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GEOLOGICAL SURVEY OF JAPAN
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By

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Studies of Fossil Molluscan Biocoenosis, No. 1.

Biocoenological Studies on the Mangrove Swamps, with Descriptions of New Species from Yatuo Group.

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Amynodon watanabei from the Latest Eocene of Japan with a Brief Summary of the Latest Eocene Mammalian Faunule in Eastern Asia.

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TOKYO 1950, JULY

Amynodon watanabei from the Latest Eocene of Japan with a Brief Summary of the Latest Eocene Mammalian Faunule in Eastern Asia.*

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ABSTRACT

This article is the study of *Amynodon watanabei* which was unearthed from the Ube coal-bearing formation of the Okinoyama Colliery in Yamaguchi Prefecture and the Gonosawa sandstone formation the lower part of the Tachibets group (the *Woodwardia* zone of the Ishikari series) of the Uryû coal-field in Hokkaidô. It is clarified that the present material belongs to the genus *Amynodon* among the six genera belonging to the Amynodontidae. *Amynodon watanabei* is newly described and compared with eight Asiatic species which belong to the Amynodontidae. By the occurrence of *Desmatotherium grangeri* and *Amynodon watanabei*, the Ube coal-bearing formation and the *Woodwardia* zone of the Ishikari series are safely correlated with the Hôsan formation of Korea. The Ubean and Hôsanian are proposed as the Japanese and Korean provincial age-names, generally corresponding to the European Bartonian and North American Uintan, for the Ube coal-bearing formation and Hôsan formation respectively. They indicate the Latest Eocene age. The Uppermost Eocene deposits of Eastern Asia are the Kuanchuang, Lower Yüanch'ü, Lushih, Fanchuang, and Lunan series and Irdin Manha and Shara Murun formations, all in China (including Mongolia), the Pondaung formation of Burma, and the Melawi group of Borneo in East Indies, besides in Japan and Korea. The Latest Eocene mammalian faunule of Eastern Asia will be divided into two subfaunules by their composition and distribution. During the Latest Eocene age the southern subfaunule arrived at the southeastern region from Europe and Africa through the southern route of Eurasia, and the northern one came from North America to the northeastern region by way of the Bering land-bridge. Japan and Borneo may have formed the eastern margin of the Asiatic Continent at that time, and the Wallace's line must have been in existence from that time.

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* Contribution from the Geological Institute, Faculty of Science, Tokyo University and the Geological Survey of Japan.

This paper was read at the 55th annual meeting of the Geological Society of Japan on the 30th April, 1948.

The writer reported the occurrence of *Desmatotherium grangeri* TOKUNAGA,[1] a member of the Latest Eocene mammalian faunule in Eastern Asia several years ago, from the uppermost Hitoishi (一重石) main coal-seam* of the Ube (宇部) Coal-field in Yamaguchi Prefecture. Until this occurrence was reported, most Japanese geologists had considered the age of the Ube coal-bearing formation to be Miocene. When the writer visited the Ube Coal-field in July 1947, he examined, through the courtesy of Kuraji SUZUKI, a fragmental left superior jaw with the second to fourth premolars which is in the geological collection of the Ube Engineering College. Also a right second inferior molar and a detached incisor was studied through the courtesy of Sakae IWAZAWA and Manabu GOAMI of the Okinoyama (沖ノ山) Colliery of the coal-field. These specimens were collected several years ago from the sandy shale layer just above the Hitoishi coal-seam of the Okinoyama Colliery.

In October of the same year, the writer identified for Yasuo SASA a fragmental right superior jaw with the second and third molars. This specimen was collected by Toshio YAMAMOTO from the Gonosawa (五ノ澤) sandstone formation, the lower part of the Tachibets (太刀別) group at a point about 50 metres northeastward of the entrance of Takasago-zawa (高砂澤), a small tributary of the River Horonitachibets (幌新太刀別), Numata-mura, Uryû-gun, Province of Ishikari in Hokkaidô. According to SASA's oral communication its horizon is correlated with the *Woodwardia* zone of the Ishikari (石狩) series at the type-locality.

These specimens are indentical with "*? Aceratherium watanabei*" and "*? Rhinoceros* sp." having been respectively described by Shigeyasu TOKUNAGA[2] from the Itsudan (五段) and Hitoishi coal-seams of the Ube Coal-field.

According to George Gaylord SIMPSON[3] the Rhinocerotoidea is clas-

1) F. TAKAI: Eocene Mammals from the Ube and Hôsan Coal-fields in Nippon. Proc. Imp. Acad. (Japan), vol. 20, no. 10, pp. 736-740. text-figs. 1-5, 1945.

2) S. TOKUNAGA: Fossils of Rhinocerotidae found in Japan. Proc. Imp. Acad. (Japan), vol. 2, no. 6, pp. 289-291, 1926.
——: Ancient Rhinocerotids lived in the Main Island of Japan, Korea and Manchuria. Dôbutsugaku Zasshi (Zool. Mag.) vol. 41, nos. 490-491, pp. 377, 378, 1929 (in Japanese).
S. TOKUNAGA and M. IIZUKA: Geological Studies on the Ube Coalfield. Mem. Fac. Sci. Eng., Waseda Univ., no. 6, pp. 1-151, pls. 1-7, geol. map 1, figs. 1-11, tables 1-36, 1930 (in Japanese).

3) G. G. SIMPSON: A New Classification of Mammals. Bull. Amer. Mus. Nat. Hist., vol. 59, art. 5, pp. 259-293, 1931.
——: The Principles of Classification and a Classification of Mammals. Ibid., vol. 85, pp. i-xvi+1-350, 1945.

sified into the following four families, namely:

Superfamily Rhinocerotoidea GILL, 1872. Rhinoceroses.

Family Hyrachyidae WOOD, 1927. Primitive rhinocerine perissodactyls.

Type genus: *Hyrachyus* LEIDY, 1871.

Geologic and geographic distribution: Lower to Upper E cene, North America.

Family Hyracodontidae COPE, 1879. Cursorial rhinoceroses.

Type genus: *Hyracodon* LEIDY, 1856.

Geologic and geographic distribution: Middle to Upper Eocene, Asia; Middle Eocene to Upper Oligocene, North America.

Family Amynodontidae SCOTT and OSBORN, 1883. Amphibious rhinoceroses.

Type genus: *Amynodon* MARSH, 1877.

Geologic and geographic distribution: Upper Eocene to Lower Miocene, Asia; Middle Oligocene, Europe; Upper Eocene to Middle Oligocene, North America.

Family Rhinocerotidae OWEN, 1845. True rhinoceroses.

Type genus: *Rhinceeros* LINNAEUS, 1758.

Geologic and geographic distribution: Upper Eocene to Recent, Asia; Middle Eocene to Pleistocene, Europe; Miocene to Recent, Africa; Upper Eocene to Lower Pliocene, North America.

The diagnoses[4)] of these families are tabulated as follows: (Table 1)

In the present material, the crista, which projects from the ectoloph into the prefossette between the protoloph and metaloph, is not developed. Since the entire loss of crista is one of the characteristics of the Amynodontidae[5)] which distinguishes it from the other three families of Rhinocerotoidea, it is sure that the present material belongs to the Amynodontidae. The genera belonging to the Amynodontidae are the following six, namely:

Amynodon MARSH, 1877.[6)]

Generic type: *Diceratherium advenus* MARSH, 1875.[7)]

Geologic and geographic distribution: Upper Eocene, Asia; Upper Eocene, North America.

Amynodontopsis STOCK, 1933.[8)]

Generic type: *Amynodontopsis bodei* STOCK, 1933.

Geologic and geographic distribution: Upper Eocene, North America.

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4) H. E. WOOD: Some Early Tertiary Rhinoceroses and Hyracodonts. Bull. Amer. Paleont., vol. 13, no. 5, pp. 161-266, pls. 41-47, tables 1-7, 1927.

5) W. B. SCOTT and H. F. OSBORN: On the Skull of the Eocene Rhinoceros, *Orthocynodon*, and the Relation of this Genus to Other Members of the Group. Contrib. E. M. Mus. Geol. Archaeol. Princeton College, Bull. no. 3, pp. 1-22, 1883.

6) O. C. MARSH: New Vertebrrate Fossils. Amer. Jour. Sci., ser. 3, vol. 14, no. 81, art. 33, pp. 251, 252, 1877.

7) O. C. MARSH: Notice of New Tertiary Mammals, IV. Ibid., ser. 3, vol. 9, no. 51, art. 26, pp. 244, 245, 1875.

8) C. STOCK: An Amynodont Skull from the Sespe Deposits, California. Proc. Natl. Acad. Sci., vol. 19, no. 8, pp. 762-767, text-fig. 1, 1933.

TABLE 1.

Diagnosis \ Family	Hyrachyidae	Hyracodontidae	Amynodontidae	Rhinocerotidae
Manus	4	3	4	4-3
Pes	3	3	3	3
Leg	slim	slim	stout	stout
Neck	long	long	short	short
Horn	rudimentary	nothing	nothing	present or nothing
Nasal	not short	short	short	not short
Nasal incision	slight	slight	slight	strong
Teeth	brachyodont	hypsodont	hypsodont	hypsodont
Dental formula	$\frac{3.1.4.3}{3.1.4\text{-}3.3}$	$\frac{3.1.4.3}{3.1.4\text{-}3.3}$	$\frac{3\text{-}2.1.4\text{-}3.3}{3\text{-}1.1.4\text{-}2.3}$	$\frac{3\text{-}0.1\text{-}0.4\text{-}3.3}{3\text{-}0.0.4\text{-}3.3}$
Incisor	unspecialized	unspecialized	small or reduced	frequent absent
Canine	moderate tusk-shaped	incisiform	powerful tusk-shaped	absent or small
Diastema	fairly long	rather short	rather short	long
Premolar	not molariform	molariform	molariform	molariform
Crista	well developed	usually present	absent	developed
Posterior extension of ectoloph	large	small	large	small
Lower molar	?	?	disproportion-ally long for width	?

Cadurcotherium GERVAIS, 1873.[9]

Generic type: *Cadurcotherium cayluxi* GERVAIS, 1873.

Geologic and geographic distribution: ?Lower Oligocene and ?Lower Miocene, Asia; Middle Oligocene, Europe.

Mesamynodon PETERSON, 1931.[10]

Generic type: *Mesamynodon medius* PETERSON, 1931.

Geologic and geographic distribution: Upper Eocene, North America.

Metamynodon SCOTT and OSBORN, 1887.[11]

Generic type: *Metamynodon planifrons* SCOTT and OSBORN, 1887.

Geologic and geographic distribution: Middle Miocene, Asia; Lower to Middle Oligocene, North America.

Paramynodon MATTHEW, 1929.[12]

Generic type: ?*Metamynodon birmanicus* PILGRIM and COTTER, 1916.[13]

Geologic and geographic distribution: Upper Eocene, Asia.

Among these six, the four genera such as *Amynodon,*[14] *Cadurco-*

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9) F. L. P. GERVAIS: Sur les fossiles trouvés dans les chaux phosphatées du Quercy. Comptes Rendus Hebdomadaires séances de l'Academie des Sciences, tome 77, no. 2, p. 106, 1873-a.

——: Mammifères dont les Ossements accompagnent les Dépôts de chaux phosphatée du Départements Tarn-et-Garonne et du Lot. 2 me memoire. Jour. Zool., tome 2, pp. 362-368, pl. 14, 1873-b.

10) O. A. PETERSON: New Species from the Oligocene of the Uinta. Annals Carnegie Mus., vol. 21, no. 2, art. 4, pp. 71, 72, text-fig. 8, 1931.

11) W. B. SCOTT and H. F. OSBORN: Preliminary Account of the Fossil Mammals from the White River Formation, contained in the Museum of Comparative Zoology. Bull. Mus. Com. Zool., Harvard College, vol. 13, pp. 151-171, 1887.

12) W. D. MATTHEW: Critical Observations upon Siwalik Mammals. Bull. Amer. Mus. Nat, Hist., vol. 55, art 7, pp. 512-514, 1929.

13) G. E. PILGRIM and G. de P. COTTER: Some Newly Discoverey Eocene Mammals from Burma. Rec. Geol. Surv. India, vol. 47, pt. 1, pp. 65-72, pl. 6, 1916.

14) *Amynodon mongoliensis* OSBORN, 1936.

O. ZDANSKY: Die alttertiären Säugetiere Chinas nebst stratigraphischen Bemerkungen. Palaeont, Sinica, ser. c, vol. 6, fasc. 2, pp. 49, 50, pl. 2 figs. 12, 13, pl. 3 figs. 7, 8, 1930.

H. F. OSBORN: *Amynodon mongoliensis* from the Upper Eocene of Mongolia. Amer. Mus. Novit., no. 859, pp. 1-9, text-figs. 1-6, 1936.

C. C. YOUNG: An Early Tertiary Vertebrate Fauna from Yuanchü. Bull. Geol. Soc. China, vol. 17, nos. 3-4, pp. 422-425, text-fig. 8, 1937.

Amynodon sinensis ZDANSKY, 1930.

O. ZDANSKY: Op. cit., 1930, pp. 42-49, pl. 2 figs. 3-11, pl. 3 figs. 3-6.

C. C. YOUNG: Op. cit., 1937, pp. 425, 426, text-fig. 9.

therium,[15] *Metamynodon*,[16] and *Paramynodon*[17] have been found in the Tertiary of Eastern Asia. On the other hand, the measurements made of the superior dentition, including the present material and representing members of the Amynodontidae from the Eocene, Oligocene and Miocene of Eastern Asia and North America, gave the following values for the ratio:

$$\frac{\text{Length M1—M3}}{\text{Length P2—M3}} \times 100$$

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15) *Cadurcotherium ardynense* OSBORN, 1923.
H. F. OSBORN: *Cadurcotherium* from Mongolia. Amer. Mus. Novit., no. 92, pp. 1, 2, 1923.
——: *Cadurcotherium ardynense*. Oligocene, Mongolia. Ibid., no. 147, pp. 1-4, text-figs. 1, 2, 1924.
C. C. YOUNG: Op. cit., 1937. p. 422, text-fig. 7.
Cadurcotherium indicum PILGRIM, 1910.
G. E. PILGRIM: The Tertiary and Post-Tertiary Freshwater Deposits of Baluchistan and Sind with Notices of New Vertebrates. Rec. Geol. Surv. India, vol. 37, pt. 2, p. 149, 1908.
——: Notices of New Mammalian Genera and Species from the Tertiaries of India. Ibid., vol. 40, pt. 1, p. 65, 1910.
——: The Tertiary Vertebrate Fauna of the Gaj Series in the Bugti Hills and the Punjab. Palaeont. Indica, n. s., vol. 4, no. 2, pp. 22-24, pls. 5, 6, 1912.
Cadurcotherium sp.
W. D. MATTHEW and W. GRANGER: The Fauna of the Houldjin Gravels. Amer. Mus. Novit., no. 97, p. 4, text-figs. 2-4, 1923.

16) *Metamynodon bugtiensis* (FORSTER-COOPER), 1922.
C. FORSTER-COOPER: *Metamynodon bugtiensis*, sp. n., from the Dera Bugti Deposits of Baluchistan.—Preliminary Notice. Ann. Mag. Nat. Hist., ser. 9, vol. 9, no. 53, art. 74, pp. 617-620, text-figs. 1, 2. 1922.

17) *Paramynodon birmanicus* (PILGRIM and COTTER), 1916.
G. E. PILGRIM and G. de P. COTTER: Op. cit., 1916, pp. 65-72, pl. 6.
H. F. OSBORN: Op. cit., 1924, p. 3, text-fig. 3.
G. E. PILGRIM: The Perissodactyla of the Eocene of Burma. Palaeont. Indica, n. s., vol. 8, no. 3, pp. 19-21, pl. 2 figs. 2, 3, 1925.
W. D. MATTHEW: Op. cit., 1929, p. 514.
E. H. COLBERT: Fossil Mammals from Burma in the American Museum of Natural History. Bull. Amer. Mus. Nat. Hist., vol. 74, art. 6, pp. 316-328, text-figs. 23-30, 1938.
Paramynodon cotteri (PILGRIM), 1925.
G. E. PILGRIM: Op. Cit., 1925, pp. 15-19, pl. 2 fig. 1.
E. H. COLBERT: Op. cit., 1938, pp. 328-330, text-fig. 31.

TABLE 2.

Species	Horizon	Ratio
Amynodon erectus	Uinta	66.34
A. intermedius	Uinta	64.91–68.63
A. mongoliensis	Shara Murun	64.19
A. watanabei	Gonosawa	66.18
Amynodontopsis bodei	Sespe	69.48[a]
Cadurcotherium ardynense	Ardyn Obo	70.21–70.98
Metamynodon bugtiensis	Bugti	70.00
M. rex	White River	69.40

a.—Approximate.

The cheek teeth of the genus *Cadurcotherium* are more strongly compressed laterally than those of the genus *Amynodon*. The cheek teeth of the genus *Metamynodon* are distinguished from those of the genus *Amynodon* by their large size and other evolutionary advanced characters. William Diller MATTHEW established the genus *Paramynodon* by "*? Metamynodon birmanicus*" as its type. It can be recognized that the genus *Paramynodon* has some characteristics which are intermediate between the American genera *Amynodon* and *Metamynodon*. Consequently, so far as the dental characteristics are concerned the genus *Amynodon* becomes the most suitable genus for the present material among the four East-Asiatic genera belonging to the Amynodontidae. The description of the new material is given below.

Amynodon watanabei (TOKUNAGA), 1926.

Pl. I, Figs. 1–4.

1926. *? Aceratherium watanabei* TOKUNAGA, Proc. Imp. Acad. (Japan), vol. 2, no. 6, pp. 289–291.
1929. *Rhinoceros watanabei*, TOKUNAGA, Zool. Mag., vol. 41, nos. 490–491, pp. 377, 378.
1929. *Rhinoceros* sp., TOKUNAGA, Ibid., vol. 41, nos. 490–491, pp. 377. 378.
1930. *? Aceratherium watanabei*, TOKUNAGA and IIZUKA, Mem. Fac. Sci. Eng., Waseda Univ., no. 6, pp. 111, 112, pl. 2 figs. 1–3.

1930. ? *Rhinoceros* sp., TOKUNAGA and IIZUKA, Ibid., no. 6, pp. 111, 112, pl. 2 figs. 4, 5.
1938. *Rhinoceros* (*Chilotherium*) pugnator, TAKAI, Jour. Geol. Soc. Japan, vol. 45, no. 541, pp. 747, 748 (in part).
1939. *Rhinoceros* (*Chilotherium*) *pugnator*, TAKAI, H. Yabe's Jubilee Publ., vol. 1, pp. 192, 193 (in part).
1941. ? *Rhinoceros* sp., SONE, H. YABE's Jubilee Publ., vol. 2, p. 1094.
1941. ? *Aceratherium watanabei*, SONE, Ibid., vol. 2, p. 1094.
1945. ? *Cadurcotherium watanabei*, TAKAI, Proc. Imp. Acad. (Japan), vol. 20, no. 10, p. 737.
1948. *Amynodon watanabei*, TAKAI, Jour. Geol. Soc. Japan, vol. 54, no. 637, pp. 131; 132.

Material:—A fragment of right superior jaw with the second and third molars in the museum of the Department of Geology and Mineralogy, Faculty of Science, Hokkaidô University. A fragmental left superior jaw with the second to fourth premolars in the geological collection of the Ube Engineering College. An isolated right second inferior molar and an incisor in the museum of Geological Institute, Faculty of Science, Tokyo University.

Description:—An isolated incisor, probably belonging to the superior jaw; has an obtusely pointed crown and exhibits a convex anterior face, a more flattened posterior face with a pronounced median convex ridge which expands into the basal cingulum, and an obliquely sloping cingulum.

The superior premolars more or less quadrate and molariform in their patterns and their basal cingula somewhat distinct. More than the buccal and anterior half part of $\underline{P2}$ and the buccal sides of $\underline{P3}$ and $\underline{P4}$ already damaged. The prefossette of $\underline{P3}$ with almost equal-sized protoloph and metaloph enclosed palatally. $\underline{P4}$ exhibits double crests of which the anterior protoloph is larger than the posterior metaloph and its prefossette opened palatally and not separated by a crista.

The superior molars roughly subquadrate in their outlines and also composed of double crests of which the anterior larger than the posterior. The obliquity of the protoloph and the metaloph to the ectoloph not so strong and the posterior extension of the ectoloph prominent. The prefossette, of which the width in $\underline{M3}$ twice as broad as in $\underline{M2}$, opened postero-palatally and not separated by a crista. The postfossette V-shaped and opened widely toward the posterior direction. The somewhat distinct basal cingula present on their anterior and posterior sides.

An isolated right inferior molar, probably belonging to the second, has a rectangular outline and not excessively elongated. Composed of double crests which are almost equal in size. Its basal cingulum very feeble. The concavity of its posterior wall shows the presence of a successive tooth. Its grinding surface is so worn that its valley between two crests seems to be small comparing its size and opens towards the postero-lingual direction.

Measurements in mm.

I	antero-postero	20.5
	transverse	17.6
P 2	antero-postero	16.7+
	transverse	19 +
P 3	antero-postero	22.5
	transverse	24 +
P 4	antero-postero	30
	transverse	29 +
M 1	antero-postero (alveolus)	39.2
	transverse (alveolus)	41.4
M 2	antero-postero	51.6
	transverse	55.3
M	antero-postero	48.3
	transverse	53.8
M2	antero-postero	55.4
	transverse	47.2
P2-P4	antero-postero	70 −
M1 M3	antero-postero	137 +

Remarks:—Comparing the present species with the Asiatic species of the Amynodontidae which are geographically fairly close to it, the following observations may be made.

As Henry Fairfield OSBORN has stated, *Cadurcotherium ardynense* OSBORN,[18] from the Lower Oligocene Ardyn Obo formation of Outer Mongolia and the uppermost Eocene lower Yüanch'ü (垣曲) series of Shansi Province in China, is comparable in size to the European species, *Cadurcotherium cayluxi* GERVAIS,[19] but it is characterized by shorter crowned molars and premolars with more fully developed median fossa. Its molars are transversely more compressed than those of the present species. *Cadurcotherium indicum* PILGRIM[20] of the Middle Miocene Gaj series of Baluchistan closely approaches the latest European representa-

18) H. F. OSBORN: Op. cit., 1923, pp. 1, 2.
19) P. GERVAIS: Op. cit, 1873-b, pp. 362-368, pl. 14.
20) G. E. PILGRIM: Op. cit., 1910, p. 65.

tive, *Cadurcotherium nouleti* ROMAN and JOLEAUD[21] and is characterized by its very large, transversely compressed molars with flat surfaces of ectoloph. It is much larger and more advanced than the present species. *Cadurcotherium* sp.,[22] which was described by W. D. MATTHEW and Walter GRANGER from the Upper Oligocene Houldjin formation of Inner Mongolia, resembles *Cadurcotherium cayluxi* GERVAIS in its size, but it is too fragmental to identify the specimens to the genus *Cadurcotherium.* For that reason a reliable comparison of the specimens with the present species is difficult.

Edwin Harris COLBERT[23] says that *Metamynodon bugtiensis* FORSTER-COOPER,[24] described from the Middle Miocene Bugti formation of Baluchistan, is also a form much larger and more advanced than the species belonging to the genus *Paramynodon.* It is closely related to the American representative, *Metamynodon planifrons* SCOTT and OSBORN[25] by its large size, relatively straight ectoloph, development of parastyle fold, and other characteristics. It shows many evolutionary advanced characters, for instance, the ratio of the length of superior molar-series, the length of superior pre-molar- and molar-series (Table 2) over the present species.

E. H. COLBERT[26] gives full details on *Paramynodon birmanicus* (PILGRIM and COTTER)[27] and *Paramynodon cotteri* (PILGRIM),[28] described from the Uppermost Eocene Pondaung formation of Burma. They show more resemblance in their dental characters to the Asiatic species belonging to the genus *Amynodon* such as *Amynodon mongoliensis* OSBORN[29] and *Amynodon sinensis* ZDANSKY[30] than do the Asiatic species of the genera *Cadurcotherium* and *Metamynodon.* Their obliquenesses of the protoloph and metaloph in the superior molars are stronger than the present species.

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21) F. ROMAN and L. JOLEAUD: Le *Cadurcotherium* de l'Isle-sur-Sorgues (Vaucluse), et Revision du Genre *Cadurcotherium.* Arch. Mus. Hist. Nat. Lyon, tome 10, art. 1, pp. 1-48, pls. 1-3, 1908.
22) W. D. MATTHEW and W. GRANGER: Op. cit., 1923, p. 4, text-figs. 2-4.
23) E. H. COLBERT: Op. cit., 1938, p. 327.
24) C. FORSTER-COOPER: Op. cit., 1922, pp. 617-620, text-figs. 1, 2.
25) W. B. SCOTT and H. F. OSBORN: Op. cit., 1887, pp. 151-171.
26) E. H. COLBERT: Op. cit., 1938, pp. 314-345, text-figs. 23-38.
27) G. E. PILGRIM and G. de P. COTTER: Op. cit., 1916, pp. 65-72, pl. 6.
28) G. E. PILGRIM: Op. cit., 1925, pp. 15-19, pl. 2 fig. 1.
29) H. F. OSBORN: Op. cit., 1936, pp. 1-9, text-figs. 1-6.
30) O. ZDANSKY: Op. cit., 1930, pp. 42-49, pl. 2 figs. 3-11 pl. 3 figs. 3-6.

Amynodon mongoliensis OSBORN, from the Uppermost Eocene Shara Murun formation of Inner Mongolia and the Uppermost Eocene lower Yüanch'ü series of Shansi and Honan Provinces in China, is comparable in size to the Burmese species, namely *Paramynodon birmanicus* (PILGRIM and COTTER) and *Paramynodon cotteri* (PILGRIM). Judging from the size of the cheek teeth and the ratio shown in table 2, it is clearly distinguished from the present species. The other Asiatic species *Amynodon sinensis* ZDANSKY, from the Uppermost Eocene lower Yüanch'ü series of Shansi and Honan Provinces in China, is an exceedingly small form and not a half as large as the present species. So far as the ratio shown in table 2 is concerned, one of the American species, *Amynodon erectus* TROXELL,[31] described from the Uppermost Eocene Uinta formation, has near relationship with the present species, but is separated from it by its smaller size.

Geologic Age of the Ube and Gonosawa sandstone Formations and the Mammalbearing Uppermost Eocene Deposits in Eastern Asia:—

In 1945 the writer[32] stated that the geologic age of the Ube coal-bearing formation must be Latest Eocene because of the occurrence of *Desmatotherium grangeri* TOKUNAGA,[33] described from the Uppermost Eocene Hôsan (鳳山) formation of Kôkai-dô in the central part of Korea, a member of the Latest Eocene mammalian faunule of Eastern Asia. On the other side Hisakatsu YABE[34] reported the occurrences of *Clypeaster* sp., *Athleta japonica* NAGAO, *Sabalites nipponicus* (KRYSHTOFOVICH), and *Nelumbo* cf. *nipponica* ENDO from the Ube coal-bearing formation. *Athleta japonica* NAGAO[35] occurs from the Uppermost Eocene Ôtsuji (大辻) group or the Upper Eocene Iôjima (伊王島) beds in the various coal-fields of the northern part of Kyûshû. Both *Sabalites*

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31) E. L. TROXELL: New Amynodonts in the Marsh Collection. Amer. Jour. Sci., ser. 5, vol. 2, no. 7, art. 2, pp. 28-33, text-figs. 3-7. 1921.

32) F. TAKAI: Op. cit., 1945, pp. 736-740, text-figs. 1-5.

33) S. TOKUNAGA: On the Geological Age of Hozan Coal Field, Chosen. Jour. Geol. Soc. Tôkyô, vol. 40, no. 475, pp. 181, 182, pl. 8 fig. 6, 1933-a. (in Japanese).
——; A List of the Fossil Land Mammals of Japan and Korea with Description of New Eocene Forms. Amer. Mus. Novit., no. 627, pp. 6, 7, text-fig. 2, 1933-b.

34) H. YABE: Palaeogene Age of the Coal Formation of the Ube Coalfield, Yamaguti Prefecture. Proc. Imp. Acad. (Japan) vol. 20, no. 10. pp. 725-731, text-figs. 1-5, 1945.

35) T. NAGAO: Palaeogene Fossils of the Island of Kyûshû, Japan. Sci. Rep., Tôhoku Imp. Univ., ser. 2 (geol.), vol. 12, no. 1, pp. 120, 121, pl. 16 figs. 1-10, 12-19, 1928.

nipponicus (KRYSHTOFOVICH)[36] and *Nelumbo* cf. *nipponica* ENDO[37] are recorded from the Palaeogene or Basal Neogene series in Kyûshû, Hokkaidô and Sakhalin. From these palaeontological data, the Ube coal-bearing formation can be, on the one hand, correlated with the Hôsan formation and on the other hand with the Ôtsuji group.

In 1939 the writer[38] stated that the synchronism between the Hôsan formation and the Palaeogene series of the Japanese Islands would be studied when new palaeontological data was found. The occurrence of *Amynodon watanabei* (TOKUNAGA) from the Ube coal-bearing formation and Gonosawa sandstone formation solves this question. As stated above the Gonosawa sandstone formation is correlated with the *Woodwardia* zone of the Ishikari series by SASA's oral communication. Then the *Woodwardia* sandstone formation can be correlated with the Ube coal-bearing formation and the Hôsan formation. This correlation is ascertained palaeobotanically. The common elements between the *Woodwardia* and Hôsan florae are the following eight species, namely, *Populus glandulifera* HEER, *Populus zaddachi* HEER, *Populus arctica* HEER, *Ficus occidentalis* LESQUEREUX, *Platanus aceroides* GOEPPERT, *Platanus guillelmae* GOEPPERT, *Acer arcticum* HEER, and *Viburnum nordenskiöldi* HEER, Seidô ENDO[39] believes the geologic age of the *Woodwardia* flora to be Late Eocene, while Takumi NAGAO[40] believes that it is Early Oligocene because the Wakkanappe (若鍋) formation which underlies the *Woodwardia* sandstone formation is correlated by the molluscan faunule with the Ashiya (蘆屋) group in Kyûshû.

Judging from the mammalian faunal assemblage in Eastern Asia, the Ube coal-bearing formation, the *Woodwardia* sandstone formation, and the Hôsan formation are contemporaneous deposits and their geo-

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36) A. N. KRYSHTOFOVICH: Occurrence of the Palm, *Sabal nipponica*, n. sp., in the Tertiary Rocks of Hokkaidō and Kyūshū. Jour. Geol. Soc. Tokyo, vol. 25, no. 303, pp. 59-66 (English part), pl. 41, 1918.
S. ENDO: Two New Early Tertiary Plants from Japan. Johns Hopkins Univ. Stud. Geol., vol. 11, pp. 268. 269, pl. 18, 1934-b.

37) S. ENDO: A New Species of *Nelumbo* from the Palaeogene of Japan. Japan. Jour. Geol. Geogr., vol. 11, nos. 3 4, pp. 255-258, pls. 36-38, 1934-a.
——: Op. cit., 1934-b, pp. 269, 270, pls. 19, 20.

38) F. TAKAI: Eocene Mammals found from the Hôsan Coal-field, Tyôsen. Jour. Fac. Sci., Imp. Univ. Tokyo, sec. 2, vol. 5, pt. 6, pp. 215-217, pls. 1-5, text-figs. 1, 2, 1939.

39) S. ENDO: Cenozoic Plants. Iwanami-Kôza (Geology and Palaeontology), 1931. (in Japanese).

40) T. NAGAO: Palaeogene series. Ibid., 1933 (in Japanese).

logic age is believed to be Latest Eocene. Therefore, the writer proposes the Ubean and Hôsanian as the Japanese and Korean provincial age-name, generally corresponding to the European Bartonian and North American Uintan, for the Ube coal-bearing formation and Hôsan formation respectively. The Uppermost Eocene deposits of Eastern Asia, which are generally correlated with the Ubean and Hôsanian stages, are found in China (including Mongolia), Burma, and East Indies—Borneo, besides in Japan and Korea. They are listed belows:—

China	Kuanchuang (官莊) series of Shansi Province.
	Lower Yüanch'ü series of Shansi and Honan Provinces.
	Lushih (盧氏) series of Honan Province.
	Fanchuang (范莊) series of Honan Province.
	Lunan (路南) series of Yunnan Province.
	Irdin Manha formation of Inner Mongolia.
	Shara-Murun formation of Inner Mongolia.
Burma	Pondaung formation.
East Indies	Melawi group of Borneo.

The Latest Eocene mammalian faunule of Eastern Asia will be discussed by the writer in detail on another occasion. However a brief summary[41] is given here. The Latest Eocene faunule in the northeastern region of Asia and that in the southeastern region are different in their composition. The former has many intimate relationships with the North American forms and the latter with the Europo-African one. That is, the northern subfaunule came from North America to the northeastern region by way of the Bering land-bridge during the Latest Eocene age, and the southern one arrived at the southeastern region from Europe and Africa through the southern route of Eurasia during the same age. It is unquestionable that these two subfaunules are intermingled. The writer considers that Japan and Borneo may have formed the eastern margin of the Asiatic Continent at this time, and that WALLACE's line, which passes between Borneo and Celebes must have been succeeded from that time.

This paper embodies the result of one of the joint studies of the Geological Institute, Faculty of Science, Tokyo University and the Geological Survey of Japan, made under the Science Research Fund

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41) F. TAKAI: Short Opinion on the History of Mammals in Eastern Asia. Kagaku (Science), vol. 18, no. 4, pp. 147-150, 1948 (in Japanese).

from the Department of Education and travelling expenses from the Geological Survey. The writer wishes to express his hearty thanks to the officials of the Department as well as to Drs. Tomofusa MITSUCHI, Katsu KANEKO, and Kinji KANEHARA, all of the Geological Survey. He acknowledges his great indebtedness to Prof. Y. SASA of the Hokkaidô University, Prof. K. SUZUKI of the Ube Engineering College, Messrs. S. IWAZAWA and M. GOAMI, both of the Okinoyama Colliery, and to Mr. T. YAMAMOTO of the Meiji Mining Company, for kindly placing their new materials at his disposal. He is also greatly indebted to Prof. Teiichi KOBAYASHI of the Tokyo University for advice and for reading the manuscript. Thanks are also due to Messrs. Chûzaburo UEKI, Sumio KUMANO, and Sirô SUZUKI for photographing and retouching.

要　　約

日本最上部始新統産 *Amynodon watanabei*

附　東アジアにおける始新世末期哺乳動物群の要約

高井冬二

山口縣宇部炭田沖ノ山炭鑛の宇部夾炭層（一重石炭層）および北海道雨龍炭田の太刀別層下部の五ノ澤砂岩層（石狩統羊齒砂岩帶）から出土した *Amynodon watanabei* の研究である。

犀超科に關する從來の研究を綜合した結果（第1表），本化石が牙犀科（Amynodontidae）に屬することがわかつた。次に牙犀科に所屬する *Amynodon, Amynodontopsis, Cadurcotherium, Mesamynodon, Metamynodon, Paramynodon* 等の6屬についてそれぞれの模式種を調べた結果，本化石が *Amynodon* に屬することが明らかになつた。

Amynodod watanabei の記載をした上，アジア產の *Cadurcotherium ardynense, C. indicum, C.* sp., *Metamynodon bugtiensis, Paramynodon birmanicus, P. cotteri, Amynodon mongoliensis, A. sinensis* 等8種との比較を試みてある。

朝鮮の鳳山層から記載された *Desmatotherium grangeri* が宇部夾炭層から產出することと今回の *Amynodon watanabei* の產出とによつて，宇部夾炭層と石狩統（羊齒砂岩帶）とは確實に鳳山層に對比される。そこでヨーロッパの Bartonian と北アメリカの Uintan とに比較される日本および朝鮮における地方的な時代區分として，宇部夾炭層・鳳山層をもとにして宇部期・鳳山期を提唱する。いづれも始新世末期を示すものである。

日本・朝鮮以外の地域における始新世末期を示す地層は中華民國の官莊統・下部垣曲統・盧氏統・范莊統・路南統・Irdin Manha 層・Shara Murun 層・ビルマの Pondaung 層・東印度（ボルネオ）の Melawi 層群等である。

東アジアにおける始新世末期哺乳動物群はその組成および分布から見て南北の兩哺乳動物亞群に區別される。南部の哺乳動物亞群はヨーロッパおよびアフリカから南方の經路を經てアジア南東部に達したもので，北部のものは北アメリカからベーリング陸橋を經てアジア北東部に達したものである。そして日本およびボルネオは始新世末期にアジア大陸の東緣を形成していたもので，ウォーレス線の前身はその當時からあつたものと考える。

PLATES

AND

EXPLANATIONS

Explanation of Plate I.

Amynodon watanabei (Tokunaga), 1926.

fig. 1a Buccal view of the right superior jaw with the second and third molars. ×2/5.

1b Crown view of same. ×2/5.

1c Palatal view of same. ×2/5.

2a Lingual view of the incisor. ×4/5.

2b & 2c Lateral view of same. ×4/5.

3a Crown view of the left superior jaw with the second, third, and fourth premolars. ×4/5.

3b Palatal view of same. ×4/5.

4a Crown view of the inferior second molar. ×4/5.

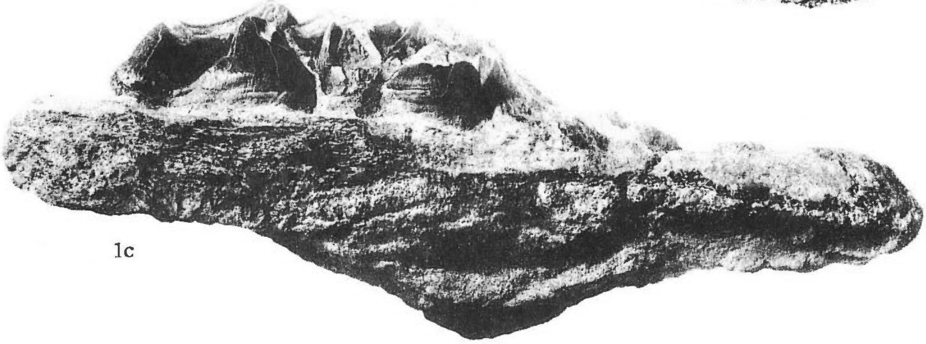
4b Buccal view of same. ×4/5.

2a

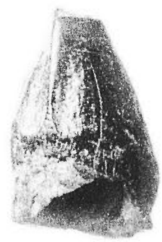
1a

1b

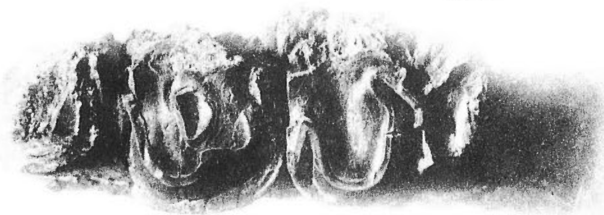
2b



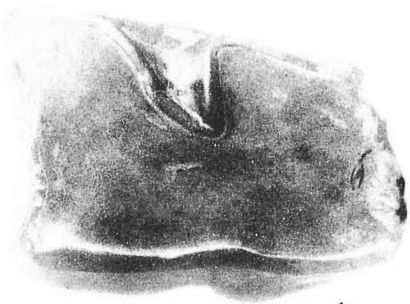
1c



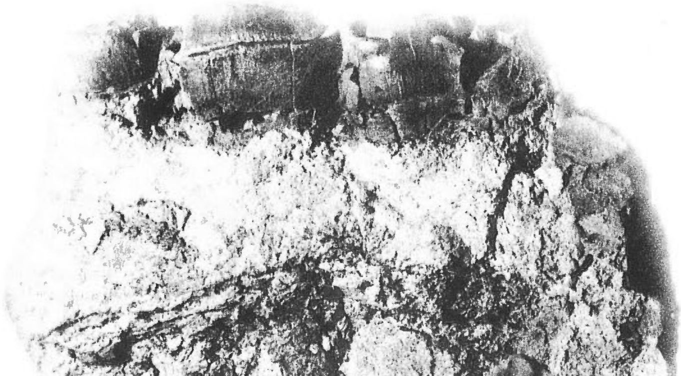
2c



3a



4a



3b

4b

(C. Ueki Photo.)

564.$^{1}/_{3}$=2 A. c. II

REPORT No. 132
GEOLOGICAL SURVEY OF JAPAN

Studies of Fossil Molluscan Biocoenosis, No. 1.

Biocoenological Studies on the Mangrove Swamps, with Descriptions of New Species from Yatuo Group.

By

Katura Oyama.

TOKYO 1950, JULY

Studies of Fossil Molluscan Biocoenosis, No. 1.

Biocoenological Studies on the Mangrove Swamps, with Descriptions of New Species from Yatuo Group.

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Contents

I. Introduction
II. Mangrove swamps and its mollusks.
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V. *Telescopium-Geloina* biocoenosis from Yatuo Group, Central Japan.
VI. Description of new and noteworthy species.
Genus *Littorinopsis* MÖRCH
Subgenus *Littorinopsis* s. str.
Littorinopsis (*Littorinopsis*) *miodelicatula* OYAMA, n. sp.
Genus *Telescopium* MONTFORT.
Telescopium nipponicum OYAMA, n. sp.
Genus *Chicoreus* MONTFORT.
Subgenus *Rhizophorimurex* nov.
Chicoreus (*Rhizophorimurex*) *tiganouranus* (NOMURA)
Genus *Geloina* GRAY
Geloina stachi OYAMA, n. sp.
Geloina yamanei OYAMA, n. sp.
Bibriography.

I. Introduction.

In summer 1947 and 1948, geological studies of P.E.A.C.[1] took place in Toyama Basin. The author joined as its member, practising a macropaleontological survey. Among the fossil biocoenosis, the author has discovered a similar biocoenosis which is found in a mangrove swanp. This paper deals a comparative study on the biocoenosis of a mangrove swamp and fossil biocoenosis supported as this.

The writer is indebted to KINJI KANEHARA, AKIRA ONO, and YASUFUMI ISHIWADA, the geologist of Geological Survey, who have given some precious advices. Sincere thanks are due to AKIRA ONO,

1) The Petroleum Exploitation Advancement Committee.

YOSHIJIRO SHINADA and TOKIO MAKINO, the junior geologisf of the same office, who have collected materials.

II. Mangrove swamps and its mollusks.

A mangrove swamp lies in the tropics and subtropics and it exposes itself to air during low tides and is submerged only below mangrove trunks during high tides. The development of the mangrove swamp depends on the relation of land and sea: along the open sea-side it is less developed, while in creeks, bays, lagoons, and estuaries it shows a good development. When the swamp is well developed, there appears a stream across it. The bottom of mangrove swamps consists of badly sorted mud with organic materials, the stream across it having a sandy bottom.

The northern limits of mangrove swamp in the east Asia are Yaeyama Islands, Ryūkyū Archipelago and South China. A mangrove grows also Ki-ire-village, Kagosima Bay, South Kyūshū, but no swamp has developed there. In winter, temperature in the mangrove swamp at the northern limit, for instance Yaeyama Islands, is 17–22°C with its exceptional coolness (15°C). In general the distribution of tropical biota (including mangroves) depends on a temperature in winter. Moreover hypohaline place may be strongly effected by the coastal water, the temperature of which falls in winter more distinctly than that of the oceanic water*. Thus the distribution of mangrove would limited in higher temperature regions, where coastal water is free from coldness in winter. The sea temperature of Ki-ire-village, South Kyūshu hardly falls in winter and so mangroves can grow, but a swamp has not developed owing to the topography.

A mangrove swamp develops in the upper tidal zone just below high tide marks. The tidal zone in the tropics and subtropics usually consists of mangrove swamp, flat sand zone and coral zone. Low tide marks situate on the coral zone. (Text figure 1).

The fauna in a mangrove swamp is rather poor, and so literatures about it are not so rich. But there are some characteristic members, the names of which are described, following after the respective authors.

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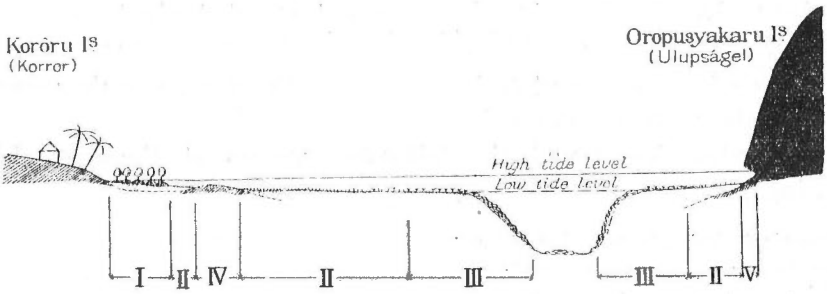
*For example the temperature in Lake Hamana (bay) 1–8°C, while at Onmae Zaki (cape), 60 kilometer east of Lake Hamana 7–12°C in January to February, 1936.



Profile of Lébugol passage, Iwayama Bay, (after HIRO)

I Mangrove zone.
II Sandy flat zone.
III Coral zone.
IV Andesite rocky zone.
V Limestone rocky zone.

HIRO, 1936 (7) reported the following species from the mangrove swamp of Palao Island.

Moncdonta labio (LINNÉ), common.
Clypeomorus trailli(SOWERBY), common.
Chicoreus capuchinus (LAMARCK), common.
Terebraria semistriata ((BOLTEN) RÖDING), common.
Gafrarium gibbum (LAMARCK), common.
Neritina (*Vittina*) *turrita cumingiana* (RÉCLUZ, lived in mangrove zone including sandy flat zone with coral sand at the East side of Palao Island.
Isognomon (*Melina*) *ephippium* (LINNÉ), attatched on crotch part of the aerial root.
Ostrea (*Lopha*) *glomerata* GOULD, attatched on the aerial roots.
Ostrea (*Lopha*) *crenulifcra* SOWERBY, ditto.
Melarhaphe (*Littorinopsis*) *scabra* (LINNÉ), and var. *filosa* (SOWERBY) crept on the leaves, while *M.* (*L.*) *obesa* (SOWERBY) are found just above the heigh tide mark of limestone islet.

ABE, 1942 (1) studied detail ecology on *Melarhaphe* (*Littorinopsis*) *scabra* (LINNE).

BEQUAERT, 1943 (3) reported the same ecology of American *Littorinopsis* as *Littorina angulifera* LAMARCK.

KURODA, 1939 cleared the home of *Cassidula mustellina* (DESHAYES), discovered by Mr. Mcri.

PILSBRY and LOWE, 1932 (15) reported some Central American Mollsca including mangrove swamp dweller:

Turritella goniostoma VAL. buried just under the surface of soft ooze of mangrove swamps in company with *Arca tuberculosa*.
Littorina pulchra SBY. [=*Littorinopsis*] On mangrove roots.
Littorina varia SBY. [=*Littorinopsis* or *Littoraria*] On mangrove roots with *L. pulchella*.

Ostrea mexicana SBY. On rocks and mangrove roots in protected locations.
Arca tuberculosa SBY. Very abundant in soft mud of mangrove swamp.

KANAMARU, 1937 (8) found *Geloina sinuosa* (DESHAYES) in the mangrove zone where stream flows.

The author has found the following species at Rempang Island, near Singapore:

Monodonta labio (LINNÉ) on air root.
Nerita lineata (GMELIN) on air root.
Nerita undata (LINNÉ) on air root.
Clithon (Pictoneritina) oualaniensis (LESSON) on sand.
Littorinopsis scabra (LINNÉ), mostly on mangrove leaf.
Assiminea (Sphaerassiminea) brevicula (PFEIFFER), on soft mud.
Terebraria sulcata (BORN), on root and mud.
Clypeomorus patulus (SOWERBY), on mud.
Clypeomorus ? corallium (KIENER), on root or mud.
Morula margariticola (BRODERIP), on root.
Chicoreus (Rhizophorimurex) capuchinus (LAMARCK) on mud.
Ellobium auris-midae (LINNÉ), on root.
Ellobium auris-judae (LINNÉ), on root.
Melina ephippium (LINNÉ), in fork of air root.
Ostrea glomerata GOULD, attatches on air root.
Katelysia (Hemitapes) japonica (GMELIN), in mud without soft part.

III. Character of the mangrove swamp biocoenosis.

All the marine swamps of tropics and subtropics are mangrove swamps, because the author has never heard of any exception. The mangrove swamp is situated in the higher tidal zone, as above mentioned. Thus it is easily understood that the fauna in mangrove swamp is devided into three elements: the first, the element of mangrove swamp proper, the second, the hypohaline element not only in tropics and subtropics, but also in temperate zones, and the third, the element found on rocks, etc.

Judging both from literatures and the observation of the author, he mentions the element of mangrove swamp proper, as follows:

Littorinopsis scabra (LINNÉ)
Littorinopsis carinifera (MENKE)
Assiminea brevicula (PFEIFFER)
Telescopium telescopium (LINNÉ)
Chicoreus (Rhizophorimurex) capuchinus (LAMARCK)
Cassidula mustellina (DESHAYES)
Ellobium auris-judae (LINNÉ)

Ellobium auris-midae (LINNÉ)
Geloina spp.
Bracteromphalus spp.

This constitution is denominated as *Telescopium-Geloina* biocoensis. The following species would also join to characteristic member of this biocoenosis

Terebraria spp.
Isognomon (*Melina*) *ephippium* (LINNÉ)
Ostrea (*Lopha*) *glomerata* GOULD

A muddy zone just like mangrove swamps has found on the beach along Ariake Bay, Kyūshū. There occurs *Salinator takii* KURODA, *Ostrea* (*Crassostrea*) *rivuralis* GOULD, etc. But the temperature of Ariake Bay in winter falls comparatively low (9–12°C) and so poor tropical and subtropical elements can live there.

IV. *Telescopium-Geloina* biocoenosis in fossils.

While the fauna of mangrove swamp has not been clear, no palentological view for this biocoenosis has been done. There are, however, some fossil members which seem to belong to this biocoenosis.

TAN, 1938 (17) reported the following species from Kansai, Sintiku Syū, Formosa (Shokkōzan Formation):

Ostrea gigas THUNBERG.
Polymesoda (*Geloina*) *luchuana* (PILSBRY) [=*fiscidens* (PILSBRY)]
Cyclina sinensis (GMELIN)
Fairbankia sp.
Assiminea kansaiensis TAN.
A. k. soka TAN.
Melanoides subscabroides TAN.
Cerithidea ornata A. ADAMS.
C. cingulata (GMELIN)
Telescopium telescopium (LINNÉ)
Cassidula paludosa nigrobrunnea PILSBRY and HIRASE.
Ellobium aurisjudae (LINNÉ).

Among these member, *Geloina*, *Telescopium* and *Ellobium* are characterized as *Telescopium-Geloina* biocoenosis and the others are more or less hypohaline shells. Then the author recognizes this formation as a mangrove swamp at the time of deposition.

From north of Kityō, Tainan Syū, Formosa, NOMURA, 1933 and 1935 (12) reported some fossils which seem to belong to the *Telescopium-Geloina* biocoenosis. Here occurs the following shells:

Anomalocardia impressa (ANTON)
Anomia lischkei DAUTZENBERG et FISCHER
Batillaria zonalis (BRUGUIÈRE)
Telescopium telescopium (LINNÉ)

In the OOSTINGH's (1935) (14) report of Boemiajoe fossils, there are some elements which seems to belong to this biocoensis. In his locality 170 (Kali Bioek Beds) there is that example. Fossils reported from this locality are as follows:

Melanoides (Melanoides) tuberculata tegalensis OOSTINGH
Melanoides (Melanoides) woodwardi (K. MARTIN)
Melanoides (Tarebia) junghuhni (K. MARTIN)
Brotia oppenoorthi OOSTINGH
Sulcospira testudinaria angulifera BROT
Telescopium titan K. MARTIN
Nassarius (Hinia) verbeeki (K. MARTIN)

V. *Telescopium-Geloina* biocoenosis from Yatuo group, Central Japan.

The *Telescopium-Geloina* biocoenosis has been found also in Japanese Tertiary Kakebata formation, Yatuo group in Toyama-prefecture. Here discovered the following fossils:

Isanda ono OYAMA, MS.	-	2**
Protorotella yuantaniensis MAKIYAMA.	-	2
Teinostoma (Paraumbonium) puncticulatum OYAMA. MS.	1*	2
Littorinopsis (Littorinopsis) miodelicatula OYAMA, n. sp.	-	2
Fairbankia ? sp.	1	-
Stenothyra ovum-vicaryae OYAMA, MS.	-	2
Batillaria (Batillaria ?) s-itoi NOMURA et ZINBO.	1	2
B. *(Tateiwaia) onoi* OYAMA, MS.	1	2
Cerithidea (Cerithidea) tokunagai OTUKA.	1	2
C. *(C.)* sp.	1	2
C. *(Cerithideopsilla) miofluviatilis* OYAMA, MS.	1	2
Vicaryella ishiiana (YOKOYAMA) var.	1	2
Vicarya yokoyamai TAKEYAMA (forma *yatuoensis* YABE et HATAI)	1	2
Telescopium nipponicum OYAMA, n. sp.	1	-
Terebraria makinoi OYAMA, MS.	1	-
Calyptraea sp.	-	2
Natica (Tanea) rostalina JENKINS	1	-

* Kakebata, Unohana-mura, Nei-gun, Toyama Prefecture. (1).
** Do, Kurosedani-mura, Nei-gun, Toyama Prefecture. (2).

Chicoreus (*Rhizophorimurex*) *tiganouranus* (NOMURA)	1	2
Hebra ? sp.	1	-
Tritia octocaudalis OYAMA, MS.	-	2
Nassaria sp.	1	-
Decolifer sp.	1	-
Striarca (*Estellacar*) *shinadai* OYAMA, MS.	1	2
S. (*E.*) *yatuoensis* OYAMA, MS.	-	2
Anadara (*Scapharca*) *daitokudoensis* (MAKIYAMA) var.	1	2
Ostrea (*Crassostrea*) sp.	?	2
Geloina stachi OYAMA, n. sp.	1	-
G. yamanei OYAMA, n. sp.	1	-
Joannisiella takeyamai OTUKA.	-	2
J. sp.	1	-
Cardium (*Acanthocardia*) sp.	1	-
Pitar (*Agriopoma*) sp.	-	2
Cyclina (*Cyclina*) sp.	-	2
Clementia (*Clementia*) *papyracea* (GRAY)	1	2
Gari (*Gari*) sp.	-	2
Macoma (*Rexithaerus*) sp.	-	2
Apolymetis (*Leporimetis*) *nipponica* OYAMA, MS.	1	-
Angulus (*Tellinides*) cf. *timorensis* LAMARCK	1	-
Glauconome sp.	-	2

Among this faunule, some elements characterized as *Telescopium-Geloina* biocoenosis are included: *Littorinopsis* (*scabra* group), *Telescopium, Rhizophorimurex*, and *Geloina*. *Batillaria, Cerithidea, Stenothyra*, and *Glauconome* live in hypohaline waters. The former two are found in tidal zone only. *Natica, Tritia, Decolifer, Estellacar, Scapharca, Joannisiella, Cyclina* (s. str.), and *Clementia* (s. str.) are found as well in hypohaline waters and in tidal zone as up to deeper water. *Tateiwaia, Vicaryella* and *Vicarya* may be considered tidal zone dweller, as ecological character of the family Potamididae exclude the subfamily Royellinae. The above mentioned facts are summerized like this: these fossils could belong to the *Telescopium-Geloina* biocoenosis.

VI. Description of new and noteworthy species.

Genus *Littorinopsis* MÖRCH, 1876.

1876 Sbg. *Littorinopsis* BECK MSS.—MÖRCH, Synop. moll. mar. Ind. occ. (11), in Mal. Bl., Bd. XXVI, p. 135-137.

1928 Subgenus *Littorinopsis* (BECK) MÖRCH 1876—THIERE, Handb. syst. Weicht. (18), S. 125.

1939 *Littorinopsis* MÖRCH 1876—WENZ, Gastropoda (20), S. 520.

Type (Orthotype): *Littorina subangulata* LAMARCK.

"Gehäuse mässig gross bis ziemlich klein, dünnschalig, gestreckt kegelförmig; Gewinde zugespitzt; Umgänge mehr oder weniger schwach gewölbt, meist mit Spiralskulptur, oft bunt gefälbt; Endwindung gross, kantig, ungenabelt; Mündung schief; Spindel gerade." (WENZ, 1939).

Remark. Under this genus WENZ, 1940, was placed a subgenus *Elimene* S. WOOD, 1872, which is four year preceeded. But *Elimene* seems hardly congeneric with the *Littorinopsis*.

Subgenus *Littorinopsis* s. str.

1939 *Littorinopsis* s. str.—WENZ, Gastropoda (20), S. 520.

"Gehäuse mässig bis fast mittelgross; Umgänge meist spiralgestreift, Endwindung gross, meist gewinkelt, order gekiert; Mündung gross, gerundet dreieckig; Aussenrand dünn; Spindel verdickt, wenig schief, in kurzer Biegung in den Basalrand übergehend; Spindelrand gleichmässig breit; abgeflacht." (Wenz, 1939).

Ecology: Recent species of this subgenus live either on the rocks or on the plants of the sea shore. *Littorinopsis undata* (GRAY), *L. pintado* (WOOD), *L. obesa* (SOWERBY), etc. are attached to the rocks, while *L. scabra* (LINNÉ), *L. melanostoma* (GRAY), *L. delicatula* (NEVILL), and *L. subintermedia* (NEVILL) are mangrove periwinkle. A detail ecological study was done by Abe (1) as above cited.

***Littorinopsis* (*Littorinopsis*) *miodelicatula* spec. nov.** Pl. I, Figs. 2, 3.

Generic position. The WENZ's diagnosis becomes to this species. This new species somewhat resembles to some Trochid shells (*Calliostoma, Cantharidus, Thalotia*, etc.), but differing by the outer lip (basal lip). Some specimen remains the quail pattern as *Littorinopsis scabra.*

Charactr. Shell small, conic, somewhat thick and somewhat fragile; whorl almost conic (little convex conic), more or less high; apex acutely pointed, embrionic and younger whorls seem smoth; whorls low, almost flat, about six in number; suture tangential-impressed; body whorl larger, acute; base flat, with 12–15 unequal cords; umbilicus crack-like; aperture subquadrate; outer lip rather thin; upper outer lip preceeded; basal lip concave with shallow arc; coumella almost errect; columellar lip short, subangulate with basal lip.

Height:	8.0	diameter:	6.7 mm (type).	(Ueno).
„	5.8+a	„	5.2	(Dō).
„	10.2	„	8.4	(Ueno).
„	11.3	„	9.0	(Ueno).

Localities: Dō and Ueno (Kakebata formation), Bridge Nozumi (Kasio formation).

Comparison: *L. mauritiana* (LAMARCK), *L. pseudolaevis* (NEVILL), *L. diemensis* (QUOY et GAIMARD), *L. luctuosa* (REEVE), and *L. cincta* (QUOY et GAIMARD) are very like this fossil in general appearance, but Yatuo shell having lower (broader) shell and more flattened base. This fossil is also stand near the recent *L. scabra* (LINNÉ) (Pl. I, fig. 1), *L. delicatula* (NEVILL) and *L. subintermedia* (NEVILL). These recent species have larger whorl, heigher and more globular whorl, and more rounded periphery than *L. miodelicatula.* This new species agrees with *L. carinifera* (MENKE) (Pl. I fig. 4) in its feature, but the sculpture is quite unlike.

Genus *Telescopium* MONTFORT, 1810.

1810 *Telescopium*—MONTFORT, Conch. syst. (10), p. 438-440.
1853 Genus *Telescopium*, CHEMNITZ—H and A. ADAMS, Genera Rec. Moll. (2), Vol. I, p. 291-292.
1887 Subgenus *Telescopium.* MONTFORT 1810—TRYON, Man. Conch. (19). Vol. IX, p. 117.
1929 *Telescopium* MONTFORT 1810—THIELE, Handb. syst. Weicht. (18), Bd. I, S. 207.
1940 *Telescopium* MONTFORT, 1810—WENZ, Gastropoda (20), S. 743.

Type (Monotype): *Telescopium indicator* MONTFORT (=*Trochus telescopium* LINNÉ).

"Gehäuse gross, festschalig, getürmt kegelförmig, zahlreiche flache Umgänge, sehr schmal, durch flache Nähte getrennt, mit Spiralfurchen, die Erhebungen dazwischen glatt (bei der rezenten Art) oder gekörnt (bei den fossilien); Endwindung nicht besonders hoch, unten stumpfkantig; Unterseite abgeflacht mit Spiralfäden; Mündung rundlich viereckig, breit, unten mit abgestutztem kanal, tief ausgeschnitten; Aussenrand dünn, bogig, oben eingebuchtet; basalrand stark zungenartig vorgezogen; Spindel sehr kurz, auf der mitte mit kräftiger falte sowie einer weiteren am Spindelende; Spindelrand sehr dünn." (WENZ, 1940).

Ecology: *Telescopium telescopium* (LINNÉ) figured in Pl. II figs. 2, 3. dwelled in the soil of Mangrove Swamps of the Indian Ocean and the West Pacific.

Telescopium nipponicum **spec. nov.** Pl. II, figs. 1, 4.

Generic position. The WENZ's diagnosis becomes to this species.

Character. Shell large, broadly conic, somewhat thick, fragile; spire large conic (convex or concave conic partially); apex eroded; apical angle 24–28; whorls low, flat, more than twelve in number; younger whorl lost its sculpture by erosion; suture linear; sculpture consist of four to five, flat-topped spiral cords, of which the second from above being slender and equal to the interspaces the other cords are wide and become bifid by age; axial sculpture is visible weak growth lines on the body whorl; body whorl roundly angulate; base hardly rounded, with strong spiral sculpture; no umbilicus; aperture subquadrate; inner lip with broad, thin callus; columellar fold indistinct; siphonal canal round, like that of *T. telescopium* (LINNÉ).

Height:	82.0	major diameter:	38.0	minor diameter	32.3	mm.
„	75.0	„ „	34.8	„ „	32.0	mm.
„	66.0	„ „	32.8	„ „	27.8	mm.

Locality. Kakebata (Kakebata formation).

Comparison. This new species related to recent *T. telescopium* (LINNÉ) and *T. montis-selae* (K. MARTIN) but the recent species possesses more broader apical angle (29–36°), narrower, and shallower spiral cords, more angulated periphery, more prominent basal spiral cords, and distinct collumellar fold. *T. telescopium titan* K. MARTIN possesses same sculpture and related columellar fold to *T. telescopium telescopium* (LINNÉ).

Genus *Chicoreus* MONTFORT, 1810.

1810 *Chicoreus.*—MONTFORT, Conch Syst. (10), p. 611.
1929 Subgenus *Chicoreus* MONTFORT 1810—THIELE, Handb. syst. Weicht. (18), S. 290.
1932 Genus *Chicoreus* MONTFORT, 1810.—GRANT and GALE, Plioc. Pleistoc. Moll. Calif. (4), p. 728-729.

Type (Orthotype): *Murex ramosus* LINNÉ.

"Shell large, stout; sculpture of three or more lamellar varices, sometimes spiny; anterior canal rather strongly recurved, partly covered by a flap." (GRANT and GALE, 1932).

Subgenus *Rhizophorimurex* nov.

Type: *Murex capuchinus* LAMARCK.

Shell comparative to hardly large, axially rhombic, transversey triangular; three varices with less prominent, fimbriate projection; anterior canal not so elongated; anterior part of the outer lip without spine.

Remarks. This new subgenus differing to *Chicoreus* s. str., *Triplex* PERRY, 1910, *Torvamurex* IREDALE, 1936, and *Siratus* JOUSSEAUME, 1880 by less prominent varix with fimbriate projections instead of spines or digitations. Moreover there are ecological difference between them. It differs to *Inermicosta* JOUSSEAUME, 1879, by continuous varices and by inside of the outer lip with a granule bearing step.

Ecology. *C.* (*T.*) *capuchinus* (LAMARCK) (Pl. I, fig. 7) was discovered on the soft mud of the mangrove swamp of Palao and Malay Archipelago.

Distribution. Recent *C.* (*R.*) *capuchinus* LAMARCK is distributed in the western tropical Pacific (Palao, Is., Sunda Is., etc). This species was also found as a fossil: Njalindoeng (middle miocene), Tjilanan (upper miocene), Mt. Gombel (lower pliocene), all Java, and Sangkrilangbai (miocene) of Borneo.

C. (*R.*) *karangensis* K. MARTIN was found from near Tjilintoeng, Java (upper Miocene).

Chicoreus* (*Rhizophorimurex*) *tiganouranus (NOMURA) Pl. I, figs. 5–6.

1935 *Murex tiganourana* n. sp.—NOMURA, Mioc. Moll. Siogama (13), p. 225–226, pl. XVII (II) fig. 18.

NOMURA reported as follows:

" Shell small, short, more or less rhombic-fusiform. Whorls about five, rapidly enlarging; spire short, about one third of shell height, shouldered a little above the middle, area above the shoulder a little obliquely flattened, below it nearly vertical; last whorl large, also distinctly shouldered above and rather abruptly narrowed towares the base. Surface of each whorls of spire ornamented with a few (about ten) rounded, strong varices which are obsolete on the upper slope of shoulder, each of them separated by nearly equal interspaces in breadth; on the last whorl, varices are about ten in number, prominent around the shoulder, being obsolete toward the base; three varices on the body whorl are larger than the others, and one of which forms the ternimal varix. Surface also marked by subequal distinct revolving threads separated by slightly widen interspaces, about five in number on the penultinate whorl about twenty-two on the last whorl below the shoulder. Aperture and canal unknown. Dimensions of the type specimen: Height, ca. 22mm., diameter 13.4."

The following features must be added: shell longitudinal rhombic and triangular in cross section. Varices three in number, with some fimbriations, but without digitation; aperture of medium size, oval, fortified by a less promenent varix; within the outer lip there are shallow groove and then a step with granule on its top; immer lip smooth, with callous; anterior canal straight, produced anteriorly, and its outer and inner lips are hardly fused.

Type locality: Siogama, Siogama beds.

Localities: Kakebata and Do (kakebata Formation). Iwaki (Kasio Formation).

Geological range: "lower miocene".

Comparison. This new species is closely related to *C.* (*R.*) *capuchinus* LAMARCK, but differing by lower spires weaker varices, broader anterior canal, and little more broader space of outer and inner lip of the anterior canal.

In addition to this, the fimbriation of the outer lip is absent perhaps it would lost during the fossilization. The affinity of this species are with *C.* (*R.*) *karangensis* (K. MARTIN), but this species differs by having weaker varices, broader and more straight anterior canal than the later.

Genus *Geloina* GRAY, 1842.

(1842 *Geloina*—GRAY, Synop. Brit. Mus., p. 75)
1934 Sectio *Geloina* GRAY 1842—THIELE, Handb. syst. Weicht. (18), S. 141, 146.
1943 Subgenus *Geloina* GRAY, 1842—SUZUKI und OYAMA, Corbiculiden Ostasiens (16), pp. 139, 140, 146.

Type *Cyrena ceylanica* LAMARCK.

"Shell large to very large; umbo almost at the anterior one-third; hinge plate broad; lateral teeth short, smooth; pallial line without sinus." (SUZUKI and OYAMA, 1943, emended).

Ecology: *Geloina* are found in the mangrove swamps of the Indo-pacific coast (India, Indochina, Sunda Islands, New Guinea, Australia, Solomon Islands, Palao Islands, Philippine, South China, Formosa, and Ryukyu Islands). Yatuo Miocene occurs two new Geloina like three Geloina of Yaeyama Islands; and *G. stachi* n. sp. and *G. yamanei* n. sp. related to *G. yaeyamensis* (PILSBRY) and *G. luchuana* (PILSBRY) respectively.

Geloina stachi **spec. nov.** Pl. III, Figs. 1,2.

Character. Shell comparative large to large, roundly quadrate, somewhat globose, very inequilateral, equivalve; beak at the anterior one-fourth, prosogyrous, somewhat conspicuous, and little exceeded off dorsal margin; antero-dorsol margin straight, not so long; anterior margin roundly angulated; anterior part of ventral margin somewhat anguated and its posterior half nearly flat; posterior margin bluntly truncated; postero-dorsal margin little convex, making a blunt angulate to antero-dorsal margin; inside of the margin smooth; sculpture consist of low undulation and fine concentric striation, and somewhat eroded near the umbo; ligamental groove long and excavated, and nymph also long: ligament long and narrow; post-ligamental cutting broad and shallow; hinge stronger and typical dentition of *Geloina;* posterior lateral teeth little longer than that of the anterior; beak cavity comparatively deep; muscle scar shallow.

Length 69.5	height 55.5	depth of left valve	18.7 mm.	
„ 69.6	„ 55.5	depth of conjoint valve	37.7 mm.	(Type)

Locality. Kakebata (Kakebata formation).

Comparison: This new species related to *G. expansa* (MOUSSON) and *G. luchuana* (PILSBRY), but the Yatuo shell differing by having more broad posterior margin, and by less strong hinge. *G. takaoi* (NAGAO et ŌTATUME) differing by smaller apical angle and smaller size.

Remark. I take great pleasure in naming this species in honour of the Chief of Petroleum Exploitation Advancement Committee, when the first survey was done.

***Gelona yemanei* spec. nov.** pl. III, Fig. 3.

Character. Shell large, not thick, quadrate-oval, somewhat globose, inequilateral, and equivalve; beak at the anterior one-third, blunt, little exceeded the dorsal margin; antero-dorsal margin straight, somewhat long; anterior margin subangulated; anterior part of ventral margin little convex, but become flat posteriorly; posterior margin subtruncated; postero-dorsal margin little convex, subangulate to the antero-dorsal margin; insie of margin smooth; sculpture like in preceeding species; ligamental groove long and excavated, nymph also long; ligament long but rather narrow; ligament situates little below the dorsal margin; postligamental cutting broad, shallower than the preceding species; hinge rather weak, shorter than that of the preceding one having normal dentition of this genus; posterior lateral teeth longer and lower than that of the anterior, and both anterior and posterior outer lateral teeth weak; beak cavity not deep, adductor muscle scar shallow.

Length 57.5, height 52, depth of left valve 14 mm. (type).

Locality: Kakebata.

Comparison. This new species belongs to typical group of *Geloina*. It agreed with *G. ceylanica* (LAMARCK), *G. triangularis* (METCALF), *G. nitida* (DESHAYES), and *G. hokkaidoensis bibaiensis* (NAGAO et OTATUME), but it differing by subtruncate posterior margin and lower shell. Comparing the *G. lauta* (DESHAYES) with my shell, the Yatuo shell having more compressed and weaker hinge (especially lateral teeth) than the former.

Remarks. The specific name is dedicated to Dr. S. YAMANE, who was the director of Geological Survey when these fossils are collected.

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要　　約

化石軟體動物群集の研究・其の 1

紅樹林沼澤群集 (*Telescopium-Geloina* 群集) の研究

附, 八尾層群の新種の記載

大　山　　桂

八尾層群掛畑層からは從來知られなかつた生物群が發見された。この生物群を群集生物學の立場から見るときは, 紅樹林沼澤に見られる群集に近似する樣に見える, 本研究は紅樹林沼澤の生態學的諸條件を述べ, 此の中に含まれる生物群を檢討して, これと同樣の環境にある化石群とを比較の對象とした。次に八尾層群の化石群集を檢討し, *Telescopium-Geloina* 群集に屬するものと考え, その指標種を取つて解說を行つた。今回新に公表した新名は次の通りである。

Littorinopsis (Littorinopsis) miodelicatula n. sp.

Telescopium nipponicum n. sp.

Rhizophorimurex n. subg., type *Murex capuchinus* LAMARCK

Geloina staichi n. sp.

Geloina yamanei n. sp.

PLATES

AND

EXPLANATIONS

Plate I.

Page

Figs. 1a, 1b, 1c. *Littorinopsis* (*Littorinopsis*) *scabra* (LINNÉ). Mangrove swamp of Rempang Island, Rhio Archipelago. ×2 9

Figs. 2a, 2b. *Littorinopsis* (*Littorinopsis*) *miodelicatula* OYAMA, n. sp. Ueno. Paratype. ×2 8

Figs. 3a, 3b, 3c. *Littorinopsis* (*Littorinopsis*) *miodelicatula* OYAMA, n. sp. Ueno. Holotype. ×2 8

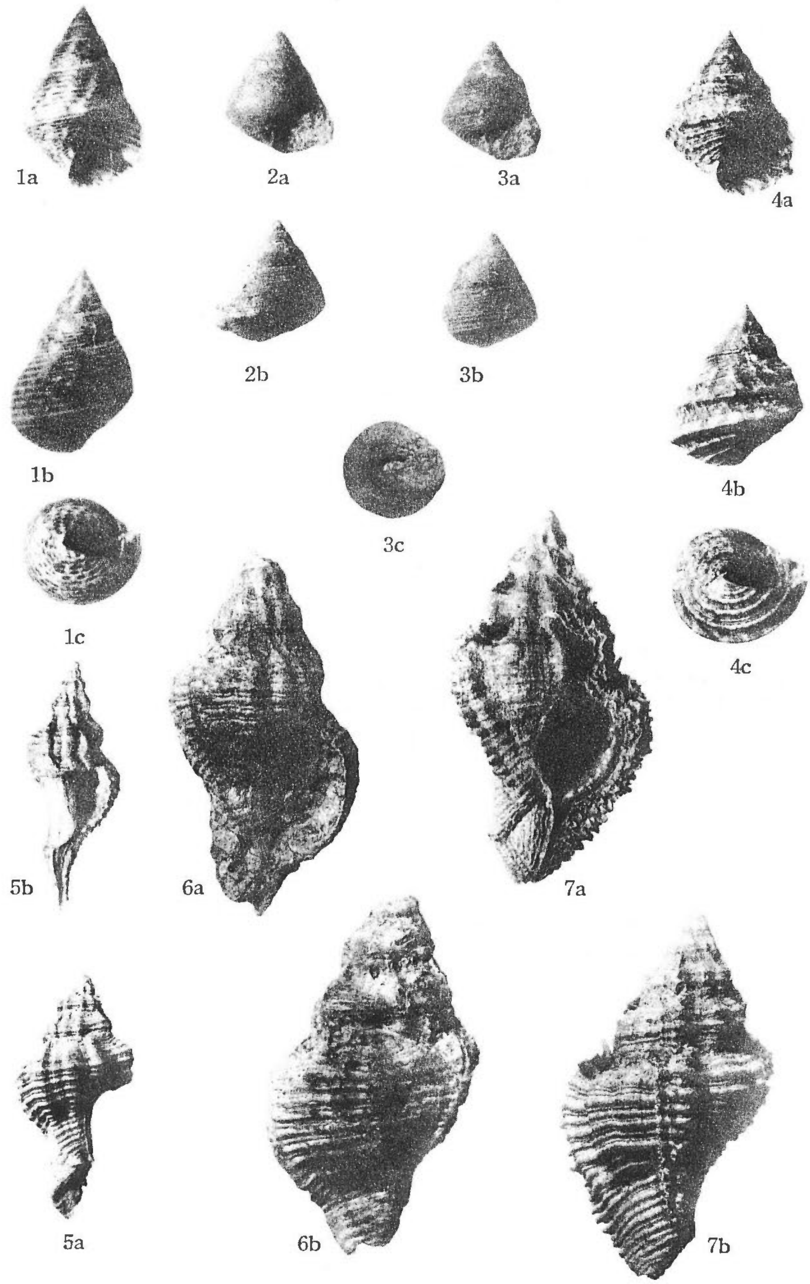
Figs. 4a, 4b, 4c. *Littorinopsis* (*Littorinopsis*) *carinifera* (MENKE). mangrove swamp of Rempang Island, Rhio Archipelago. ×2 9

Figs. 5a, 5d. *Chicoreus* (*Rhizophorimurex*) *tiganouranus* (NOMURA). Kakebata. Compressed laterally ×1........ 11

Figs. 6a, 6b, *Chicoreus* (*Rhizophorimurex*) *tiganouranus* (NOMURA). Kakebata. Compressed obliquly. ×1 11

Figs. 7a, 7b. *Chicoreus* (*Rhizophorimurex*) *capuchinus* (LAMARCK). Mangrove swamp of Rempang Island, Rhio Archipelago. ×1 11

(a: front (ventral) view; b: dorsal view; c: basal view; d: lateral view).



(C. Ueki Photo.)

PLATE II

Plate II.

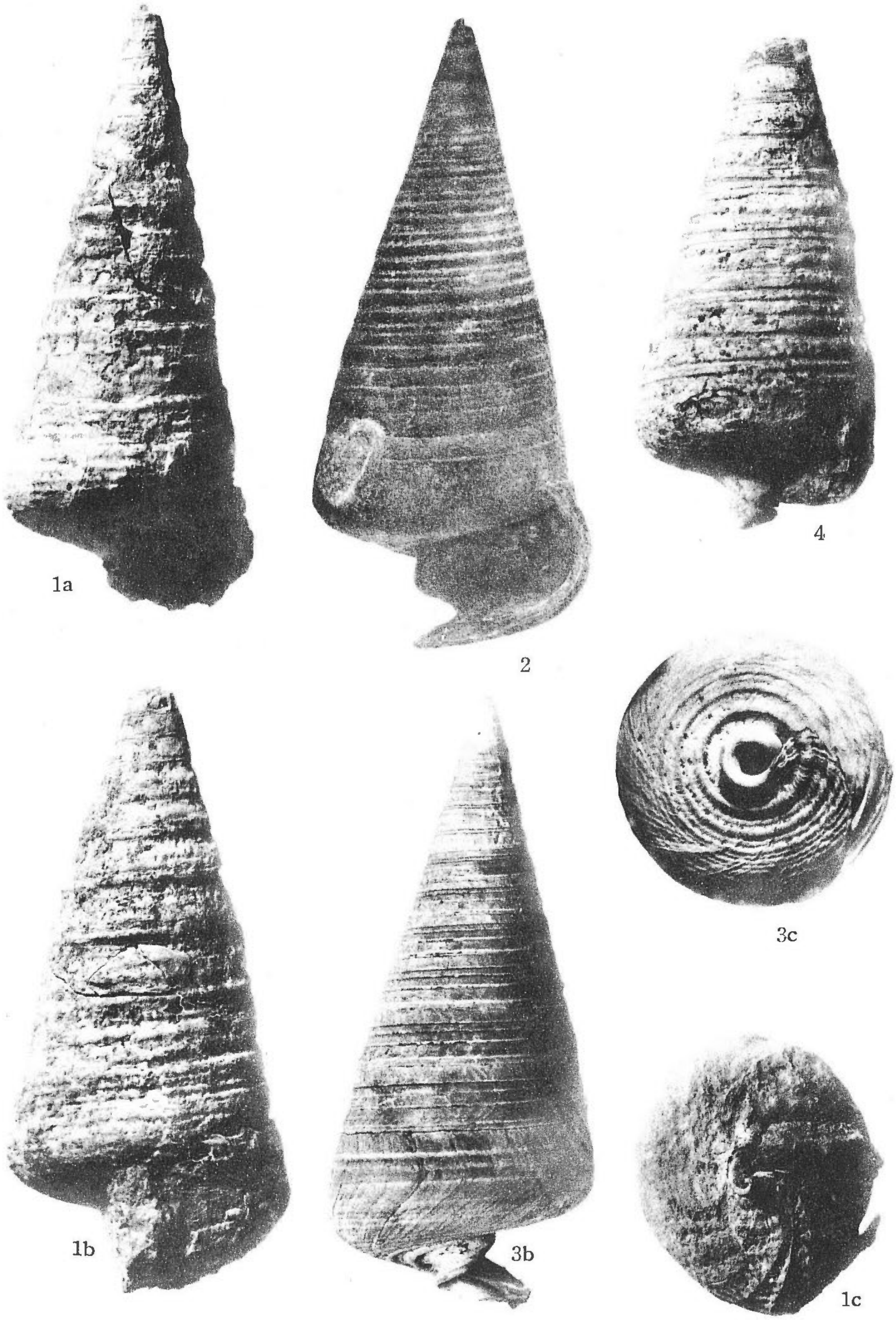
Page

Figs. 1a, 1b, 1c. *Telescopium nipponicum* OYAMA, n. sp. Kakebata. Little compressed laterally. Holotype. ×1. 10

Fig. 2, 3b, 3c. *Telescopium telescopium* (LINNE). 2, Mindanao, 3, Philippine. (3, HATAI, 1941). ×1 9

Figs. 4. *Telescopium nipponicum* OYAMA, n. sp. Kakebata. Compressed dorso-ventrally. Paratype ×1. 10

(a: front (ventral) view; b: lateral view; c: basal view).



(C. Ueki Photo.)

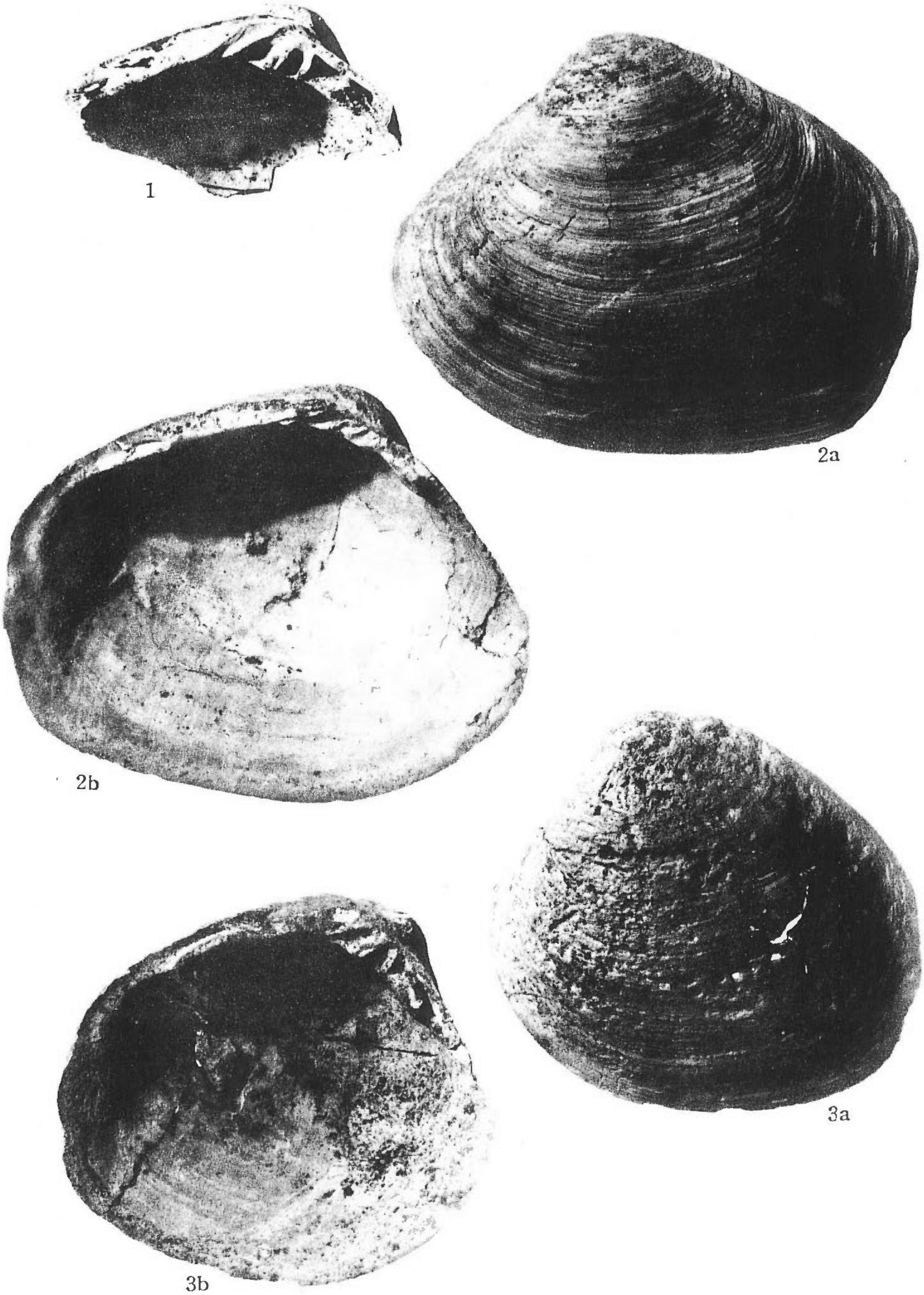
PLATE III

Plate III.

		Page
Fig. 1.	*Geloina stachi* OYAMA, n. sp. Kakebata, Paratype. ×1.	12
Figs. 2a, 2b.	*Geloina stachi*, OYAMA, n. sp. Kakebata. Holotype. ×1	12
Figs. 3a, 3b.	*Geloina yamanei* OYAMA, n. sp. Kakebata. Holotype. ×1	13

(a: outer view; b: inner view).

REPORT OF GEOLOGICAL SURVEY OF JAPAN, No. 132, PLATE III



(C. Ueki Photo.)

The Geological Survey of Japan has published in the past several kinds of reports such as the Memoirs, the Bulletin, and the Reports of the Geological Survey.

Hereafter all reports will be published exclusively in the Reports of the Geological Survey of Japan. The currently published Report will be consecutive with the numbers of the Report of the Imperial Geological Survey of Japan hitherto published. As a general rule each issue of the Report will have one number, and for convenience's sake, the following classification according to the field of interest will be indicated on each Report.

A. Geology & allied sciences
- a. Geology.
- b. Petrotology and Mineralogy.
- c. Palaeontology.
- d. Volcanology and Hotspring.
- e. Geophysics.
- f. Geochemistry.

B. Applied geology
- a. Ore deposits.
- b. Coal.
- c. Petroleum and Natural Gas.
- d. Underground water.
- e. Agricultural geology. Engineering geology.
- f. Physical prospecting. Chemical prospecting & Boring.

C. Miscellaneous

D. Annual Report of Progress

Note: Besides the regularly printed Reports, the Geological Survey is newly going to circulate "Bulletin of the Geological Survey of Japan," which will be published monthly commencing in July 1950.

本所刊行の報文類の種目には從來地質要報．地質調査所報告等があつたが今後はすべて刊行する報文は地質調査所報告に收めることとし，その番號は從來の地質調査所報告を追つて附けることにする，そして報告は一報文につき報告1冊を原則とし，その分類の便宜の爲に次の如くアルフアベツトによる略號を附けることにする。

- A 地質及びその基礎科學に關するもの
  - a. 地　質
  - b. 岩石，鑛物
  - c. 古生物
  - d. 火山，溫泉
  - e. 地球物理
  - f. 地球化學
- B 應用地質に關するもの
  - a. 鑛　床
  - b. 石　炭
  - c. 石油，天然瓦斯
  - d. 地下水
  - e. 農林地質，土木地質
  - f. 物理探鑛，化學探鑛及び試錐
- C 其　他
- D 事業報告

尙刊行する報文以外に當分の間報文を謄寫して配布したものに地下資源調査所速報があつたが此後は地質調査所月報として第1號より刊行する。

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