 17) probably represents an adult shell. This is supported by another example of a similar size from Japan.

Specific Characters

The shell is comparatively small, attaining a diameter of 60 mm or so in a probably adult shell. It is discoidal, having an umbilicus about 33 to 45 (?) percent of the diameter. The whorl enlarges moderately on the average, embracing slightly less than a third to about fifth of the inner one. It is higher than broad, with a proportion about 10 : 6 to 8. Its flanks are slightly convex or flat; venter narrowly arched; umbilical shoulder abruptly rounded; umbilical wall low and steeply inclined.

The venter is provided with a distinct, continuous, median keel, which may apparently look entire but is actually ser-

rate. The serrations, which correspond in number to the ribs, are weak in the early growth-stage but moderately strong in the adult stage.

The flank, except in the very early growth-stage (of 2-5 mm in diameter), is ornamented with numerous, fine, somewhat prorsiradiate and gently sigmoidal ribs, about 34 to 56 (or perhaps more) per whorl, which are separated by interspaces as narrow as or slightly broader than the ribs. They are as a rule alternately long and short. The longer ribs have a bullate, rather weak tubercle at the umbilical shoulder. The shorter ones normally arise from a point slightly above and ahead of the umbilical bulla of the longer ones, but sometimes are nearly in contact with the latter, as if branched at the bulla. Every rib is provided with two ventrolateral tubercles, lower, (or inner) and upper (or outer). The lower one is small, at which the rib is bent somewhat forward. The upper one is clavate or obliquely elongated, situated on a line fairly close to the median keel. At this tubercle the rib is bent strongly forward and then weakened as it approaches the keel.

The suture consists of E, L, U_2, U_3 (=S), U_4 and I. The elements are rather massive and not much deeply incised.

Variation

It is reasonable and natural to assume that the lectotype and ten other syntypes of D'ORBIGNY represent a single variable species, because one grades into another. This is, furthermore, supported by the specimens described by ROMAN and MAZERAN, with whom we agree in admitting a considerable extent of variation of the species in question.

The following measurements illustrate the situation.

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.	Ribs
Lectotype	15.5(1)	5.8(0.37)	6.2(0.40)	3.8(0.34)	0.61	52
Syntype No. 1	14.3	6.4(0.44)	5.0(0.35)	4.4(0.30)	0.8	36
„ No. 3	11.8	5.2(0.44)	4.2(0.36)	3.5(0.30)	0.8	42
„ No. 4	15.0	5.2(0.35)	5.6(0.37)	*c*.4.0(0.27)	0.7	12×3(?)
„ No. 7	12.5	4.8(0.38)	5.3(0.42)	—	—	50(?)
D'ORBIGNY, p. 309	20	7 (0.35)	7 (0.35)	5 (0.25)	0.71	"40-60"
* D'ORBIGNY, pl. 91, f. 3-4	29.0	12.8(0.44)	10.4(0.36)	8.5(0.29)	0.74	34
* R.+M., pl. I, f. 13	14.4	5.5(0.38)	5.5(0.38)	—	—	46
„ , pl. 1, f. 14	*c*15	*c*5 (0.33)	6.3(0.42)	—	—	56(+*α*)
„ , pl. 1, f. 15	12.3	4.8(0.39)	4.7(0.38)	—	—	50
„ , pl. 1, f. 16	14.0	5.4(0.38)	5.7(0.40)	—	—	36
„ , pl. 1, f. 17	*c*60	*c*24 (0.4)	*c*19.6(0.33)	—	—	36(?)

* as measured from the illustration.

To know precisely the extent of variation we should collect sufficiently numerous specimens from the type- and other localities. At present we are unable to do field work in France, so we depend on the previous collections. As far as these materials are concerned, a considerable number of specimens show a form in which the whorl increasses moderately, with its height 0.35 to 0.40

of diameter, the umbilicus is also moderately wide, occupying about 35 to 40 percent of the diameter, and ribs are numerous (45 to 50), comparatively fine and gently flexuous. The lectotype designated above falls within this range. Although it has a comparatively higher whorl, it is not at the extreme end of the variation, since there is a form, exemplified by ROMAN and MAZERAN's pl. 1, fig. 14, in which the whorl is higher, more involute, more narrowly umbilicate (33 percent of diameter), and has denser and more numerous ribs. On the other hand syntype No. 1 (Pl. 40, Fig. 2) seems to represent the other end of the variation, seeing that its umbilicus is fairly wide (44 percent) and the ribs are coarser, less numerous and less flexuous. D'ORBIGNY's drawing also comes close to this extreme form. Syntype No. 3 (Pl. 40, Fig. 3) is as widely umbilicate and as thickly whorled as No. 1, but has more numerous, denser, gently flexuous ribs. Syntype No. 4 (Pl. 40, Fig. 4) is as narrowly umbilicate as the lectotype but its ribs are coarser and less numerous than in the latter and are denser and more flexuous than in No. 1.

Examples from the Onogawa Group, Japan, seem to show another aspect of variation in which the umbilicus is comparatively wide but the ribs are fine and numerous (Pl. 40, Figs. 7, 8). They could be grouped as a subspecies which is separable from the French one.

Affinities and Generic Attribution

The present species is closely allied to *Subprionocyclus neptuni* (GEINITZ) (see MATSUMOTO, 1959, p. 112; 1965, p. 52), a world-wide Turonian species, in various respects but is distinguished by its less involute, on the average more widely umbilicate whorl. The former has as a rule regularly alternating longer and shorter ribs which do not show such distinct branching as in certain growth-stages of the latter. *S. neptuni* has stronger but less numerous umbilical tubercles and more frequent shorter ribs. It is noted, however, that the extents of variation somewhat overlap each other between the two species with regard to the involution of whorl, size of umbilicus, proportion of breadth to height, etc. Moreover, in some immature shells of *S. neptuni* fine, numerous ribs of alternating length occur without branching on a part of the whorl in addition to the paired ones. This looks as if it foreshadows the diagnostic character of the present species. A specimen from Hokkaido (MATSUMOTO, 1965, p. 54, pl. 13, fig. 1) may exemplify such a connecting feature. In the adolescent and adult stages of *S. neptuni* ribs are coarser, much more distant and more prorsiradiate and the tubercles and serrations are stronger, probably reflecting certain characters of the ancestral *Collignoniceras woollgari* (MANTELL) (see MATSUMONO, 1965, p. 11).

The comparatively coarsely ribbed variety of the present species is somewhat similar to *Subprionocyclus branneri* (ANDERSON) (emended by MATSUMOTO, 1959, p. 109; 1965, p. 50), but the latter has still coarser, stronger, more distant and less numerous ribs, in which shorter ribs are much fewer. Its keel is more strongly serrate and its whorl section is rather rectangular, being not so slender as that of the present species.

Some of the variable immature shells of *Collignoniceras woollgari* (MANTELL), as described under subgroup D by MATSUMOTO (1965, p. 14), may resemble the present species, but they have more distinctly simple, almost equally long, less flexuous and more prorsiradiate

ribs. The distinction in the adolescent and adult stages is great between the two species.

In the present species a serration of the keel corresponds to each rib, although the character is obliterated or apparently modified on the weathered surface of some specimens (including syntypes). This species is, accordingly, not referable to *Prionocyclus* in which the serrations are fine and more numerous than the ribs, the upper ventrolateral tubercles are normally indistinct, the lower ventrolateral tubercles are prominent and the ribs are less flexuous, nor is it referable to *Gauthiericeras* in which the median keel is entire or very finely crenate, faint side keels may develop and the ventrolateral tubercules are not double.

To sum up *Ammonites bravaisianus* is most closely allied to but distinguished from *Subprionocyclus neptuni* and certainly attributed to the genus *Subprionocyclus*, as one of us (MATSUMOTO, 1965, p. 54) has already mentioned.

Occurrence

D'ORBIGNY (1841, p. 310) indicated the occurrence of his original specimens in "Le grès vert supérieur d'Uchaux et de Mondragon, près d'Orange (Vaucluse)." We have not examined the specimens from Mondragon. Grès vert d'Uchaux (Vaucluse) (D'ORBIGNY, 1841, p. 419) in southeast France is referred to Turonian (see SORNAY, 1956, p. 359).

ROMAN and MAZERAN (1913, p. 4) cited HÉBERT's (1875) subdivision of the Grès d'Uchaux and stated that the third level (from the bottom) is the principal layer from which came the gastropoda and cephalopoda described in their monograph, of which the species of more stratigraphical importance for correlation are *Lewesiceras mantelli* WRIGHT and WRIGHT (=*Pachydiscus vaju* in ROMAN and MAZERAN, *Lewesiceras romani* SORNAY, 1964) (WRIGHT, 1966, personal communication), *Romaniceras deverianum* (D'ORBIGNY) and *Baculites undulatus* D'ORBIGNY—all widespread Upper Turonian species. *Subprionocyclus bravaisianus* (D'ORBIGNY) occurs in the same fossiliferous bed along with *Coilopoceras requienianum* (D'ORBIGNY). This layer is referred to Upper Turonian by BASSE and SORNAY (1959, p. 18), too.

In Touraine, the type area of the Turonian in the northern province of France, this species is recorded as occurring in the "Craie à Bryozoaires", Upper Turonian, along with *Romaniceras deverianum* (D'ORBIGNY) and *Coilopoceras requienianum* (see GROSSOUVRE, 1901, p. 336; BASSE and SORNAY, 1959, p. 16). We have not yet examined the specimens of this species from Touraine.

FRITSCH and SCHLOENBACH (1892, p. 29, pl. 8, fig. 5; pl. 16, fig. 4) reported "*Ammonites bravaisianus*" from the Weissenberger and other beds of Bohemia, while LEONHARDT (1897, p. 58, pl. 6, fig. 3) described "*Schloenbachia bravaisianus*" from the Brongniartizone of "Oberschlesia" (now in Poland), but we cannot give good comments without seeing the specimens.

In Japan, as seen in the sequence of the Upper Cretaceous of the Onogawa basin, eastern Kyushu, probable examples of *Subprionocyclus bravaisianus* occur in a bed above that of *Subprionocyclus neptuni* (GEINITZ) and below that of *Subprionocyclus normalis* (ANDERSON). A probable example of *S. branneri* has been obtained from the same level as *S. bravaisianus*. *S. neptuni* occur in the zone of *Inoceramus hobetsensis*, approximately lower Upper Turonian, while *S. bravaisianus*, *S. branneri* and *S. normalis*

in the zone of *Inoceramus teshioensis*, approximately upper Upper Turonian.

A specimen described as *Prionotropis* sp. by ROMAN and MAZERAN (1913, p. 25, pl. 4, fig. 18, 18a) is probably identified with *S. branneri* ANDERSON [=*S. cristatus* (BILLINGHURST)]. It came from the very layer where *S. bravaisianus* occurred more abundantly. We would like to know whether the same succession of the species of *Subprionocyclus* as that in Japan is maintained or not in the Turonian sequence of France and various other areas in the world.

P.S. C.W. WRIGHT has recently given us information that *S. neptuni*, *S. hitchinensis*, *S. branneri* and *S. normalis* all occur together at Hitch Wood in England. He does not agree with us to distinguish *S. bravaisianus* from *S. neptuni* (letter Sept. 9, 1966).

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Explanation of Plate 40

Figs. 1–8. *Subprionocyclus bravaisianus* (D'ORBIGNY) ..... Page 360

1. Lectotype, from Uchaux (Vaucluse), France, in D'ORBIGNY's collection. Two lateral (a, b), ventral (c) and frontal (d) views, ×2.5. The serrations of the ventral keel seem to have been in part modified by weathering.
2. Syntype No. 1, a widely umbilicate and coarsely ribbed variety. Lateral (a) and frontal (b) views, ×2.5.
3. Syntype No. 3, an example with a similarly wide umbilicus but denser ribs. Lateral view, ×2.5.
4. Syntype No. 4, an example with a narrow umbilicus and dense but coarse ribs. Lateral view, ×2.5.
5. Syntype No. 7, an example which is fairly similarly to but smaller than the loctotype. Lateral view, ×2.5.
6. A set of syntypes of "*Schloenbachia bravaisiana* (D'ORBIGNY)" in D'ORBIGNY's collection, Musèum National d'Histoire Naturelle, Paris. No. 2 is the lectotype designated in this paper. No. 5 should be excluded from the present species. Natural size.
7. GK.H 6975, an example from Nakahaji Shale, Onogawa Group (Coll. M. NODA). Lateral view, ×1.5.
8. GK.H 6976, a smaller example from Nakahaji Shale, Onogawa Group (Coll. M. NODA). Lateral view, ×2. The last two specimens are preserved in the Type Specimen Room, Department of Geology, Kyushu University.

1a

1c

1b

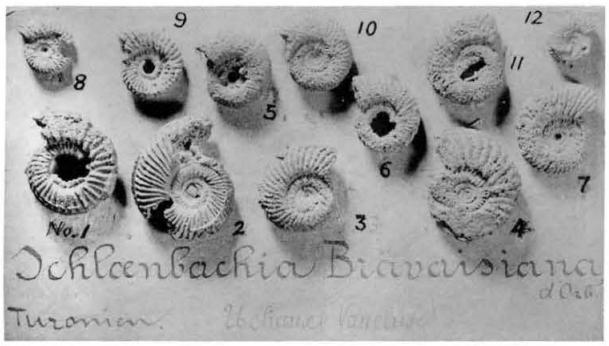
1d

2b

2a

3

4



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Nakahaji 中土師　　Onogawa 大野川

PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会第94回例会は，1966年9月24日(土) 秋田大学鉱山学部講義室において開催された．尚，9月25日(日) には八郎潟付近の見学旅行が行われた。(参加者 13 名)

個　人　講　演

房総半島上総層群の底棲有孔虫による分帯
青木直昭

日本更新統産 *Gobius* 化石　青木直昭

沖縄本島より発見された Halobiidae (代読)
石橋　毅・小林貞一・小西健二

A Lower Carboniferous Ammonoid from Sasanohara, Southern Kitakami Mountains
Yasuji SAITO

宇部炭田の夾炭層植物群
藤岡一男・棚井敏雅・高橋英太郎

山口県福井植物群 (中期中新世)
藤岡一男・高橋英太郎

下関市の中新世植物化石　藤岡一男・高橋英太郎

秋田県の宮田植物群 (後期中新世)　藤岡一男

[見　学　旅　行]

男鹿・八郎潟及び福米沢油田の地質見学
案内者　藤岡一男

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(New Series No. 57–No. 64).

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INDEX OF FAMILIES, GENERA AND SPECIES

Notes: Words listed below are names of families, genera and species, which are either described or illustrated in the Transactions and Proceedings of the Palaeontological Society of Japan, New Series, Nos. 57–64; words in heavy type are names of new genera and species.

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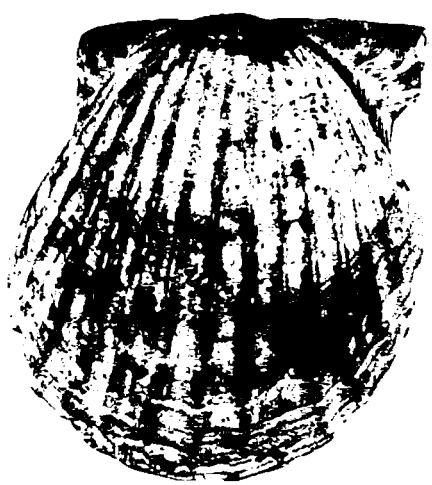
日本古生物学會報告・紀事

Transactions and Proceedings of the Palaeontological Society of Japan

New Series

No. 57 ~ No. 64

1965 ~ 1966



日本古生物学会

Palaeontological Society of Japan

The heading in Japanese commemorates the handwriting of Prof. M. YOKOYAMA, father of Japanese Palaeontology, who was Professor of Stratigraphy and Palaeontology at the Geological Institute, Imperial University of Tokyo.

The fossil on the front page is *Pecten takahashii* YOKOYAMA, 1930.

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例会通知

	開催地	開催日	講演申込締切日
1967年総会・年会	東京大学	1967年1月21,22日	1966年12月20日
第96回例会	大阪市大	1967年6月中旬	1967年5月10日

NEWS

◎ 来年開催を予定されている主な関係国際会議（期日，開催地，連絡先）は次の通りである。

Intl. Symposium on Jurassic Stratigraphy
July 17-27, Luxemburg: Dr. P. L. MAUBEUGE, 141 ave. Carnot, St-Max, France.

Intl. Sedimentological Congress
Aug. 11-15, Reading and Edinburgh: Sedimentology Research Lab., Geol. Dept., the University, Whiteknights Park, Reading, England.

European Colloquium of Micropaleontology
Sept. 2-9, Poland: Polska Academia Nauk, Zklad Paleozoologii, Al. Zwirki i Wigury 6, Warszawa, Poland.

Intl. Symposium on Devonian
Sept. 6-8, Calgary, Alberta: Alberta Soc. Petroleum Geologists, POB 53, Calgary, Alberta, Canada.

Intl. Congress of Carboniferous Stratigraphy and Geology
Sept. 11-16, Shefield, England: Dr. A. W. WOODLAND, Secretary-general, Geological Survey Office, Ring Road Halton, Leeds 15, England.

Congress on Mediterranean Neogene Stratigraphy
Sept. 19-30, Bologna: Prof. R. SELLI, Instituto di Geologia e Paleontologia, Univ. di Bologna, Via Zamboni 63, Bologna, Italy.

Symposium on Gondowana Stratigraphy
Sept. 26-Oct. 15, Buenos Aires: Dr. E. R. PLUMSTEAD, Dept. of Geology, Univ. of the Witwatersland, Johannesburg, South Africa.

Intl. Conference on Planktonic Microfossils
Sept. 27-Oct. 3, Geneva: Univ. & Museum of Nat. Hist. of Geneva, Planktonic Conference, Box. 160, 1211 Geneva 4, Switzerland.

◎ Meetings of the International Palaeontological Union, 1966. 第11回太平洋学術会議中9月1日に国際古生物学連合の会議が開かれた。午前には Bureau, Filiales, Committees の役員などが東大総合研究資料館に集まって Business Meeting を開いた。正午から日本学術会議古生物学研究連絡委員会が各国の代表を招待して赤門横の学士会館分館で午餐会を開いた。午後は Asian Filial の第1回会合が東大総合研究資料館で開かれ，内外 10 ケ国 22 名の学者が集まって今後の活動について意見を交換した。

◎ 国際古生物学連合では Directory of Palaeontologists of the World (2nd ed.) を出版すべく Questionnaire を配布中です，配布ご希望の向きは 15 円切手を貼付した封筒に宛先を記入して本会宛お申込み下さい。

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1966年12月15日 発行

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(Jan. 15, 1963)

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3. Manuscripts (including of text-figures, maps and tables) will be limited to 24 printed pages (less than 54 type-written pages).
4. Illustrations will be limited to two plates (14.2×20.0 cm).
5. Text-figures will be limited to 10 in number, not exceeding 60 tsubo in total area (1 tsubo is 1 square sun). They should be drawn carefully on white paper with drawing or Indian ink, letters used in the figures should be either printed or typed letters pasted-in. Figures may be reduced, so authors are requested to carefully select the size and thickness of the lines or letter used.
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