

collection, a label of the former museum is retained for all registered specimens. The names of museum in the labels are “Rijksmuseum van Geologie en Mineralogie”, “Rijksmuseum van Geologie Leiden”, or “Rijks Geologisch-Mineralogisch Museum Leiden”.

Labels in Japanese letters: The limited number of specimens are accompanied by Japanese labels. In most cases, labels are directly pasted on specimens. Names are written in Katakana letters only (e.g. Fig. 1E) or both in Chinese and Katakana letters (e.g. Figs. 1B, 3C, 3F).

Identification of a few specimens in Japanese label is different from current our recognition and interesting. “Ryôkotsu” in Figs. 3F and 3H means dragon bones, but they are actually fragments of molluscan shells and eroded mammalian bones, respectively. In China, fossil vertebrate bones are called “Longgu” which is written in the same Chinese characters as “Ryôkotsu” in Japan, and have been used as a crude medicine.

“Mimizu-ishi” in Fig. 2E stands for an earthworm stone, and winding tubes on the rock are bore holes of boring bivalve (“Teredo” sp.) with interior lining.

Other fossils were precisely identified at phylum or class level. Examples are fossil fish (“Sekigyô”: Fig. 1B), fossil of wood (“Moku-kwaseki”: Fig. 4A), stone clam (“Ishi-hamaguri”: Fig. 11A), and fossil of heart urchin (“Kaien-no-kwaseki”: Fig. 3A).

Molluscan specimens in Siebold fossil collection

The molluscs in the Siebold fossil collection consist of more than 40 species as described below (Figs. 5-14). This number, however, does not contain the shell fragments in sandstone (Figs. 1D-G, 2A). In the following accounts, the depository of the specimens is in the mineralogical collection in Naturalis, unless otherwise mentioned.

The identification was roughly made by the first author at genus level at Naturalis. Then, species-level identification was discussed by both authors based on photographs in Japan. For taxonomic judgment, we referred to various literature on Japanese molluscan fossils and also compared with specimens preserved at the Department of Historical Geology and Paleontology in The University Museum, The University of Tokyo (Fig. 15).

Localities were inferred mostly by the second author on the basis of author’s experience and also information from old literature in the Edo Period. Fossil localities already known at that age

are likely to represent actual localities of Siebold's specimens. In some cases localities can be inferred from the condition of fossil preservations (e.g. Figs. 9B and 15B). The locality of narrowly distributed species is more easily detected than that of wide-ranged species.

Class Bivalvia

Subfamily Pteriomorpha

Order Arcoida

Family Arcidae

1. *Anadara (Anadara?)* sp. (Fig. 5A-B). The specimen is articulated, but the shell material is dissolved except for dorsal and umbonal parts. The anterior and posterior adductor muscle scars are discernible on the surface. There are crenulations along the posterior margin, corresponding to radial ribs and grooves. The locality may be from the Upper Pliocene-Lower Pleistocene Omma Formation in Kanazawa, Kaga (= Ishikawa Prefecture). In Kinouchi (1773), there is a description "there are "Akagai-ishi" (= arc shell stones) in "Kaga-no-Ashikubo".

2. *Anadara* sp. (Fig. 5C-D). The specimen is an internal mold of articulated valves. The shell is completely dissolved. Locality is probably the same as above.

3. *Anadara (Hataiarca)* cf. *kakehataensis* Hatai & Nisiyama, 1949 [Japanese name of *A. kakehataensis*: Kakehata-aka-gai or Kakehara-sarubô] (Fig. 5E-F). The valves are articulated. Shell material of the umbonal area is dissolved, and the shell surface and ligamental area are worn. The umbonal keel is very strong. The vertical lines in the ligamental area represent an internal layer continuing from the hinge teeth, and are not the original sculpture (Fig. 5E). The locality is probably the Lower Miocene Kurosedani Formation in Etchû (= Toyama Prefecture) or the Lower–Middle Miocene Katsuta Group in Bitchû (= Okayama Prefecture).

4. *Anadara (Tegillarca)* *granosa* (Linnaeus, 1758) [Japanese name: Hai-gai] (Fig. 5G-H). The valves are articulated and nearly completely preserved. The nodules on the radial ribs are more or less eroded. There are chevron grooves in the ligamental area (Fig. 5H). It is living in Southeast

Asia to southwestern Honshû. In Japan, this species is commonly found from the Pleistocene and younger formations (Noda, 1966; Noda & Nakashima, 2003). Therefore, its locality cannot be approximated.

Family Glycymerididae

5. *Glycymeris (Veletuceta) cisshuenis* Makiyama, 1926 [Japanese name: Kisshû-tamaki-gai](Fig. 6B). There are punctated radial lines on the surface. The locality is probably the Lower Miocene Ayukawa Group in Kôga County, Gôshû (= Shiga Prefecture) or the Lower–Middle Miocene Mizunami Group in Mino (= Gifu Prefecture). This species is known from the Late Eocene to Upper Miocene in Japan (Matsukuma, 1986).

Order Mytiloida

Family Mytilidae

6. *Modiolus* sp. (Fig. 6A). The ventral and posterior margins are straight, and the surface is ornamented by dense commarginal sculptures. It is probably from the Lower Miocene Mizunami Group in Mino (= Gifu Prefecture).

Order Pterioida

Family Ostreidae

7. Ostreidae, gen. et sp. indet. (Fig. 3E-F). The shell is fragmented; therefore the genus and species are unidentifiable. There are several repeated shell layers of similar thickness. The locality cannot be approximated.

Order Pectinoida

Family Pectinidae

8. *Amussiopecten praesignis* (Yokoyama, 1922) [Japanese name: Momiji-Tsukihi] (Fig. 7A-B).

The valves are completely articulated. The locality is the Upper Pliocene–Lower Pleistocene Kakegawa Group in Enshû (= Shizuoka Prefecture) (see Ozawa et al., 1998: pl. 22, fig. 1), or the Upper Pliocene-Lower Pleistocene Ananai Formation of the Tônohama Group in Tosa (= Kôchi Prefecture) (see Matsubara, 2004: pl. 3, fig. 7, pl. 4, fig. 1a-b). The locality of holotype (Fig. 16A) was believed to be in the Kakegawa Group before, but is probably from the Tônohama Group (Matsubara et al., 2009).

9. *Mizuhopecten tokyoensis hokurikuensis* (Akiyama, 1962) [Japanese name: Hokuriku-hotate](Fig. 7C-D). The valves are articulated but heavily eroded especially in umbonal area. The locality is probably in the Upper Pliocene - Lower Pleistocene Omma Formation in Kanazawa, Kaga (= Ishikawa Prefecture).

10. *Swiftopecten swiftii* (Bernardi, 1858) [Japanese name: Ezo-kinchaku] (Fig. 8A-B). Registration number 43147, single specimen, in paleontological collection. The left valve is shown in the Fig. 8A. The locality is “Prov. Hitachi?” according to label (Fig. 8B). This specimen may be from the Pliocene Hitachi Formation in Hitachi (= Ibaraki Prefecture), although *S. swiftii* is a common pectinid species from the Pliocene - Pleistocene formations in central to northeastern Honshû and Hokkaidô (Masuda, 1972).

11. *Chlamys* sp. (Fig. 8C-D). Registration number 43154, single specimen, in paleontological collection. The specimen is left valve only. The locality is “Prov. Hitachi?” according to label (Fig. 8D).

Subclass Palaeoheterodonta

Order Trigonioida

Family Trigoniidae

12. *Pterotrigonia* sp. (Fig. 6C-D). Some internal and external molds are included in sandstone. The prominent oblique ribs are characteristics of the genus. It is probably from the Upper Cretaceous in Amakusa, Higo (= Kumamoto Prefecture) or Awa (= Tokushima Prefecture). There

are several similar species in the genus (Tashiro, 1992: pls. 42-45).

Order Unionioida

Family Unionidae

13. *Cuneopsis?* sp. (Fig. 9A). The valves are articulated and compressed laterally. The posterior side of the valve is elongate, and the umbo is shifted anteriorly.

14. *Anodonta?* sp. (Fig. 9B). The valves are articulated and well inflated. The surface is markedly rugose, but it is not original sculpture due to diagenetic effect. Similar condition of preservation is apparent in the holotype of *Anodonta ponderosa* (Yokoyama, 1925) from the Kobiwako Group (Fig. 16B).

Both specimens (Figs. 9A, B) are probably from the Pliocene-Pleistocene Kobiwako Group in Gôshû, Ômi (= Shiga Prefecture), or Iga (= northern Mié Prefecture). Kôundô (1804a, b) figured similar specimens from Gôshû (Itoigawa & Akagi, 1978).

Subclass Heterodonta

Family Lucinidae

15. *Lucinoma* sp. (Fig. 10A). The surface is sculptured by broadly spaced, lamellate commarginal ribs and several fine interstitial ribs. The specimen is somewhat deformed and does not show the original shell form. The locality is uncertain.

16. *Lucinoma?* sp. (Fig. 10B). The valves are articulated. The surface is finely striated with numerous weakly lamellate commarginal ribs. The beak is located at mid-length and the umbone is weakly elevated. The dorsal margin is convex anteriorly but slightly concave posteriorly. The locality cannot be approximated.

Family Thyasiridae

17. *Conchocele bisecta* (Conrad, 1849). (= *Conchocele disjuncta* Gabb, 1864) [Japanese name: Ouna-gai]. Registration number 43138 (5 specimens) and 43139 (3 specimens) in paleontological collection. 43139 consists of two isolated specimens and a single specimen with matrix and other unidentifiable bivalves. Since this species is common in the Cenozoic formations in central and northeastern Honshû (e.g. Kochibe, 1882; Yabe & Nomura, 1925; Ueda & Sugiyama, 1984), its locality cannot be approximated.

Family Hiatellidae

18. *Panopea* sp. (Fig. 12H). The valves are articulated in finely preserved condition. The surface is undulate with smooth commarginal ribs. The beak is located at one-fourth anteriorly. The umbone is weakly elevated. The posterior dorsal margin is long. The posterior end is truncate and widely open. As the genus is commonly recorded from the Early Miocene onward, its locality cannot be approximated.

Family Veneridae

19. *Cyclina japonica* Kamada [Japanese name: Mukashi-oki-shijimi], 1952. There are four lots, no. 43140 (four specimens), 43142 (single specimen), 43150 (single specimen) and 43151 (two specimens) in paleontological collection. These were all identified as *C. japonica* from the Lower–Middle Miocene Mizunami Group in Gifu Prefecture by Dr. Itoigawa. The specimens from the Mizunami Group were illustrated by Itoigawa *et al.* (1974: pl. 25, figs. 11-12).

20. *Cyclina* sp. (Fig. 10F). The valves are articulated. The shell is completely dissolved. The dorsal margin is strongly concave anteriorly and convex posteriorly. The adductor muscle scar is faintly discernible posteriorly. The locality cannot be approximated. *Cyclina japonica* Kamada from the Mizunami Group (see above) is one possibility of identification.

21. *Phacosoma* cf. *kawagense* (Araki, 1960)[Japanese name of *Ph. Kawagense*: Kawage-kagami] (Fig. 11A-B). The specimen is an internal mold of articulated valves. The adductor muscle scars,

pallial line and pallial sinus are well impressed. Among the internal characters, the form of the pallial sinus is well identical with that of *Phacosoma kawagense* (Araki, 1960). The locality is “Mino”, according to the label (Fig. 11B). It should be from the Lower Miocene Akeyo Formation of the Mizunami Group in Mino (= Gifu Prefecture).

22. *Phacosoma* sp. (Fig. 11C). The surface is weakly dissolved but with numerous dense regular commarginal ribs which are one of the diagnostic characters of the genus. The locality is probably the Lower Miocene Tsuzuki Group in Yamashiro (= Kyôto Prefecture).

23 Veneridae, gen. et sp. indet. *Pitar?* sp. (Fig. 11D). The genus is *Pitar* (?) in the opinion of the second author, though the first author thought it is more similar to “*Mercenaria*”. The specimen is a left valve and its cardinal properties are unknown. The locality cannot be approximated, but may be from the same locality as specimen of Fig. 11C. Japanese *Mercenaria* spp. were transferred to the genus *Securella* Parker, 1949 on the basis of the sculpture of a nymph (Harte, 1998). If it is a member of *Securella*, it has radial striations in the shell surface.

24. *Globivenus* aff. *treuma* (Gould, 1850) [Japanese name of *G. treuma*: Maru-surade-gai] (Fig. 11E-F). The valve is well swollen and globular. The surface is sculptured sharp commarginal ribs. Part of the hinge teeth can be observed on the inner side. The specimen is cracked and repaired with adhesive. The locality is probably the Upper Pliocene-Lower Pleistocene Kakegawa Group in Énshû (= Shizuoka Prefecture).

25. *Clementia vatheleti* Mabilie, 1901 [Japanese name: Fusuma-gai] (Fig. 10C-D). The valves are articulated with nearly perfectly preserved surface. However, the specimen is deformed along the longitudinal axis as is seen from the apical view (Fig. 10D). The commarginal sculptures are variable in thickness: Relatively thick ribs are repeated periodically, and their interspaces are filled with finer ribs.

The species is also known from the Recent fauna. Based on the mode of preservation, the figured specimen is inferred to be from the Upper Pliocene Ananai Formation of the Tônohama Group in Tosa (= Kôchi Prefecture) (see Matsubara, 2004: pl. 5, fig. 5). This species is also known from the

Mizunami Group, but the specimen is better preserved.

In paleontological collection, there are two lots of this species, 43141 (5 specimens) and 43143 (1 specimen). They were identified as “*Clementia papyracea* (Gray)” and were considered to be from the Lower Miocene Mizunami Group in Mino (= Gifu Prefecture) by Dr. Itoigawa. The specimens of the same species from the Mizunami Group were illustrated by Itoigawa *et al.* (1974: pl. 27, fig. 6).

26. *Clementia* sp. (Fig. 10E). The specimen is an internal mold of articulated valves. The remains of commarginal sculpture is visible on the surface. The umbo is strongly prosogyrate. The locality is uncertain.

27. *Paphia* (*Paphia*) *schnelliana* (Dunker, 1867) [Japanese name: Ô-sudare-gai] (Fig. 12A-B). The surface of articulated valves is nearly completely preserved, and sculpture consists of low commarginal ribs except the ventral margin. The anterodorsal margin is covered with matrix. The locality is possibly in the Upper Pliocene Ananai Formation of the Tônohama Group in Tosa (= Kôchi Prefecture) (see Matsubara, 2004: pl. 5, fig. 3).

28. *Paphia* sp. (Fig. 12C-D). The shell material is mostly dissolved, and the original sculpture can be seen only on the ventral side. The valves are articulated. The locality is probably the same as above.

Family Psammobiidae

29. *Hiatula minoensis* (Yokoyama, 1926) [Japanese name: Mino-iso-shijimi]. Registration number 43144 (3 specimens) and 43145 (1 specimen) in paleontological collection. The specimens were identified by Dr. Itoigawa in September, 1990, and were estimated to be from the Mizunami Group in Gifu Prefecture.

Family Tellinidae

30. *Macoma izurensis* (Yokoyama, 1925) [Japanese name: Izura-shiratori]. Registration number

43152, 5 specimens, in paleontological collection. Dr. Yabe made a note that the specimens are “from Prov. Mino Tertiary.” The species was identified by Dr. Itoigawa in September, 1990, and thought to be from the Mizunami Group in Gifu Prefecture.

31. *Macoma* sp. (Fig. 12E-F). The specimen is an internal mold of articulated valves. There are many similar species in the genus, and it is difficult to identify the species without a complete shell. The locality cannot be approximated.

Family Pharidae

32. *Cultellus izumoensis* Yokoyama, 1923 [Japanese name: Izumo-no-ashita-gai] (Fig. 12G). The specimen is a poorly preserved internal mold of articulated valves. The surface is partly damaged and cracked. However, the species is identifiable based on its unique elongate outline (cf. Fig. 16B, holotype). The locality and cannot be approximated, as it has been recorded widely from the Oligocene to Lower Pliocene in Japan.

Order Myoida

Family Teredinidae

33. “*Teredo*” sp. (Fig. 2E-H). The locality is probably the Lower Miocene Mizunami Group. Kôundô (1804a, b) figured a similar specimen from Yamauchi Village (currently Mizunami City), Nôshû (= Mino) (Itoigawa & Akagi, 1978).

Class Gastropoda

Order Vetigastropoda

Family Trochidae

34. *Umbonium (Suchium) moniliferum* (Lamarck, 1822) [Japanese name: Ibo-kisago] (Fig. 2B). This species is diagnosed by the presence of weak nodules along the suture. The several specimens

are contained in sandstone. This species is common in sandy tidal flat in a sheltered environment in the Recent fauna. It also commonly occurs from the Pleistocene or Holocene deposits in Honshû and Kyûshû. Therefore, its locality cannot be approximated.

Order Sorbeoconcha

Family Batillariidae

35. *Batillaria multiformis* (Lischke, 1869). [Japanese name: Umi-nina] (Fig. 2B). The species is similar to *B. cumingii* (Crosse, 1862), but is distinguished by larger diameter of whorls. The shell is eroded and probably was conveyed before fossilization. This specimen is embedded in the same sandstone with *Umbonium moniliferum*.

Family Turritellidae

36. *Turritella (Hataiella)* cf. *sagai* Kotaka, 1951 [Japanese name of *T. (H.) sagai*: Saga-kirigai-damashi] (Fig. 13A-B). The note “Kii” (= Wakayama Prefecture) is attached to this specimen, and possibly it was made by Dr. Yabe. However, this locality information is incorrect, because the specimen is identified as *Turritella (Hataiella)* cf. *sagai* Kotaka, 1951 on the basis of the sigmoidal growth line and fine numerous spiral cords (see Kotaka, 1959). The species from the Miocene in “Kii” is identified as *Turritella (Turritella) kiiensis* Yokoyama, 1924 (Fig. 16D: syntype) and possesses nearly flat whorls and simply arched growth lines. This is probably from the Lower–Middle Miocene Mizunami Group in Mino (= Gifu Prefecture) or the Lower Miocene Ayukawa Group in Kôga County, Gôshû (= Shiga Prefecture).

37. *Turritella* sp. (Fig. 14A). Registration number 54582, single specimen, in paleontological collection. The spire of this species is higher and more tightly coiled than the species listed above. The surface sculpture, which is the most important taxonomic character in the genus, is eroded, and its subgenus and species are unidentifiable. The locality may be the same as above.

Family Potamididae

38. *Vicarya yokoyamai* Takeyama, 1933 (Fig. 13C) [Japanese name: Yokoyama-bikaria]. There are four specimens of this species: two specimens in mineralogical collection (no. 328992, Fig. 13C, and No. 23066), and two specimens in paleontological collection (no. 431530). All specimens are inner casts consisting of chalcedony, and are called “Osagari” meaning droppings in Japanese. Their locality is the Province of Mino (early Miocene, Mizunami, Gifu Prefecture). The specimen from Tsukiyoshi Village, Mino, was figured by Kôundô (1804a, b) (Itoigawa & Akagi, 1978).

39. *Vicaryella ishiana* (Yokoyama, 1926) [Japanese name: Ishii-bikariera]. Registration number 43153, in paleontological collection. The locality is the same as above. The specimen is also an inner cast made of whitish chalcedony, and is called “Tsukino-oasagari” meaning droppings of the moon in Japanese. Three specimens are also included in No. 23066 in mineralogical collection.

Family Pseudomelaniidae

40. *Microschiza japonica* (Nagao in Yabe, 1927) (Fig. 14G). Registration number 43131, 3 specimens, in paleontological collection. *M. japonica* is the only described species of the genus in Japan (Hayami & Kase, 1977: 45; Kase, 1984: 110, pl. 14, figs. 5-7). The type specimens are from the “Ryoseki Series” (probably the Cretaceous Kawaguchi Formation) in Yatsushiro area (Kumamoto Prefecture). This species is confined to the Cretaceous. The locality cannot be approximated. *M. japonica* was originally assigned to *Purpuroidea* as is described in the label (Fig. 14H). “Krijt” in the label means Cretaceous in Dutch.

Family Cassiopidae

41. *Cassiope neumayri* (Nagao in Yabe, 1927) (Fig. 14E). Registration number 43133, 5 specimens, in paleontological collection. The species has three prominent and two weaker spiral ribs in the body whorl. The locality cannot be approximated, possibly from the same locality as the above species. Kase (1984: 113, pl. 17, figs. 7-11, 13, 14) reported specimens from the Cretaceous Kawaguchi Formation in the Yatsushiro area (Kumamoto Prefecture). The species was originally

described as *Glauconia* (not *Plauconia* as in the label in Fig. 14F).

Infraorder Littorinimorpha

Family Naticidae

42. *Euspira* cf. *meisensis* (Makiyama, 1926) (Fig. 13D-E) [Japanese name of *E. meisensis*: Meisen-tama-gai]. The umbilicus is obvious and filled with matrix. The umbilical pad is broken. The locality is probably the Lower Miocene Ayukawa Group in Kôga County, Gôshû (= Shiga Prefecture) or the Lower Miocene Tsuzuki Group in Yamashiro (= Kyôto Prefecture).

Infraorder Neogastropoda

Family Buccinidae

43. *Siphonalia*? spp. (Fig. 14C). Registration number 43146, 8 specimens, in paleontological collection. The shells are completely dissolved and remain as internal molds. All of them would not be referred to as a single species, and a few specimens may not be *Siphonalia*. However, they are not clearly identifiable. The locality is “Province Mino?, Tertiary”, according to the label (Fig. 14D). Similar specimens from Mino were figured by Kôundô (1804a, b) (Itoigawa & Akagi, 1978). Four species, *S. makiyamai*, *S. minuta*, *S. minoensis*, and *S. shukuborensis*, are known from the Mizunami Group (Itoigawa et al., 1974: pl. 49, figs. 1-7).

44. *Neptunea* sp. (Fig. 15A). The surface is eroded, and the lower part of body whorl and the aperture is missing. The locality cannot be approximated.

45. *Neptunea* cf. *hukusimensis* Nomura & Hatai, 1936 [Japanese name of *N. hukusimensis*: Fukushima-ezo-bora] (Fig. 15B). The apex and the siphonal canal are broken. The locality is probably the Upper Miocene Kubota Formation in Iwaki (= Fukushima Prefecture).

46. *Japellion*? sp. (Fig. 15C-D). The upper whorls are broken. The surface is smooth except for incremental lines. The subsutural zone is probably grooved and filled with matrix. The locality

cannot be approximated.

47. *Ancistrolepis* cf. *mogamiensis* (Nomura & Zinbô, 1935) [Japanese name of *A. mogamiensis*: Mogami-wadachi-bai] (Fig. 15E-F). Fig. 15E and F are each of paired halves of the single nodule. The shell material is mostly absent, but the character of external sculpture is well preserved. There are at least six prominent spiral ribs separated by grooves with similar thickness. The specimen is probably from the Upper Miocene Furukuchi Formation in Dewa (= Yamagata Prefecture). Kinouchi (1773) listed “Dewa, Yudonosan” as one of the localities of “long whelks”. This specimen is also similar to *A. grammatus* (Dall) (Amano *et al.*, 1996) but differs in having a larger apical angle. The Recent species of the genus inhabit the lower part of continental shelves and deeper level in temperate to cold-water region.

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