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Paleogene Molluscan Faunas from the Kushiro Coal Field, Eastern Hokkaido

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ABSTRACT

The Urahoro Group consists of sandstone and conglomerate, with intercalated coal seams, and yields nonmarine and shallow marine molluscs, including *Ostrea*, *Chlamys*, *Corbicula*, *Nemocardium* and *Mya*. The Ombetsu Group rests unconformably upon the Urahoro Group, and consists of siltstone, with a basal sandstone. It yields shallow (and a few deep) marine molluscs, including *Yoldia*, *Portlandia*, *Acila*, *Cyclocardia*, *Turritella*, *Dentalium*, *Eocylichna*, *Orectospira*, *Clinocardium*, *Neverita*, *Conchocele*, *Macoma*, *Periploma* and *Profulvia*. These faunas are characterized by many cold water taxa that are widespread today in the northern Pacific.

The Urahoro and Ombetsu molluscs include many species in common with those of Oligocene strata of central Hokkaido, Honshu, Japan, and Sakhalin, Kamchatka, and the Koryak Upland, eastern USSR. In contrast, they include only a few species in common with those of Oligocene strata of Kyushu, southern Japan. It is notable that several genera originated during the Late Eocene or Oligocene in Japan and Sakhalin, including *Neptunea*, *Clinocardium* and *Mya*. These facts imply that a significant number of northwestern Pacific taxa might have migrated eastward during Paleogene time. This is also indicated by the presence of 25% Asiatic species in western Gulf of Alaska Paleogene molluscan faunas, and a decline to only 12% Asiatic species in coeval eastern Gulf of Alaska faunas (Marincovich and McCoy, 1984). Seven species of bivalves and two species of gastropods are newly described herein: *Nucula* (*Ennucula*) *omagariensis*, *Crenella* (*Megacrenella*) *shitakaraensis*, *C.* (*Megacrenella*) *nuibetsuensis*, *Cyclocardia poronaiensis*, *Solen shitakaraensis*, *Thracia* (*Thracia*) *shitakaraensis*, *Cardiomya* (*Cardiomya*) *kotakai*, *Turritella* (*Hataiella*) *nuibetsuensis*, and *Neptunea ogasawarai*.

Key words: Paleogene, molluscs, faunal provinces, paleobiogeography, Kushiro coal field

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INTRODUCTION

Paleontological studies of the Paleogene System of the Japanese Islands have been made by many paleontologists, beginning in the latest 19th century, and our knowledge of Paleogene geohistory has increased remarkably during the past two decades. Saito, Okada and Kaiho (1984, eds.) recently

summarized studies of Paleogene biostratigraphy and correlation within the Japanese Islands, based mainly on benthic and planktonic foraminifers, radiolarians and calcareous nannofossils, as well as molluscs. However, many aspects of Paleogene molluscs of the Japanese Islands are still poorly understood, particularly their spatial and temporal distributions in adjacent northwestern Pacific regions.

Since Yokoyama's (1890) pioneer work, about 500 molluscan species have been described from Paleogene of the Japanese Islands and adjacent regions. Many of the paleontological works provide only descriptions of new species, and there are few comprehensive studies of entire molluscan faunas. It is now necessary, even mandatory, to study Paleogene faunas from the viewpoints of paleoecology and paleobiogeography in addition to descriptive paleontology.

In Japan, Paleogene strata crop out mainly in: (1) coal fields of central and eastern Hokkaido, (2) the Joban coal field, Northeast Honshu, (3) the southern part of the Kii Peninsula, Southwest Honshu, and (4) coal fields of Northwest Kyushu. These regions yield abundant molluscs, and the Kushiro coal field is one of the most significant regions for Paleogene molluscan studies in Japan.

The purpose of the present study is to describe Paleogene molluscan assemblages from the Urahoro and Ombetsu Groups in the Kushiro coal field, eastern Hokkaido, and to discuss their paleoecologic and paleogeographic implications. Correlations are made with other faunas in the Japanese Islands, Sakhalin, Kamchatka, Alaska and Northwest America.

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HISTORICAL REVIEW

In this chapter, the author describes and discusses the history of studies of Paleogene molluscs, including those of foraminifers, in the Japanese Islands and adjacent regions.

Yokoyama (1890) first studied Paleogene molluscs of Japan, and described eight new species from the Poronai Formation of the Ishikari coal field, central Hokkaido. Nagao (1928a, b) summarized Paleogene molluscan faunas from coal fields of Northwest Kyushu, and described a total of 190 species. He divided the Paleogene strata of Northwest Kyushu into Horizon I (Eocene), Horizon II (upper Eocene), and Horizon III (Oligocene). The molluscan faunas from Horizon III are very similar to Oligocene faunas of Northwest America (Nagao, 1928b). Nagao (1933) correlated the Wakkanabe Formation of the Ishikari Group, central Hokkaido, with Horizon III of the Ashiya Group, Northwest Kyushu, on the basis of their similar molluscan faunas.

Makiyama (1934) described the molluscs from the Asagai Formation of the Joban coal field, Northeast Honshu, and Machigar, northern Sakhalin, USSR. Many species are common to both areas. Otuka (1939) discussed the Cenozoic geohistory of Japan, and divided the Japanese Paleogene into the "Eocene", the "Asiya-Isikari age" (Oligocene) and the "Asagai-Poronai age" (latest Oligocene or earliest Miocene), on the basis of fossil faunas and floras.

Takeda (1953) described a total of 85 species of Oligocene molluscs, including 34 new species from the Poronai Formation and correlative strata of the Kushiro coal field and of southern Sakhalin. His study indicates that many species are common to these areas. Matsui (1962) discriminated six molluscan assemblages in the Shitakara Formation of the Urahoro Group of the Kushiro coal field. These assemblages are: 1) *Ostrea eorivularis* and *Corbicula sitakaraensis* (brackish zone), 2) *Nemocardium ezoense*, *Mya grewingki kusiroensis* and *O. eorivularis* (tidal zone), 3) *Chlamys shitakaraensis*, *Macoma* spp., *Neptunea* spp., *Molopophorus kusiroensis*, and *N. ezoense* (euneritic zone, low-water line −20 or 30 m), 4) *Epitonium* spp., *Neptunea* spp., *Nemocardium* spp., and *Cyclocardia* spp. (mesoneritic zone, 20 or 30–50 or 60 m), 5) *Yoldia* spp., *Portlandia* spp., *Periploma besshoense*, *Turritella poronaiensis*, and *Scaphander* spp. (subneritic zone, 50 or 60–100 or 120 m), and 6) *Acila* sp., *Malletia poronaica*, *Conchocele bisecta*, and *Nuculana* sp. (subneritic to bathyneritic zone, 50 or 60–200 m).

Matsui (1962) also discriminated a total of five molluscan assemblages in the Ombetsu Group of the Kushiro coal field. These assemblages are: 1) *Ostrea*, *Corbicula*, *Batissa*, *Tectonatica*, *Neverita*, *Mya*, *Linthia*, *Olivella*, *Molopophorus*, *Eocylichna*, and *Macoma* (tidal to euneritic zone), 2) *Epitonium*, *Neptunea*, *Nemocardium*, and *Cyclocardia* (euneritic to mesoneritic zone), 3) *Turritella Yoldia*, *Portlandia*, *Nuculana*, *Malletia*, *Fulgoraria*, and *Acila* (mesoneritic to subneritic zone), 4) *Acila*, *Trominina*, *Callianassa*, "*Spirotropis*", and *Turcicula* (subneritic to bathyal zone): and 5) "*Spirotropis*", *Turcicula*, *Solemya*, and *Propeamussium* (bathyneritic to hemibathyal zone, 100 or 120–300 m).

Many paleontologists have noted that the Poronaian fauna is closely related to those in Sakhalin, Kamchatka, Alaska, and Northwest America, on the basis of molluscan and foraminiferal taxa (Asano, 1949, 1961; Hatai and Kamada, 1950; Takeda, 1953; Durham and Sasa, 1961; Serova, 1976). The fauna has

been regarded as a boreal or cold-water one (Otuka, 1939; Makiyama, 1934, 1939; Hatai and Kamada, 1950) and is a cold-water equivalent of the Ashiya fauna (late Oligocene to early Miocene) of Kyushu, southern Japan (Tsuchi and Shuto, 1984).

Hatai and Kamada (1950) listed 15 species from the Asagai Formation of the Joban coal field that are closely related or identical to species of Northwest America, including *Cyclocardia laxata* (Yokoyama), *C. tokunagai* (Yokoyama), *Profulvia harrimani* (Dall), *Conchocele bisecta* (Conrad), *Yoldia laudabilis* Yokoyama, *Neverita asagaiensis* (Makiyama), *Turritella importuna* Yokoyama, and *T. tokunagai* Yokoyama.

In Kyushu, Mizuno (1956) proposed Paleogene molluscan zones, which in ascending order are the *Venericardia nipponica* (Eocene), *V. yoshidai* (early Oligocene) and *V. vestitoides* (late Oligocene) zones. He noted that some elements of the so-called Asagai-Poronai fauna of northern Japan occur abundantly in the *V. vestitoides* zone of southern Japan. Subsequently, Mizuno (1962a, 1964a) divided the Paleogene and lower Miocene strata of Kyushu into six units, which in ascending order are the Takashiman (Eocene), the Okinoshiman (Eocene), the Funazuan (Oligocene), the Mazean (Oligocene), the Nishisonogian (Oligocene), and the Saseboan (lower Miocene) Stage. Mizuno (1964a) also summarized the Paleogene and lower Miocene molluscs from Kyushu, and recorded a total of 230 species.

Oyama, Mizuno and Sakamoto (1960) summarized Paleogene molluscs from Japan and adjacent regions, and recorded a total of 453 taxa. Kamada (1962) described Paleogene molluscan faunas from the Uchigo Group of the Joban coal field, Northeast Honshu, and recorded a total of 57 taxa. Shimokawara (1963) studied the geology of the Ishikari coal field, central Hokkaido, and recorded a total of 80 species from the Ishikari Group (Eocene to lower Oligocene), and 53 species from the Poronai Formation, which rests unconformably upon the Ishikari Group.

Mizuno (1964b) summarized the Paleogene molluscan faunas of North Japan, and divided them into the lower, middle and upper Ishikarian and the Poronaian faunas, in ascending order. These faunas have a few species in common with those of the Nishisonogian Stage (Oligocene) of Kyushu. They are *Yoldia laudabilis*, *Y.* (*Tepidoleda*) *sobrina* Takeda, *Periploma besshoense* (Yokoyama), and *Orectospira wadana* (Yokoyama), which are representatives of the Poronaian fauna.

The lower Ishikarian fauna (Eocene) is found in the Noborikawa, the Horokabetsu, the Yubari, the Wakkanabe, and the Bibai Formation, in the lower part of the Ishikari Group. This fauna also occurs in the Shiroki and the Uryu Formation of the Uryu Group, Rumoi coal field, central Hokkaido (Mizuno, 1964b). Mizuno correlated the lower Ishikarian fauna with those of the Takashima and Okinoshima Stages (Eocene) of Kyushu.

A representative lower Ishikarian fauna is seen in the Wakkanabe Formation, where it is largely composed of shallow marine or brackish, warm water dwellers. It is characterized by *Pyrazus* new species, *Crassatellites* (*Eucrassatella*) *yessoensis* Minato and Kumano, *Venericardia* (*Venericardia*) *otatumei* Uozumi, *Geloina hokkaidoensis* (Nagao and Ôtatume), *Corbicula* (*Corbicula*) *tokudai* (Yokoyama), *Claibornites quinquangulus* Uozumi, "*Paphia*" *munroei* Yokoyama, and *Mya* (*?Arenomya*) *ezoensis* Nagao and Inoue (Mizuno, 1965).

The middle Ishikarian fauna (Oligocene) is found in the Akabira Formation, which forms the middle part of the Ishikari Group (Mizuno, 1964b). It is characterized by *Siphonalia sakakurai*

Mizuno, *Portlandia* (*Portlandella*) *watasei ogasawarai* Uozumi, *Acila* (*Acila*) *shimoyamai* Oyama and Mizuno, *Corbicula tokudai*, *Conchocele bisecta omarui* (Oyama and Mizuno), *"Paphia" munroei*, and *Mya ezoensis*, new subspecies (Mizuno, 1965). The middle Ishikarian fauna is correlated with that of the Funazuan Stage of Kyushu (Mizuno, 1964b).

The upper Ishikarian fauna (Oligocene) occurs in the Hiragishi and the Ashibetsu Formation, in the upper part of the Ishikari Group, and in the Urahoro Group of the Kushiro coal field (Mizuno, 1964b). It is characterized by *Corbicula* (*Batissa*) *sitakaraensis* Suzuki, *Portlandia watasei* (Kanehara), *Nemocardium* (*Arctopratulum*) *ezoense* (Takeda), *Yoldia laudabilis*, and *Mya* (*?Arenomya*) *grewingki* Makiyama (Mizuno, 1965). The upper Ishikarian fauna is correlated with that of the Mazean Stage of Kyushu (Mizuno, 1964b).

Several species found in the Ishikari Group also occur in the Paleogene strata of Kyushu, including *Venericardia* (*Venericor*) *subnipponica* Nagao, *Pitar matsumotoi* (Nagao), *Callista matsuraensis* (Nagao), *C. hanzawai* (Nagao), and *Angulus maximus* (Nagao). There are many warm water genera in the Ishikari Group, including *Glycymeris*, *Pitar*, *Dosinia*, *Cyclina*, *Venericor* and *Geloina*. Warm water genera also occur in Eocene strata of the Koryak Upland, eastern USSR, including *Pacificor*, *Crassatella* and *Eucrassatella* (Volobueva, 1980).

The Poronaian fauna (or the Asagai-Poronai fauna, Otuka, 1939 ; Oligocene) is found in the Poronai Formation of the Ishikari coal field, the Tappu Group of the Rumoi coal field, the Ombetsu Group of the Kushiro coal field, and the Asagai Formation of the Joban coal field (Mizuno, 1964b). It is characterized by *Orectospira wadana*, *Portlandia watasei watasei*, *Acila* (*Truncacila*) *picturata* (Yokoyama), *Crassatellites teshimai* Inoue and Mizuno, *Cyclocardia akagii* (Kanehara), *Conchocele bisecta*, *Periploma besshoense*, *Profulvia harrimani*, and *Yoldia laudabilis* (Mizuno, 1965).

The Poronaian fauna notably contains many cold water genera such as *Portlandia*, *Yoldia*, *Cyclocardia*, *Mya*, *Neptunea*, *Buccinum*, *Clinocardium*, *Conchocele*, *Liocyma*, and *Margarites*, which are widespread today in the northern Pacific. Mizuno (1964b) correlated the Poronaian fauna with that of the Nishisonogian Stage of Kyushu.

Matsumoto (1964) described the Asagai-Poronai fauna from the Ôga Formation (late Oligocene or earliest Miocene), which is unconformably underlain by the so-called Mikura and Setogawa Groups, Shizuoka Prefecture, Central Japan. Iwasaki and Ono (1977) described a molluscan fauna allied to the Asagai-Poronai fauna from the Setogawa Group. They regarded the Setogawa Group fauna as being transitional between faunas of Hokkaido and Kyushu.

Mizuno (1973) summarized the molluscan fauna of the Muro Group of the Kii Peninsula, Southwest Honshu. This fauna is mostly composed of Poronaian species, and Mizuno (*op. cit.*) tentatively assigned it an age of late Oligocene to early Miocene. Taira *et al.* (1980) also recorded several Poronaian species from the Shijujiyama Formation (late Oligocene to early Miocene) of Shikoku, southern Japan. Matsumoto and Terashima (1976) also recorded several Poronaian species from the Muroto Formation (late Oligocene to early Miocene) of Shikoku. In addition, Hatai and Koike (1957) recorded Poronaian molluscs from the Hota Group (early Miocene) of the Boso Peninsula, Central Japan, including *Acila elongata* Nagao and Huzioka, *Portlandia watasei* and *Periploma besshoense*. Kanno (1960) also recorded several Poronaian species from the Hikokubo Group (early Miocene) of the Chichibu Basin, Saitama Prefecture, Central

Japan.

Mizuno (1965, 1977) proposed two paleozoogeographic provinces in Japan and adjacent regions during Paleogene time: the Northeast (North) Japan-Okhotsk and Formosa-Southwest (West) Japan Provinces. The Northeast Japan-Okhotsk Province includes areas of Sakhalin and Kamchatka, and is characterized by tropical, subtropical, and temperate forms in the Eocene and is dominated by temperate ones in the Oligocene (Mizuno, 1977). In contrast, the Formosa-Southwest Japan Province is characterized by many tropical and subtropical forms in both Eocene and Oligocene times (Mizuno, 1977).

Yoldia laudabilis was essentially a cold-water species, which lived on upper neritic fine sand bottoms, as shown by its occurrence predominantly in sandstone and only rarely in mudstones in northern Japan, whereas in southern Japan it occurs only in mudstones and is associated with cold-water species (Mizuno, 1954). In Kyushu, the molluscan fauna in sandy strata is represented by *Crassatellites* (*Eucrassatella*) *yabei* Nagao, *Glycymeris cisshuensis* Makiyama, and *Septifer nagaoi* Oyama, replacing *Y. laudabilis* in northern Japan (Mizuno, 1954).

Some of the molluscan assemblages of the Urahoro and the Ombetsu Group in the Kushiro coal field are similar to the "C assemblage" of the Setogawa Stage (Iwasaki and Ono, 1977), and to assemblage of the Asagai Formation of the Joban coal field, Northeast Honshu (Nemoto and O'Hara, 1979).

A total of 11 molluscan assemblages were recorded from the Ashiya Group (Nishisonogian Stage, Oligocene) of Kyushu, southern Japan (Shuto and Shiraishi, 1971); a total of 12 molluscan assemblages were recorded from the Kishima Formation (Mazean Stage, Oligocene) of Kyushu (Inoue, 1972); and a total of 8 molluscan assemblages were recorded from the Hioki Group (late Oligocene or early Miocene) of Yamaguchi Prefecture, Southwest Honshu (Fuse and Kotaka, 1986). But these molluscan assemblages are very different from those of northern Japan, in both generic and specific composition.

In Alaska, Kanno (1971) described the Tertiary molluscan faunas from the Kulthieth, the Poul Creek and the Yakataga Formation. He correlated the Kulthieth Formation (late Paleocene to Eocene) with the Ishikari Group of Hokkaido, based on both lithological and paleontological evidence. He correlated the lower part of the Poul Creek Formation (Oligocene), which rests "unconformably?" upon the Kulthieth Formation, with the Poronai Formation of Hokkaido. The Poul Creek fauna contains 26.4% Asiatic species (Kanno, 1971).

Serova (1976) studied benthic foraminifers from the eastern Kamchatka Peninsula, and recognized the *Caucasina eocaenica kamchatica* Zone (Eocene) from the upper part of the Kovacha Formation. She noted that the foraminiferal assemblage of this zone is similar to those of the Refugian Stage of California and the Poronai Formation of Hokkaido. Volobueva (1980) listed the Paleocene, the lower, middle and upper Eocene, the Oligocene, and the Miocene bivalves from the Koryak Upland, eastern USSR. There are many Oligocene bivalves in common among the Koryak Upland, Japan and Sakhalin, whereas only a few Oligocene bivalves from these areas also occur in Alaska and Northwest America (Volobueva, 1980). In contrast, there are no Eocene bivalves in the Koryak Upland in common with those of Japan and Sakhalin, although many are common to both the Koryak Upland and Northwest America (Volobueva, 1980).

On the other hand, Eocene molluscan faunas of Hokkaido are more allied to those of Kyushu than to those of Kam-

chatka, Alaska and Northwest America. Marincovich and McCoy (1984) indicated that there are 25% Asiatic species in the Paleogene molluscan faunas of the western Gulf of Alaska, whereas there are only 12% Asiatic species in coeval faunas of the eastern Gulf of Alaska.

OUTLINE OF GEOLOGY

The Kushiro coal field occupies an area of 3000 square km along the Pacific coast of eastern Hokkaido (Fig. 1) (Okazaki, 1974), and is largely composed of clastic rocks of post-Cretaceous age. The strata are lithologically divided into the Nemuro, Urahoro, Ombetsu, Atsunai, and Hombetsu (or Akan) Groups and Quaternary deposits in ascending order (Okazaki, 1974). They are exposed generally in an NNE-SSW trend and are complexly folded and faulted. The stratigraphic classification of the Kushiro coal field is shown in Table 1 and Fig. 2.

The Nemuro Group is divided into the Katsuhira and Kawaruppu Formations in ascending order (Table 1). The group is made up largely of black mudstone, dark gray sandy mudstone and greenish gray sandstone, and it attains a thickness of more than 1,000 m (Sasa, 1953). The group is of marine origin and contains molluscs such as *Yoldia* sp., *Portlandia*

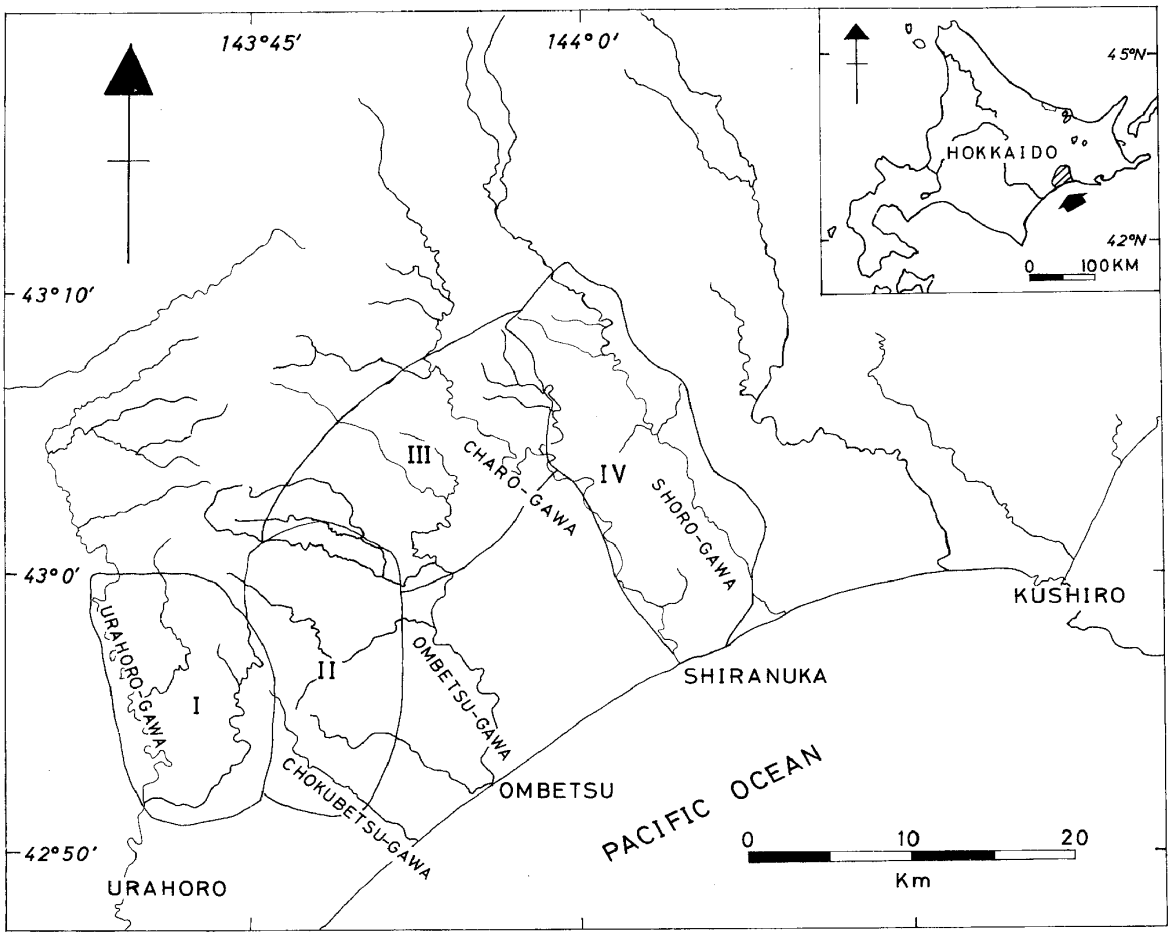
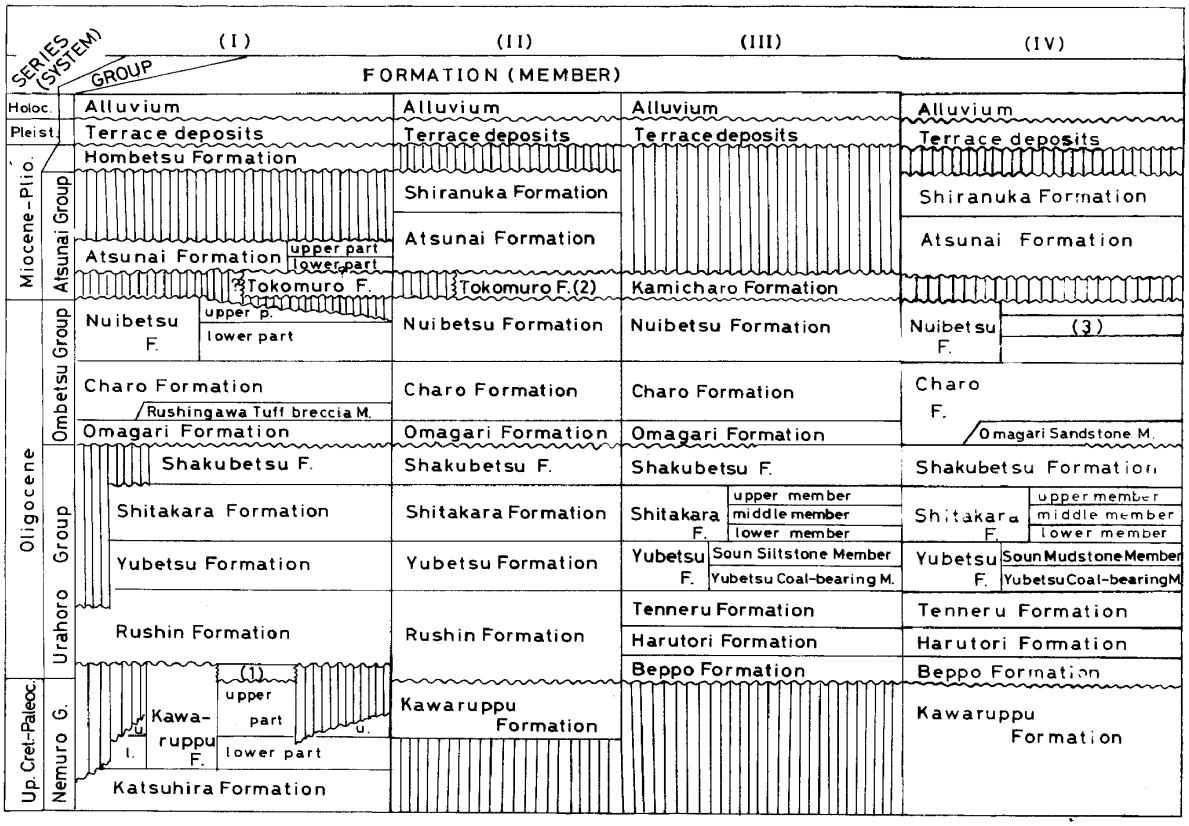


Fig. 1. Map showing the study area. I, Tokomuro district; II, Ombetsu district; III, Kamicharo district; IV, Akan district.

Table 1. Stratigraphic classification within the Kushiro coal field. (I), Tokomuro district (Yui, 1975MS); (II), Ombetsu (Honda, 1980a) and western area of the Kamicharo districts (Kaiho, 1977MS, 1984a); (III), eastern area of the Kamicharo district (Kaiho, 1977MS, 1984a); and (IV), Akan district (Yanagisawa, 1979MS). (1), Ichigozawa Coal-bearing Member; (2), or Kamicharo Formation (unconformably overlain by the Terrace deposits); (3), Ishinosawa Pyroclastic Rocks Member.



(*Cnestriella*) *cuneistriata* Ichikawa and Maeda, *Nucula* sp., *Acila* (*Truncacila*) *hokkaidoensis* Nagao, *A.* (*T.*) *yoshidai* Tashiro and Otsuka, *Propeamussium coowperi yubarense* Yabe and Nagao, *Periploma* sp., and *Dentalium* sp., (Sasa, 1953; Mitani *et al.*, 1959; Yoshida, 1961; Tashiro, 1985).

The Urahoro Group rests unconformably upon the Nemuro Group and is widespread in the western to central part of the Kushiro coal field. It largely consists of gray, poorly-sorted fine-grained sandstone and pebbly to granular conglomerate of red chert pebbles, with intercalated coal seams. In the central part of the Kushiro coal field, the group is divided into six units, which in ascending order are the Beppo, Harutori, Tenneru, Yubetsu, Shitakara, and Shakubetsu Formations (Sasa, 1940a, b, 1953; Sato, Tanai and Suzuki, 1961; Mizuno, Sato and Sumi, 1963; Kaiho, 1977MS, eastern area; Yanagisawa, 1979MS; Table 1). In the western part of the Kushiro coal field, the Urahoro Group is divided into four units, which in ascending order are the Rushin, Yubetsu, Shitakara and Shakubetsu Formations (Tanai, 1957; Oda, Nemoto and Uemura, 1959; Mitani *et al.*, 1959; Inoue and Suzuki, 1962; Sogabe, 1967; Yui, 1975MS; Kaiho, 1977MS, western area, Table 1). The group attains a thickness of about 1,000 m. It yields nonmarine and shallow marine molluscs, including *Ostrea eorivularis* Oyama and Mizuno, *Chlamys shitakaraensis* Honda,

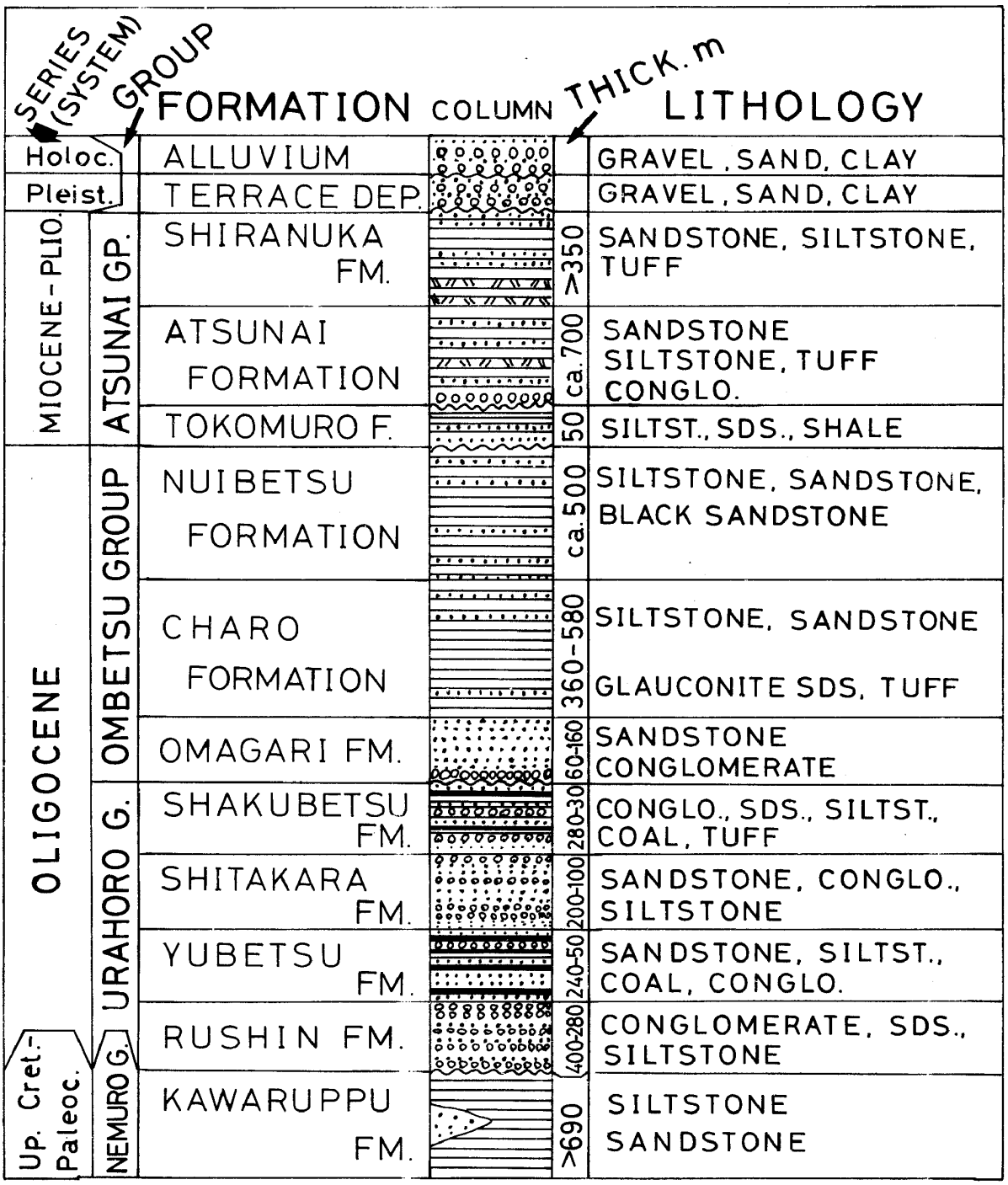


Fig. 2. Stratigraphic classification in the Ombetsu district.

Corbicula (*Batissa*) *sitakaraensis*, *C. tokudai*, *Nemocardium* (*Arctopratulum*) *ezoense*, *N.* (*A.*) *yokoyamai* Takeda, and *Mya grewingki*.

The Beppo Formation is mainly composed of the so-called black conglomerate that is made up of clasts of black slate, chert, sandstone, tuff, etc., and has a thickness of 0 to 150 m; the Harutori Formation is of gray or pale gray sandstone, with intercalated coal seams, and varies in thickness from 20 to 90 m; and the Tenneru Formation is composed of the so-called red conglomerate that is

Table 2. Occurrences of fossil molluscs from the Urahoro and Ombetsu Groups. Urahoro Group: RN, Rushin Formation; YB, Yubetsu Fm.; SK, Shitakara Fm.; SB, Shakubetsu Fm. Ombetsu Group: OM, Omagari Fm.; CH, Charo Fm.; NB, Nuibetsu Fm.

Species	RN	YB	SK	SB	OM	CH	NB
Solemya (Acharax) cf. dalli Clark							+
Malletia poronaica (Yokoyama)						+	+
Malletia sp.							+
Saccella pseudoscissurata (Takeda)						+	
Saccella sp.						+	+
Yoldia (Yoldia) laudabilis Yokoyama			+		+	+	+
Yoldia (Yoldia) akanensis Uozumi					+		
Yoldia (Tepidoleda) sobrina Takeda					+	+	+
Yoldia sp.						+	+
Portlandia (Portlandella) watasei watasei (Kanehara)			+		+	+	+
Portlandia (Portlandella) watasei semiovata Uozumi						+	
Portlandia (Portlandella) ovata (Takeda)					+		+
Portlandia (Portlandella) sp.						+	+
Portlandia (Megayoldia) yotsukurensis Uozumi						+	+
Portlandia (Megayoldia) thracieaformis (Storer)						+	+
Portlandia sp.						+	+
Nucula (Ennucula) omagariensis, n. sp.					+	+	+
Nucula (Ennucula) sp.						+	+
Acila (Acila) cf. praedivaricata Nagao and Huzioka					+		
Acila (Acila) elongata Nagao and Huzioka							+
Acila (Acila) brevis Nagao and Huzioka					+		+
Acila (Acila) kusiroensis Nagao and Huzioka					+	+	+
Acila (Acila) sp.					+	+	+
Acila (Truncacila) picturata (Yokoyama)							+
Acila (Truncacila) sp.					+		+
Acila sp.						+	+
Crenella (Megacrenella) shitakaraensis, n. sp.			+				
Crenella (Megacrenella) nuibetsuensis, n. sp.						+	+
Mytilus mabuchii Oyama and Mizuno	+		+	+			
Mytilus cf. M. luciferus Yokoyama			+				
Mytilus sp.			+	+			
Modiolus sp.				+	+		
Brachidontes sp.						+	
Delectopecten ikushyunbetsuense (Utashiro)						+	+
Delectopecten sp.						+	+
Propeamussium kusiroense (Takeda)						+	+
Chlamys shitakaraensis Honda			+				
Lima (Acesta) sp., indet.						+	
Ostrea eorivularis Oyama and Mizuno	+	+	+	+	+	+	
Margaritifera sp.				+			
Anodonta subjapanensis yokoyamai Suzuki				+			
Cyclocardia takedai (Honda)							+
Cyclocardia poronaiensis, new name					+	+	
Cyclocardia laxata (Yokoyama)					+	+	
Cyclocardia akagii (Kanehara)					+	+	+
Cyclocardia expansa (Takeda)					+	+	+
Cyclocardia tokudai (Takeda)					+	+	+
Cyclocardia orbica (Yokoyama)					+		
Cyclocardia tokunagai (Yokoyama)							+
Cyclocardia ezoensis (Takeda)						+	+
Cyclocardia sp.			+			+	+
Geloina cf. G. takaoi (Nagao and Ôtatume)			+				
Corbicula (Batissa) sitakaraensis Suzuki	+	+	+	+	+		
Corbicula (Corbicula) tokudai (Yokoyama)		+		+			
Corbicula (Corbicula) kotakai Honda		+					
Corbicula sp.		+	+		+		

Table 2. Continued

Species	RN	YB	SK	SB	OM	CH	NB
Lucinoma hannibali (Clark)					+	+	
Lucinoma sp., indet.						+	+
Conchocele bisecta (Conrad)			+		+	+	
Conchocele nipponica (Yabe and Nomura)					+		
Nemocardium (Arctopratulum) ezoense Takeda			+		+		
Nemocardium (Arctopratulum) yokoyamai Takeda			+		+		
Nemocardium (Keenaea) iwakiense (Makiyama)					+		
Nemocardium sp.			+	+			
Clinocardium omagariense Honda					+		
Clinocardium sp.					+	+	+
Trachycardium kinsimarae (Makiyama)					+		
Profulvia harrimani (Dall)						+	
Profulvia sp.							+
Hubertschenckia ezoensis (Yokoyama)			+				
Callista sp.			+				
Liocyma terrena (Yokoyama)						+	+
Liocyma furtiva (Yokoyama)							+
Clementia sp.							+
Mactra sp.			+				
Spisula (Mactromeris) sorachiensis Uozumi		+	+				
Spisula sp.			+				
Macoma (Macoma) sejugata (Yokoyama)			+		+	+	+
Macoma (Macoma) optiva (Yokoyama)					+		
Macoma sp.			+		+	+	+
Peronidea sp.			+				
Siliqua sp., indet.						+	
Phaxas sp.			+				+
Solen shitakaraensis, n. sp.			+				
Caryocorbula sp.							+
Mya (?Arenomya) grewingki grewingki Makiyama			+		+		
Mya (?Arenomya) grewingki kusiroensis Nagao and Inoue			+		+		
Mya sp.					+		
Mya sp.?							+
Myadora sp., indet.						+	+
Periploma (Aelga) besshoense (Yokoyama)			+		+	+	+
Periploma (Aelga) ezoense Mizuno and Inoue			+				
Periploma sp.						+	
Periploma? sp.						+	+
Thracia (Thracia) shitakaraensis, n. sp.			+				
Cardiomya (Cardiomya) kotakai, n. sp.							+
Cardiomya (Cardiomya) makiyamai (Kanehara)					+		+
Cardiomya (Cardiomya) sp.						+	
"Minolia" funiculata (Yokoyama)						+	+
Machaeroplax eos (Hirayama)						+	
Turcicula (Ginebis) sakhalinensis (Takeda)							+
Turcicula sp.						+	+
Margarites makiyamai Hirayama							+
Margarites sp.							+
Bellamya (Sinotaia) mabutii (Suzuki)				+			
Cipangopaludina isikariensis (Suzuki)				+			
Orectospira wadana (Yokoyama)						+	+
Turritella (Hataiella) nuibetsuensis, n. sp.						+	+
Turritella (Hataiella) poronaiensis Takeda					+	+	+
Turritella tokunagai Yokoyama					+	+	+
Turritella importuna Yokoyama					+	+	+
Turritella sp.			+		+	+	+

Table 2. Continued

Species	RN	YB	SK	SB	OM	CH	NB
Semisulcospira fiscina yokoyamai Suzuki				+			
Melanoides? sp.		+		+			
Cerithidea ishikariensis Yokoyama?				+			
Neverita (Neverita) asagaiensis (Makiyama)			+		+	+	+
Neverita (Neverita) sp.			+	+		+	
Naticidae gen. et sp., indet.			+				+
Crepidula matajiroi Makiyama					+		
Crepidula sp.			+			+	
Colus sp.			+				
Trominina japonica (Takeda)						+	+
Trominina hokkaidoensis (Hayasaka and Uozumi)							+
Trominina ishikariensis (Hayasaka and Matsui)						+	+
Trominina umbelliformis (Hayasaka and Uozumi)						+	+
Trominina cf. umbelliformis (Hayasaka and Uozumi)						+	
Trominina sp.						+	+
Neptunea dispar Takeda						+	+
Neptunea ezoana Takeda					+		
Neptunea modestoidea Takeda			+		+	+	+
Neptunea ogasawarai, n. sp.						+	
Neptunea sp.					+		
Siphonalia sp.					+		
Buccinum sp.						+	+
Molopophorus kusiroensis Takeda							+
Molopophorus sp.							+
Priscofusus ishijimai Hirayama					+		
Fulgoraria (Musashia) antiquior (Takeda)						+	+
Fulgoraria sp.						+	
Olivella ezoana Matsui							+
Riuguhdrillia rugosa (Takeda)						+	+
Eocylichna multistriata (Takeda)					+	+	+
Eocylichna ezoana (Matsui)						+	+
Cylichna sp.						+	
Dentalium (Fissidentalium) nunomae Takeda			+		+	+	+
Dentalium sp.			+		+	+	+

made up of clasts of red chert, slate, sandstone and tuff, and is 60 to 110 m thick (Sasa, 1940a, b). The Rushin Formation is largely composed of conglomerate, sandstone and siltstone, and ranges in thickness from 195 to 280 m in the Kushiro coal field (Nagao and Sasa, 1939). In the Tokomuro district, the lower part of the formation is largely composed of sandstone, with an intercalated coal seam, and is called the Ichigozawa Coal-bearing Member (Oda, Nemoto and Uemura, 1959 ; Yui, 1975MS, Table 1). The Rushin Formation is correlated with the Beppo, Harutori and Tenneru Formations (Sasa, 1953 ; Table 1).

The Yubetsu Formation consists of sandstone with intercalated conglomerate, coal seams and siltstone, and ranges in thickness from 100 to 180 m in the Kushiro coal field (Sasa, 1940a, b). The Shitakara Formation, also within this coal field, is mainly composed of sandstone in its lower part, mudstone and sandy mudstone in its middle part and sandstone in its upper part; it ranges in thickness from 200 to 300 m in the Kushiro coal field (Sasa, 1940a, b). These three lithologic units of the Shitakara Formation have been recognized in the central part of the Kushiro coal field (Suzuki, 1958 ; Mizuno and Hyakkoku, 1960 ; Sato, Nagahama and Yo-

Table 3. Occurrences of fossil molluscs from the Shitakara Formation in the Ombetsu district. common (5 to 9 individuals); F, few (2 to 4 individuals); R, rare (one individual). SK-01, SK-02, ..., SK-62; and SK-A, SK-B, ..., SK-E, respectively, in the text.

Species	1	2	3	4	5	6	7	8	9	9*	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Crenella shitakaraensis, n. sp.																															
Mytilus mabuchii																							VA				F				
Chlamys shitakaraensis		R	R	R			R				VA		F		R					C	F	R					F	A	R	R
Ostrea eorivularis	R	F		R				R	F						F					VA	C	R	VA	F			F	F		R	
O. sp.						R																			R						R
Corbicula sitakaraensis																							F							F	
Nemocardium ezoense	F	C	F				A	C			F	A	C	R	C	C	R	C	A				F					C		R	
N. yokoyamai																		R													
N. sp.																															
Hubertschenckia ezoensis																															
Mactra sp.																															
Spisula sorachiensis																										C					
S. sp.																															
Macoma sejugata											R	F																			
M. sp.		R	R																												
Phaxas sp.																										R					
Solen shitakaraensis, n. sp.																															
Mya grewingki grewingki																															
M. grewingki kusiroensis																															
Periploma besshoense																															
Thracia shitakaraensis, n. sp.																															
Turritella sp.																															
Neverita asagaiensis																															
Dentalium nunomae																															
D. sp.																															

shida, 1961, middle to eastern area; Sato, Tanai and Suzuki, 1961; Kaiho, 1977MS; Yanagisawa, 1979MS, Table 1).

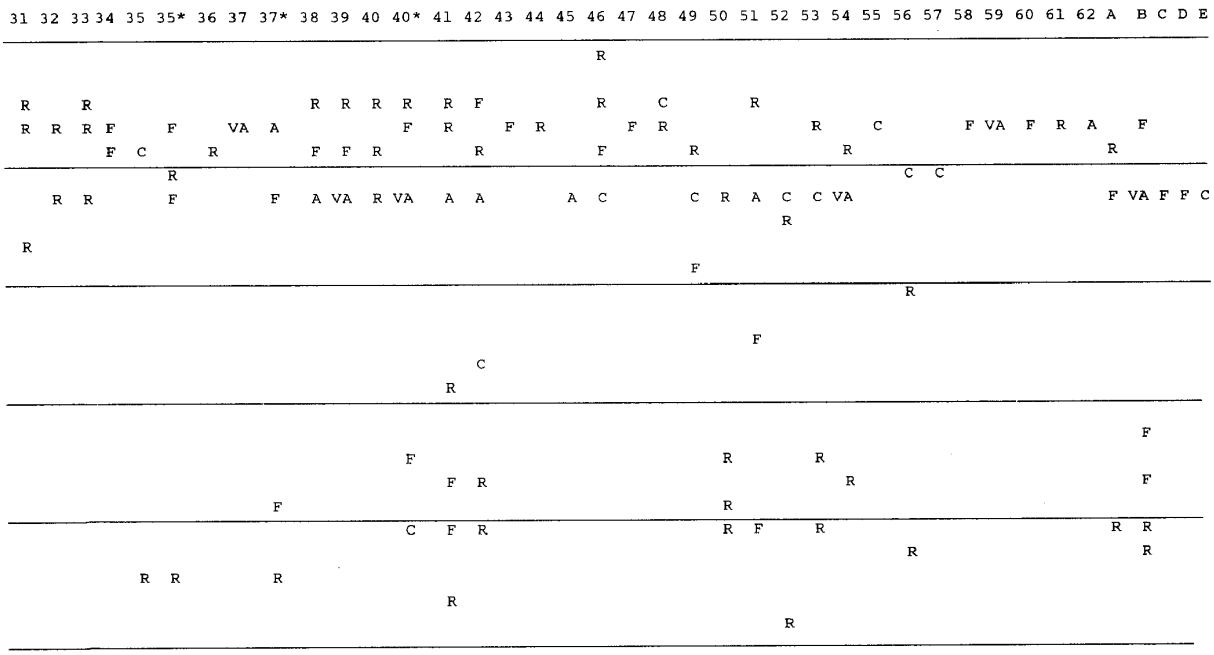
However, in the western part of the Kushiro coal field, the Shitakara Formation gets coarser and is made up largely of conglomerate (Sasa, 1940a), and is not subdivided into lithologic members (Tanai, 1957; Mitani *et al.*, 1959; Oda, Nemoto and Uemura, 1959; Sato, Nagahama and Yoshida, 1961, western area; Tanai and Yamaguchi, 1965; Yui, 1975MS, Table 1).

The Shakubetsu Formation is composed of conglomerate, sandstone, siltstone and tuff, with intercalated coal seams, and ranges in thickness from 120 to 220 m (Sasa, 1940a, b). The conglomerate is composed of red chert, white rhyolitic rocks and slate. As a whole,

Table 4. Occurrences of fossil molluscs from the Rushin and Yubetsu Formations in the Ombetsu district. For "VA", "A", "C", "F", and "R", *see* Table 3. Numerals 1 and 2; 1, 2, ..., 14; and letters A, ..., D correspond to the locality numbers RN-01, RN-02; YB-01, YB-02, ..., YB-14; and YB-A, ..., YB-D, respectively, in the text.

Species	RN-		YB-																
	1	2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	A	B	C	D
Mytilus mabuchii	R																			
Ostrea eorivularis		R									VA			C						
O. sp.									R											
Corbicula sitakaraensis	A	VA									VA						R		F	
C. tokudai				F		C	F	A	C						C			F		VA
C. kotakai					F							VA	C							
C. sp.										F										
Nemocardium sp.																R				
Melanoides? sp.																			R	

VA, very abundant (20 or more individuals); A, abundant (10 to 19 individuals); C, Numerals 1, 2, ..., 62; and letters A, B, ..., E correspond to the locality numbers



the Urahoro Group is of brackish- or fresh-water origin, while the Shitakara Formation is largely of marine origin. The occurrences of fossil molluscs from the Urahoro Group are shown in Tables 2–5 and 9.

The Ombetsu Group is of marine origin and is exposed in the western to central part of the Kushiro coal field, where it is more than 1,000 m in maximum thickness. It is composed of gray siltstone with greenish gray basal sandstone, and has been divided into three units which in ascending order are the Omagari, Charo and Nuibetsu Formations (Yui, 1975MS; Kaiho, 1977MS, Table 1), or into two units of the Charo and Nuibetsu Formations (Tanai, 1957,

Table 5. Occurrences of fossil molluscs from the Shakubetsu Formation in the Ombetsu district. For "VA", "A", "C", "F", and "R", *see* Table 3. Numerals 1, 1*, ..., 8; and letters A, B, ...U correspond to the locality numbers SB-01, SB-01*, . . ., SB-08; and SB-A, SB-B, ..., SB-U, respectively, in the text.

Species	1	1*	2	3	4	5	6	7	8	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Mytilus mabuchii													R												A					
M. sp.			F																											
Modiolus sp.							F																							
Ostrea eorivularis										A															R					
O. sp.										R																				
Corbicula sitakaraensis	VA	A		R	VA					VA	VA		VA		VA	C	VA							F	VA		R			
C. tokudai			VA			VA	VA	VA				A		A				VA	VA	R	C	C	C			F		C	C	F
Bellamya mabutii		R																												
Cipangopaludina isikariensis															R															
Melanoides? sp.																							R							
?Cerithidea ishikariensis															R															

1961; Mizuno and Hyakkoku, 1960; Sato, Nagahama and Yoshida, 1961; Tanai and Yamaguchi, 1965; Yanagisawa, 1979MS; Table 1).

Opinions are diverse concerning the relationship between the Ombetsu and the Urahoro Group. Some workers suggest that the Ombetsu Group rests unconformably upon the Urahoro Group (Tanai, 1957, 1961; Suzuki, 1958; Oda, Nemoto and Uemura, 1959; Mitani *et al.*, 1959; Mabuti, 1962; Mizuno, Sato and Sumi, 1963; Mitani, Fujiwara and Ishiyama, 1964; Tanai and Yamaguchi, 1965; Sogabe, 1967; Yui, 1975MS; Kaiho, 1984a; Table 1). However, other workers believe that the Ombetsu Group has only a partially unconformable relationship with the Urahoro Group (Sato, Nagahama and Yoshida, 1961; Sato, Tanai and Suzuki, 1961; Yanagisawa, 1979MS; Table 1) or even a conformable relationship (Mizuno and Hyakkoku, 1960; Inoue and Suzuki, 1962). The upper part of the Shakubetsu Formation (the uppermost unit in the Urahoro Group) has been eroded by a maximum thickness of about 10 to 15 m in the Ombetsu district (Tanai, 1957). Although field evidence does not necessarily show an unconformity between the two groups, as stated by Tanai (1957), the relationship between them is inferred here to be a slight unconformity.

The Ombetsu Group yields such shallow to deep marine molluscs as *Yoldia laudabilis*, *Portlandia watasei watasei*, *Acila* (*Acila*) *elongata*, *A.* (*A.*) *brevis* Nagao and Huzioka, *Cyclocardia ezoensis* (Takeda), *C. expansa* (Takeda), *C. tokudai* (Takeda), *C. laxata*, *Turritella* (*Hataiella*) *poronaiensis* Takeda, *T. tokunagai*, *T. importuna*, *Dentalium* (*Fissidentalium*) *nunomae* (Takeda), *Eocylichna multistriata* (Takeda), *Orectospira wadana*, *Clinocardium omagariense* Honda, *Neverita* (*Neverita*) *asagaiensis*, *Conchocele bisecta*, *Macoma* (*Macoma*) *sejugata* (Yokoyama), *Periploma besshoense*, and *Profulvia harrimani*.

The Omagari Formation is characterized by greenish gray, massive or stratified, medium- to fine-grained sandstone and sandy siltstone, with a thin basal conglomerate. The formation ranges in thickness from 50 to 110 m in the Kushiro coal field (Sasa, 1940a, b). The Omagari Formation has frequently been treated as a Member within the lower part of the Charo Formation, in which case it has been called the Omagari Sandstone Member (Tanai, 1957, 1961; Oda, Nemoto and Uemura, 1959; Mizuno and Hyakkoku, 1960; Sato, Nagahama and Yoshida, 1961; Sato, Tanai and Suzuki, 1961; Tanai and Yamaguchi, 1965; Yanagisawa, 1979MS; Table 1). But, this lithostratigraphic unit is characterized by greenish gray sandstone that is different from the gray siltstone of the Charo Formation, and is widespread in the Kushiro coal field. Thus, it is treated here as of formational rank.

The Charo Formation consists of massive or stratified, dark gray or gray siltstone, with intercalated gray sandstone, and with acidic tuff and glauconitic sandstone in its basal part. In the Tokomuro district, the lower part of the formation is composed of acidic tuff breccia and conglomerate, and is called the Rushingawa Tuff Breccia Member, which attains a thickness of 160 m (Yui, 1975MS, Table 1). The Charo Formation ranges in thickness from 200 to 300 m in the Kushiro coal field (Sasa, 1940a, b).

The Nuibetsu Formation is largely composed of gray siltstone with intercalated gray sandstone and with intercalations of so-called black sandstone becoming dominant toward its upper portion. The formation ranges in thickness from 350 to 500 m in the Kushiro coal field (Sasa, 1940a, b). In the Akan district, in central part of the coal field (Fig. 1), the upper part of the formation

Table 6. Occurrences of fossil molluscs from the Omagari Formation in the Ombetsu district. For "VA", "A", "C", "F", and "R", *see* Table 3. Numerals 1, 2, ..., 12 ; and letters A, B, ..., H correspond to the locality numbers OMH-1, OMH-2, ..., OMH-12 ; and OMH-A, OMH-B, ..., OMH-H, respectively, in the text.

Species	1	2	3	4	5	6	7	8	9	10	10*	11	12	A	B	C	D	E	F	G	H
Yoldia laudabilis		C		R			F				F			F			C		F		
Y. sobrina																		R			
Y. sp.		R																	R		
Lucinoma hannibali			R																		
Conchocele bisecta	VA																				
Nemocardium ezoense															R						
Clinocardium sp.			R			R		F	F	R				A						F	R
Trachycardium kinsimarae												F		R							
Macoma sejugata															R		R	R			R
Mya grewingki kusiroensis																	C				
Periploma besshoense										F											
Turritella tokunagai			R																		
T. sp.										R											
Neverita asagainensis											F										
Neptunea modestoidea																				R	
N. sp.																					R
Dentalium nunomae			R																		
D. sp.					R	R											F			R	

is predominantly composed of andesitic lavas and tuff breccia which are called the Ishinosawa Pyroclastic Rocks Member and range in thickness from 200 to 370 m (Yanagisawa, 1979MS ; Table 1). The occurrences of fossil molluscs from the Ombetsu Group are shown in Tables 2, 6-8, 10 and 11.

The Atsunai Group rests unconformably upon the Ombetsu Group, and is well exposed along the Pacific coast in the western to central part of the Kushiro coal field. It is characterized by gray siltstone and sandstone, and is divided into the Tokomuro, Atsunai and Shiranuka Formations in ascending order. The group attains about 1,000 m in maximum thickness.

The Atsunai Group yields such marine molluscs as *Portlandia hayasakai* Uozumi, *Anadara hokkaidoensis* Noda, *Mytilus tichanovitchi* Makiyama, *Mizuhopecten nakatombetsuensis* (Akiyama), *Cyclocardia abesinaiensis* (Otuka), *Lucinoma annulata* (Reeve), *Macoma tokyoensis* Makiyama, *Turritella shataii* Nomura and *Tectonatica janthostomoides* Kuroda and Habe (Table 12).

The Tokomuro Formation is composed of alternating beds of gray siltstone, sandstone, sandy tuff and hard shale. It attains a thickness of about 180 m in the Tokomuro district (Yui, 1975MS) and thins northward to about 50 m in the Ombetsu district. The formation in the Ombetsu district unconformably overlies the Nuibetsu Formation with an andesitic coarse-grained sandstone that has a thickness of only a few meters. Maiya, Akiba and Ichinoseki (1981b, c) recorded diatom fossil assemblages, which belong to the *Kisseleviella carina* Zone (early Miocene) of Koizumi (1979), from the Tokomuro Formation of the Ikuchise and the Hombetsu area in the western part of the Kushiro coal field.

The Atsunai Formation is composed of gray, tuffaceous, sandy siltstone with sandstone becoming dominant higher in the sequence and acidic tuff, and it is about 700 m thick in the Ombetsu district. The Atsunai Formation unconformably overlies the Tokomuro and the Nuibetsu Formation (Table 1). Diatoms in mudstone of the Atsunai Formation of the Ombetsu district belong to

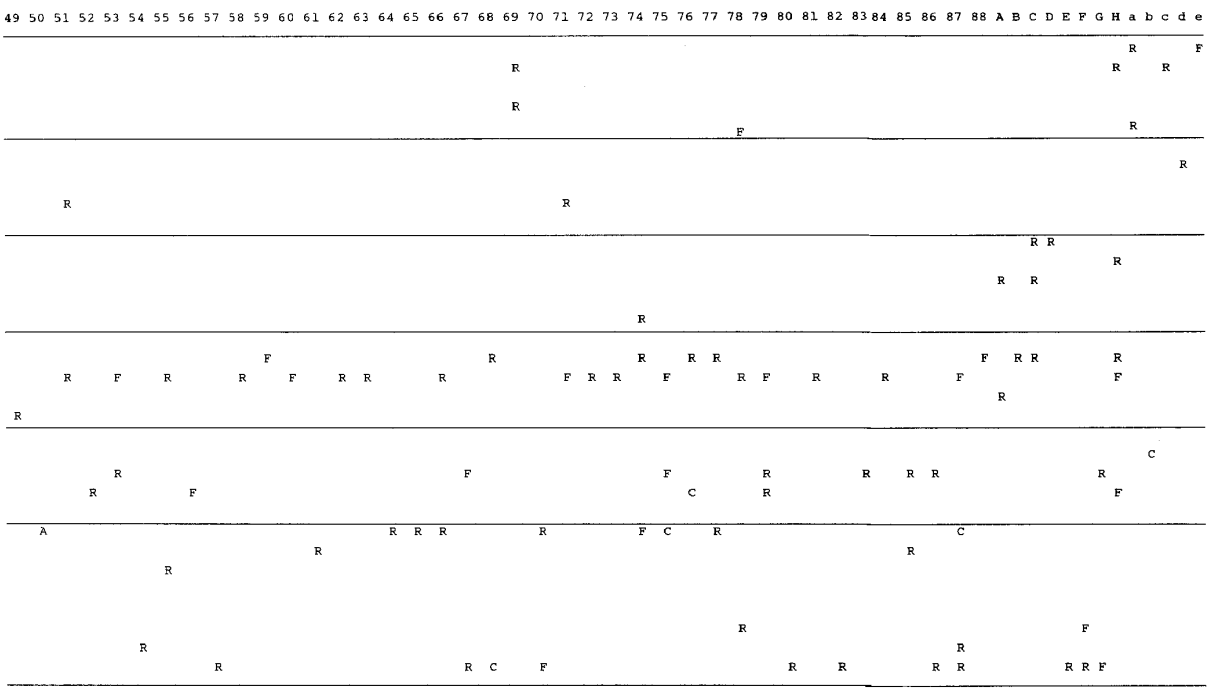
Table 7. Occurrences of fossil molluscs from the Charo Formation in the Ombetsu district. locality numbers CH-01, CH-02, ..., CH-88 ; and CH-A, CH-B, ..., CH-e, respectively,

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	18	19	20	21	22	25	26	27	28	29	30	32	33	34	35	36	38	39	40	41	42	43	44	45	46	47	48
Malletia poronaica																																										
Yoldia laudabilis																										R	R															
Y. sobrina																									F																
Y. sp.																														R											
Portlandia watasei watasei																																									
P. sp.								R																												R					
Acila kusiroensis																																		R							
A. (Truncacila) sp.																									R																
A. sp.																																									
Crenella nuibetsuensis, n. sp.																										R																
Delectopecten ikushyunbetsuense																																									
D. sp.																																									
Propeamussium kusiroense																															F								F		
Ostrea eorivularis								R																																	
Cyclocardia laxata																																									
C. expansa																F																								F		
C. ezoensis			F						R																R			R	R						F				R		
C. sp.	R	R		R	R	F							C	R			R	R	R			R	R	F						R			F	F						
Lucinoma sp.																																									
Clinocardium sp.																																									
Myadora sp., indet.																																R									
Periploma besshoense																																									
Orectospira wadana									R							F															F										
Turritella poronaiensis																																									
T. tokunagai																				R																					
T. sp.											R			F		C			R		F		F	C	F					F					R				R		R
Trominina japonica																																									
T. sp.																																									
Neptunea modestoidea								R																																	
N. ogasawarai, n. sp.																					R																				
Eocylichna multistriata																	R															R									
Dentalium nunomae															R																										
D. sp.	R		R			R	F					R	R	F	F										R					F	C				R		R			

Table 8. Occurrences of fossil molluscs from the Nuibetsu Formation in the Ombetsu district. B, ..., R, a, b, ..., h correspond to the locality numbers NB-01, NB-02, ..., NB-79 ;

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Malletia poronaica	F																R																					R					
Saccella sp.																																											
Yoldia laudabilis							R				R						R	R		R																							
Y. sobrina																																										
Y. sp.																				R																		R					
Portlandia watasei watasei									R								R	C																		R							
P. ovata											R																																
P. thraciaeformis							R																											F									
P. sp.																				R																							
Acila brevis																		R																									
A. kusiroensis																		F																									
A. sp.																																										R	
Crenella nuibetsuensis, n. sp.								F		R					R												R																
Delectopecten ikushyunbetsuense		R																																								
Cyclocardia expansa					R																																					
C. tokunagai																																										
C. ezoensis												R						R		R		R			F									R					R			
C. sp.	R	R						F		R			R	R							R			F				R	F						R			F			F	R
Lucinoma sp.					R																R																					
Clinocardium sp.																																										
Liocyma furtiva																														F												
Phaxas sp.																																										
Caryocorbula sp.																																										
Mya sp.?																																										
Periploma besshoense							R																																				
P.? sp.																																				R						
Cardiomya kotakai, n. sp.																	R																										
Orectospira wadana	F	R				F											C																										R
Turritella poronaiensis																R							R											F						R		
T. tokunagai																																										
T. sp.					C	F								R			VA				R			R			R	VA			F		C					R				
Neverita asagaiensis																																										
Trominina japonica																																										
T. sp.																																										
Neptunea modestoidea																																										
Buccinum sp.																																										
Molopophorus kusiroensis																																										
Olivella ezoana																																										
Eocylichna multistriata									F	R				R			C														R							R				
E. ezoana			R																																							
Dentalium nunomae										R																																
D. sp.						R	A	R							R		R	F	R	R					R	R		R		F	C											

For "VA", "A", "C", "F", and "R", *see* Table 3. Numerals and letters correspond to the
in the text.



For "VA", "A", "C", "F", and "R", *see* Table 3. Numerals 1, 2, ..., 79; and letters A,
NB-A, NB-B, ..., NB-R; and NB-a, NB-b, ..., NB-h, respectively, in the text.

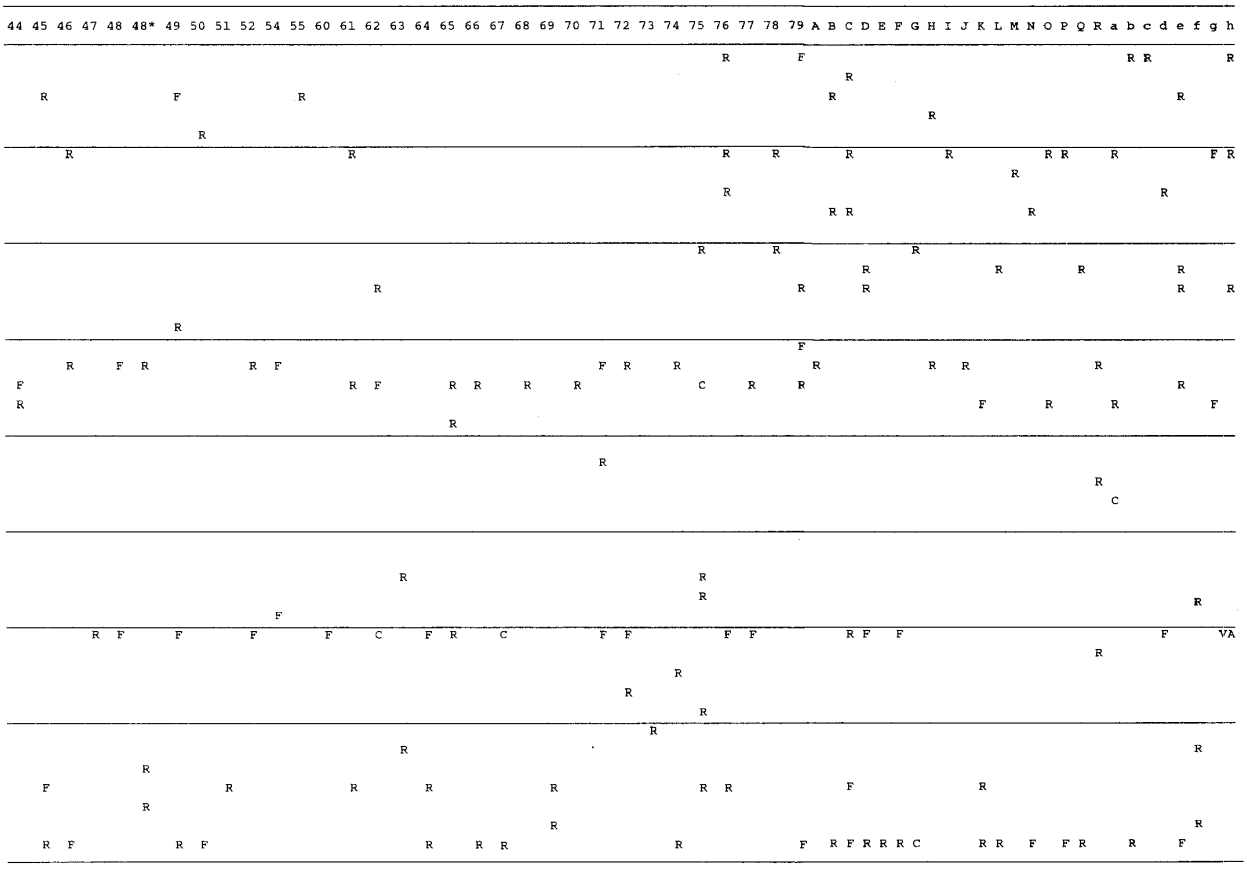


Table 9. Occurrences of fossil molluscs from the Urahoro Group in the Akan district. For "VA", "A", "C", F", and "R", *see* Table 3. YBY-1....4, Soun Mudstone Member of the Yubetsu Formation; SK1-1....3, lower part of the Shitakara Fm.; SK2-1....17, middle part of the Shitakara Fm.; SK3-1....9, upper part of the Shitakara Fm.; SBY-1....6, Shakubetsu Fm.

Species	YBY-				SK1-			SK2-																SK3-									SBY-					
	1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6
Yoldia laudabilis									R																F	R		A		C	VA								
Portlandia watasei watasei																				C													R					
Modiolus sp.																																					R		
Mytilus mabuchii																												F											
Ostrea eorivularis			F	F	R	R	R		F	R	F		R	R	F		R	F				R						R				F	R					
Anodonta subjapanensis yokoyamai																																					R		
Cyclocardia sp.							R				F				F		R		F			F						F										
Corbicula sitakaraensis	VA		A	A		C			R																		C										
C. tokudai		C																																VA	VA	A	A	R	C
Conchocele bisecta																				R	F	R																
Nemocardium ezoense							R			R			R	R									C	C			F												
Macoma sp.																						F						A										
Mya grewingki kusiroensis									F				C	C		R					F	A							A				F					
Mya sp.																					R																	
Periploma besshoense																				R																		
P. ezoense								R																														
Cipangopaludina isikariensis																																					R		
Semisulcospira fiscina yokoyamai																																					F		
Neverita asagaiensis															F					R																		
N. sp.																						R																
Colus sp.																												R										
Neptunea modestoidea															R				R		A	C						R										
Dentalium sp.													R							R																		

the lower part of the *Denticulopsis kamtschatica* Zone (late Miocene) of Koizumi (1977) (Koizumi, *written commun.*, 1977). Maiya, Akiba and Ichinoseki (1981a) also recorded a diatom assemblage from the Atsunai Formation that belongs to the *Thalassionema hirosakiensis* s. l. Zone (latest late Miocene) of Akiba, Yanagisawa and Ishii (1982): this zone is approximately correlative with the lower part of the *D. kamtschatica* Zone of Koizumi (1979).

The Shiranuka Formation is mainly composed of gray sandstone and siltstone, and may be more than 350 m thick in the Ombetsu district, but only 30 m thick in the Akan district (Yanagisawa, 1979MS). Maiya, Akiba and Ichinoseki (1981a) recorded Pliocene diatom assemblages from the Shiranuka Formation of the Atsunai area, which belong to the upper part of the *D. kamtschatica* (Koizumi, 1973), the *D. seminae* var. *fossilis-D. kamtschatica* (Koizumi, 1973) and the *D. seminae* var. *fossilis* (Koizumi, 1975) Zone.

The Hombetsu Group (or Akan Group) rests unconformably upon the Shiretoko or the Ombetsu Group, and is exposed along the western margin and in the central part of the Kushiro coal field (Sasa, 1953). The Hombetsu Group of marine and nonmarine origin is largely composed of conglomelate, tuffaceous sandstone, mudstone and tuff, and attains a maximum thickness of 2,100 m (Sasa, 1953).

Maps indicating fossil localities of the Urahoro and Ombetsu Groups are shown in Figs. 4–6, and a geologic map of the Ombetsu district is shown in Fig. 3.

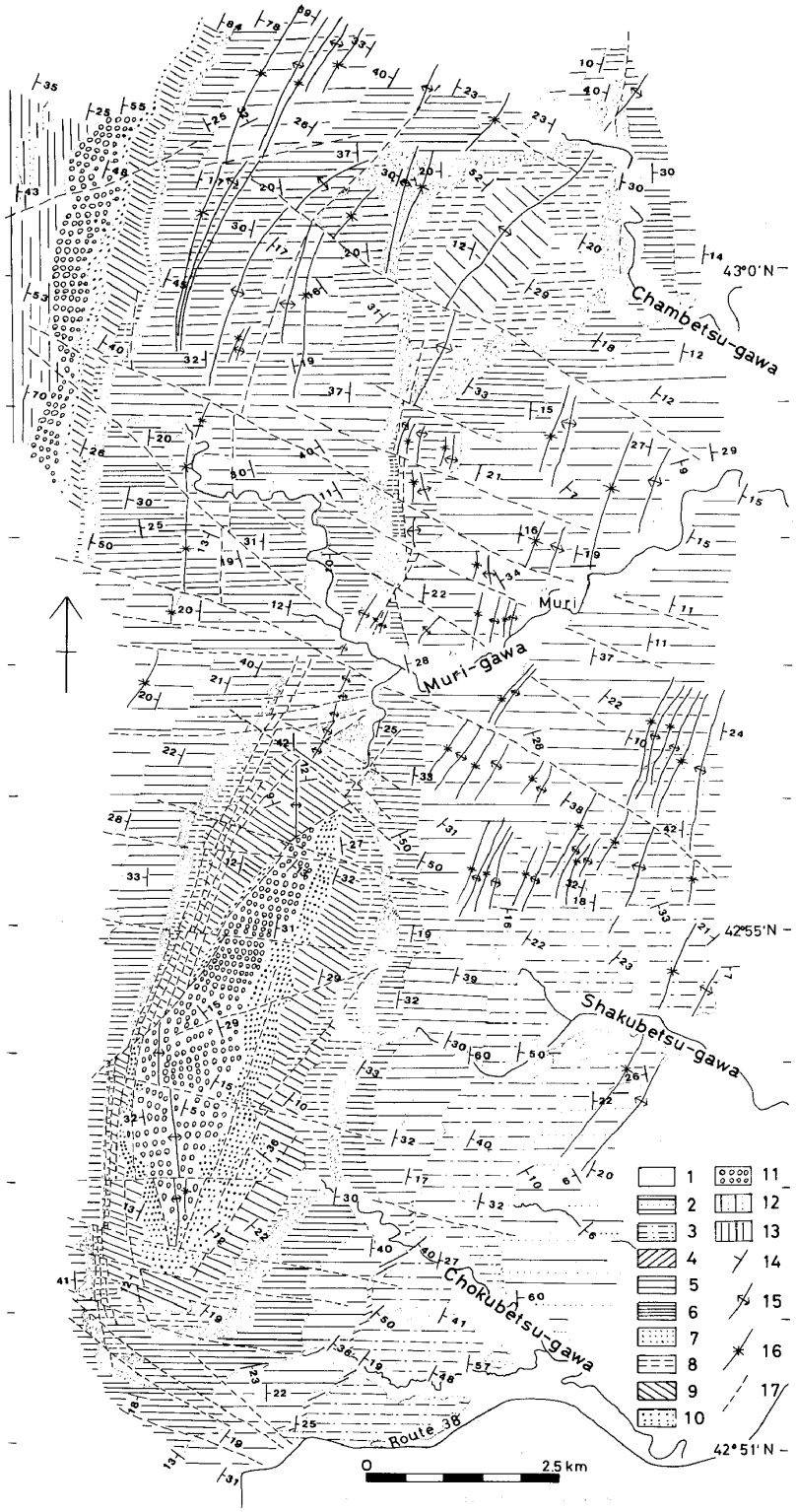


Fig. 3. Geologic map of the Ombetsu district. 1, Alluvium and Terrace deposits. 2-4, Atsunai Group: 2, Shiranuka Formation; 3, Atsunai Formation; 4, Tokomuro Formation. 5-7, Ombetsu Group: 5, Nuibetsu Formation; 6, Charo Formation; 7, Omagari Formation. 8-11, Urahoro Group: 8, Shakubetsu Formation; 9, Shitakara Formation; 10, Yubetsu Formation; 11, Rushin Formation. 12, 13, Nemuro Group (Kawaruppu Formation): 12, Sandstone; 13, Siltstone. 14, Strike and dip. 15, Anticline. 16, Syncline. 17, Inferred fault.

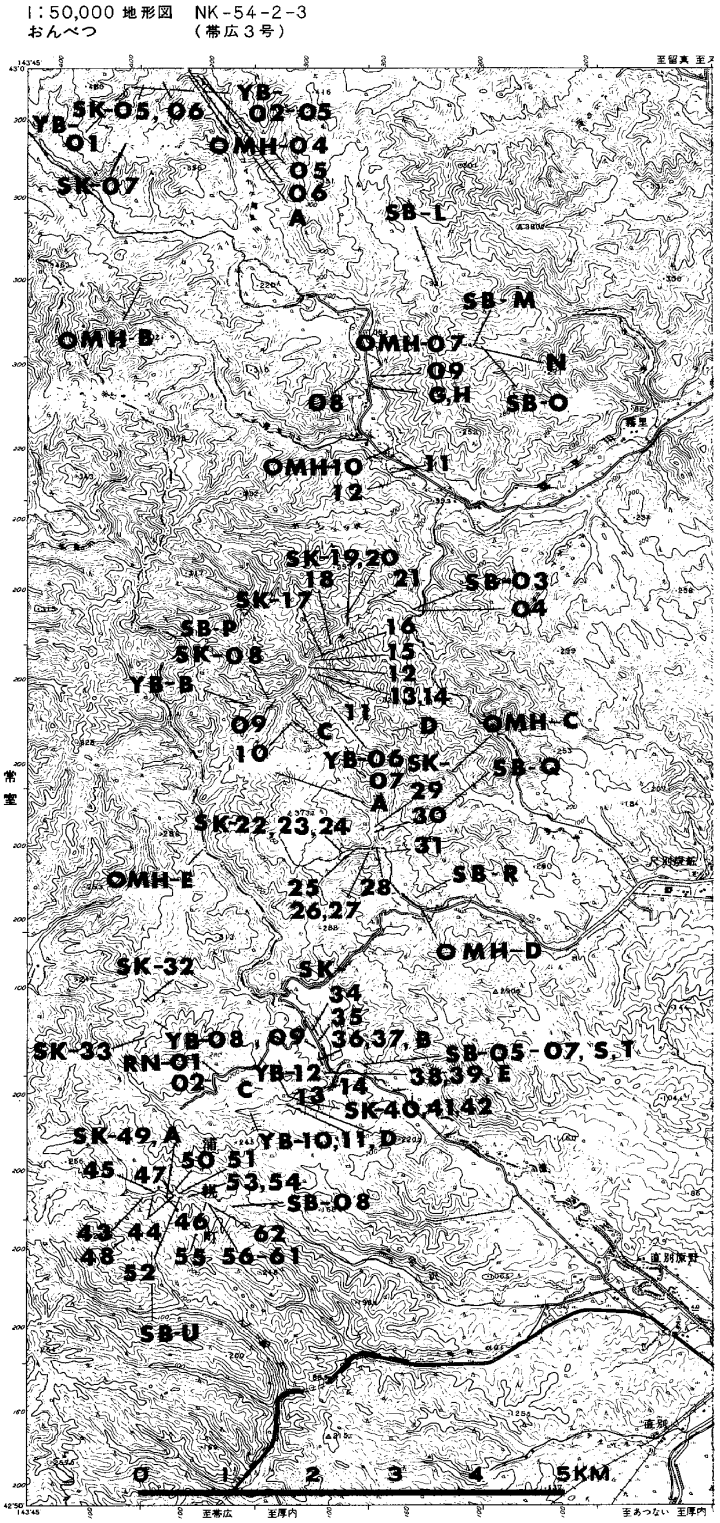


Fig. 4. Map showing fossil localities in the Urahoro Group and the Omagari Formation of the Ombetsu district. RN-, Rushin Formation; YB-, Yubetsu Fm.; SK-, Shitakara Fm.; SB-, Shakubetsu Fm.; OMH-, Omagari Fm. A part of the 1 : 50,000 scale map of "Ombetsu" published from Geographical Survey Institute of Japan.

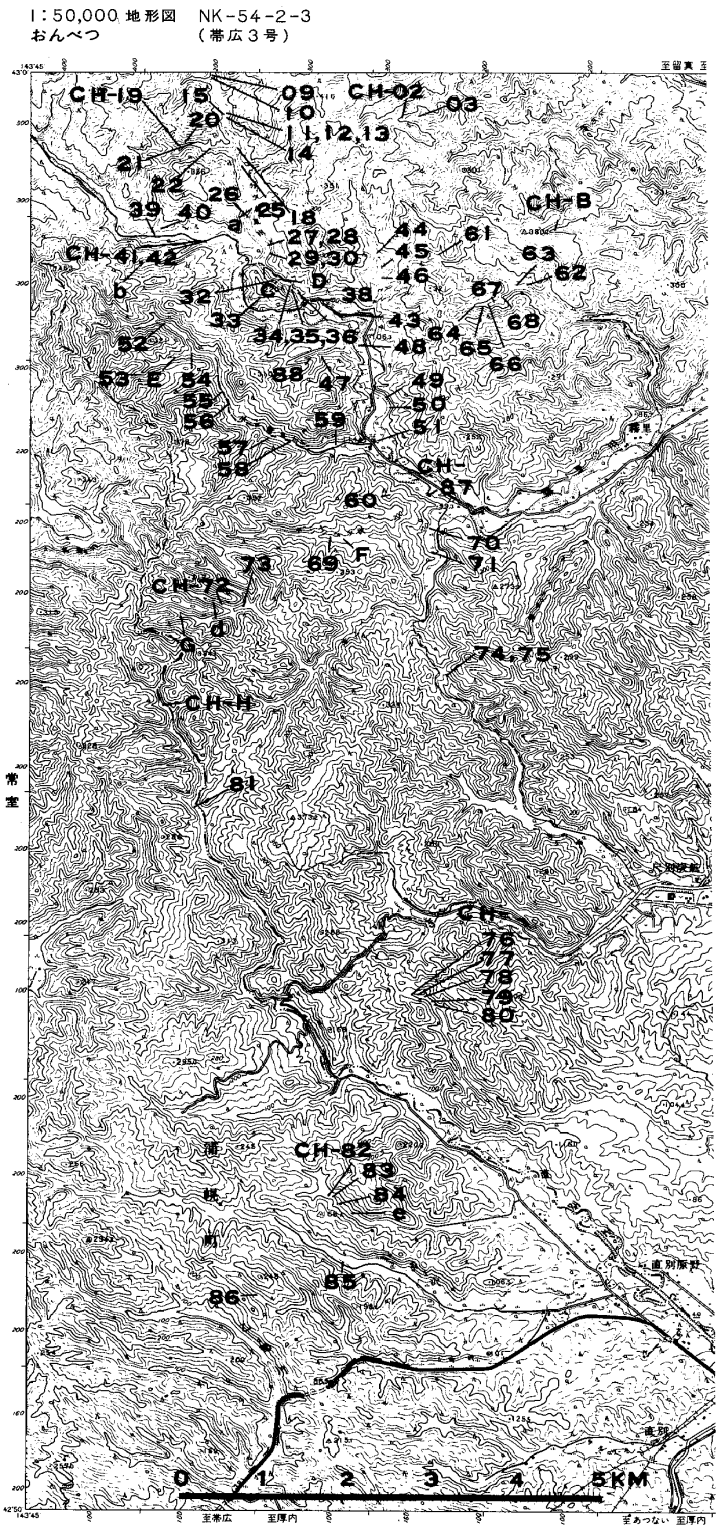


Fig. 5. Map showing fossil localities in the Charo Formation of the Ombetsu district. A part of the 1 : 50,000 scale map of "Ombetsu" published from Geographical Survey Institute of Japan.

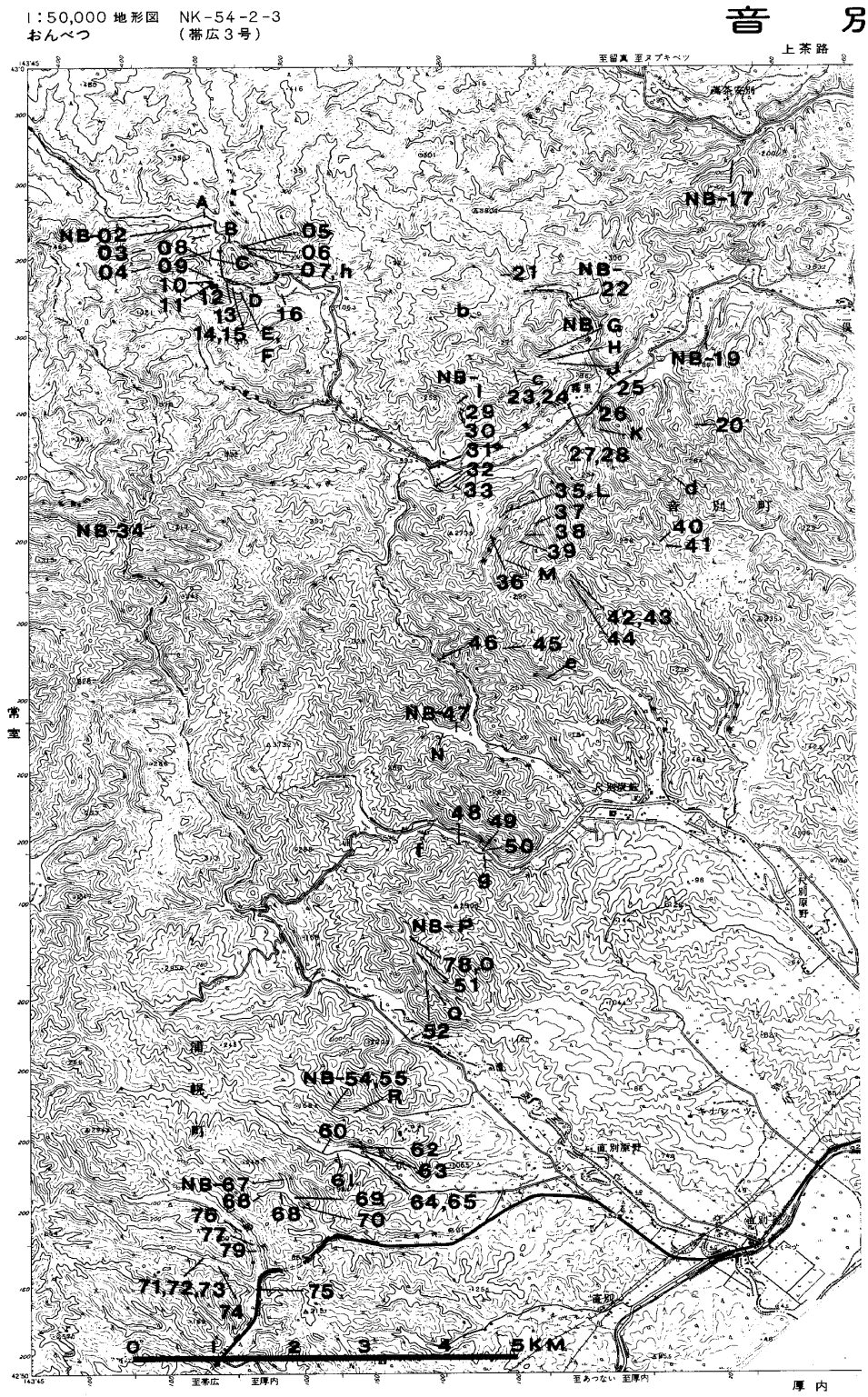


Fig. 6. Map showing fossil localities in the Nuibetsu Formation of the Ombetsu district. A part of the 1 : 50,000 scale map of "Ombetsu" published from Geographical Survey Institute of Japan.

Table 10. Occurrences of fossil molluscs from the Ombetsu Group in the Akan district. For "VA", "A", "C", "F", and "R", *see* Table 3. OMY-1, ..., 3, Omagari Sandstone Member of the Charo Formation; CHY-1, ..., 34, Charo Fm.; NBY-1, ..., 18, Nuibetsu Fm.

Species	OMY-			CHY-																																		NBY-																
	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Malletia poronaica																																C																									
Saccella pseudoscissurata					R																																																			
Yoldia laudabilis																R			F													F				R																				
Portlandia watasei watasei														R	A				VA											C	R	A	VA	R	F		F																		
P. watasei semiovata																																			C																				
Acila sp.																						R																																	
Delectopecten ikushyunbetsuense																						R																																	R
Propeamussium kusiroense												R														F		F																												
Lima sp., indet.								R																																																
Ostrea eorivularis	F	F																																																						
Cyclocardia expansa					R			F																										R																					
C. ezoensis																																																							
C. sp.									F		C				F	R			C		F		R	R	R	C	R		R		F		F			F	F	F	F		R	F	F	R	F	F			F		
Corbicula sitakaraensis	F																																																				
C. tokudai		R																																																				
Conchocele bisecta															F																						R																		
Periploma besshoense															F																																							
P. sp.													F		R															R																							
Cardiomya sp.																													R																								
"Minolia" funiculata					F																											F																				
Orectospira wadana				R						F	R																																										
Turritella poronaiensis																										R									R	F					F			R								
T. tokunagai															R																																						
T. importuna						R																																															
T. sp.								R	R	R									R											R								R					R						R	C		
Neverita asagaiensis																			R												R	R																				
N. sp.																																																			A		
Crepidula sp.																																		R																			
Trominina japonica																	R																	R																		
T. ishikariensis																																											R	F								
Neptunea dispar								R																																					R	R							
N. modestoidea																															R																				
Fulgoraria antiquior									R																																									R		
Riuguhdrillia rugosa																				R																																R		
Eocylichna multistriata															R						R																												R			R		
Cylichna sp.															R																																						
Dentalium nunomae								R										R																																	R		R
D. sp.																			R												R																					

Table 11. Occurrences of fossil molluscs from the Omagari Formation in the Tokomuro district (*modified from* : Yui, 1975MS). For "VA", "A", "C", "F", and "R", *see* Table 3. Numerals 1, 2, ..., 32, 36, correspond to the locality numbers OM-01, OM-02, ..., OM-32, OM-36, in the text.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	36
Yoldia laudabilis						C	A				C			VA	A	F	VA		VA		C	A		A	A			VA	F	R		VA	
Y. akanensis																			F						C								
Y. sobrina		R												F				R						R									
Y. sp.							R							R										F									
Portlandia watasei watasei		C				F	R			C	F	R		VA	A	R	VA	R	C		F	A		VA	VA	F	F	VA				C	
P. ovata																																	F	
Nucula omagariensis, n. sp.				C		A				C	C	C	VA																					
Acila cf. praedivaricata										A		C						VA								R								
A. elongata																		R																
A. brevis										VA	VA	VA	C					C								R				C				
A. kusiroensis				R																														
A. sp.																														R				
Ostrea eorivularis	R				R																													
Cyclocardia poronaiensis, new name		F				R		R				R			C		R			R														R
C. laxata				F	F					VA	C	C	C			C		R							R		F					VA	R
C. akagii																			F						R					F			
C. expansa																														VA				
C. tokudai		F	C	C	C	C						VA	VA			A		VA	F						C	C	C							
C. orbica																		R															F	
Conchocele bisecta								A						F			A						VA											
C. nipponica																					C		F											
Nemocardium ezoense						R																			C								A	
N. yokoyamai																										F								
N. iwakiense																									C									
Clinocardium omagariense	C	A	A		R		C	VA			F			VA	VA	A	VA				A	R		R	R	C		F	VA			VA	
Macoma optiva																	R																	
Mya grewingki grewingki																															VA			
Periploma besshoense				R		R								F	F		C						R			C	C					VA	
Cardiomya makiyamai																														F				
Turritella poronaiensis		R		R								R		F	F						F	F			R				F		C	
T. tokunagai		R										R					R										F						
T. importuna							R												F						F				F				
T. sp.																					R	R												
Neverita asagaiensis	R		R			C					F		R	F	F		C		C	C		C		F	C			A			VA	
Crepidula matajiroi																																	R	
Neptunea ezoana	F	F	R		R	F					F			R		R	F		R	A					R				R		R	
N. modestoidea					F								R	R			F													R		R	
Priscofusus ishijimai		F																			R											F	
Eocylichna multistriata																	R																
Dentalium sp.		C												C							R												

MOLLUSCAN FAUNAS OF THE URAHORO AND OMBETSU GROUPS

Several thousand specimens from 570 localities in the Urahoro and Ombetsu Groups were examined : 336 localities in the Ombetsu district, 86 in the Tokomuro district, 93 in the Akan district, 55 in the Kamicharo district, and specimens from one locality in the Akan district in the collection of Emeritus Professor Tamio Kotaka of Tohoku University. These specimens comprise 44 genera and 58 species of bivalves, 25 genera and 30 species of gastropods, and one species of scaphopod (Table 2). These species are described herein, including six new and one renamed species of bivalves, and two new species of gastropods.

Most specimens are complete and composed of original shell material, whereas others are partly preserved, and some of them are somewhat deformed from burial. As a rule, molluscan fossils occur as closely packed accumulations within granule to pebble conglomerates or poorly-sorted fine-grained sandstone of the Urahoro Group. *Ostrea eorivularis*, *Corbicula tokudai* and *C. sitakaraensis*

Table 12. Occurrences of fossil molluscs from the Atsunai Group (Honda, 1984, *partly revised*). TM, Tokomuro Formation; KC, Kamicharo Fm.; AN, Atsunai Fm.; SN, Shiranuka Fm. Asterisks denote the records of Mizuno, Sumi and Yamaguchi (1969, in part).

SPECIES	TM	KC	AN	SN
Malletia poronaica (Yokoyama)	+			
Nucula? sp.		+		
Nuculanidae, gen. et sp., indet.			+	
Nuculana sp., indet.				+
Portlandia (*Acilana*) *hayasakai* Uozumi	*	*	*	*
Portlandia sp.		+		
Yoldia (*Yoldia*) *sagittaria* Yokoyama	+			
Yoldia sp.		+		+
Anadara (*Anadara*) *hokkaidoensis* Noda			+	
Mytilus tichanovitchi Makiyama	*			
Glycymeris (*Glycymeris*) *idensis* Kanno			+	
Glycymeris (*Glycymeris*) sp.			+	
Mizuhopecten nakatombetsuensis (Akiyama)			+	
Mizuhopecten sp.			+	
Ostrea sp.			+	
Cyclocardia abesinaiensis (Otuka)	*	+		
Cyclocardia sp.			+	
Laevicardium angustum (Yokoyama)			+	
Clinocardium sp.				+
Serripes sp.	+			
"*Venerupis*" sp.		+		
Mercenaria yiizukai (Kanehara)			+	
Ezocallista sp.	+			
Lucinoma annulata (Reeve)		+		
Conchocele bisecta (Conrad)		+		
Macoma (*Macoma*) *calcarea* (Gmelin)			+	+
Macoma (*Macoma*) *tokyoensis* Makiyama	+	+	+	+
Macoma (*Macoma*) n. sp.			+	
Peronidia sp.			+	
"*Tellina*" sp.		+		
Mya (*Mya*) *cuneiformis* (Böhm)				+
Periploma sp.		+		
Homalopoma sp.			+	
Turritella (*Hataiella*) *shataii* Nomura	*			
Turritella sp.	+	+	+	
Mesalia yessoensis Kotaka	*			
Mesalia sp.	+			
Crepidula sp.		+		
Crepidula? sp.			+	
Tectonatica janthostomoides Kuroda and Habe	+			
Tectonatica sp.			+	
Euspira sp.			+	
Sinum sp.		+		
Buccinidae, gen. et sp., indet.				+
Dentalium sp.			+	

frequently form beds attaining several tens of centimeters in thickness.

It is noteworthy that *Nemocardium ezoense* and *O. eorivularis* occur together in gray, poorly-sorted, fine-grained sandstone bearing reworked pebbles and granules of the Shitakara Formation. The former occurs in large numbers in sandstone, and the latter occurs where pebbles are closely packed in sandstone.

Molluscan fossils occur sporadically in gray siltstone of the Charo and Nuibetsu Formations, but closely packed in groups, often lying parallel with stratification, in gray fine-grained sandstone of the Omagari Formation. These modes of occurrences suggest that they are autochthonous or only slightly allochthonous assemblages.

The Urahoro and Ombetsu faunas contain many species of genera such as *Yoldia*, *Portlandia*, *Acila*, *Cyclocardia*, corbiculids, cardiids, *Turritella*, and *Neptunea*. It is notable that Oligocene bivalves (Mallenian Stage) of the Koryak Upland, eastern USSR (Volobueva, 1980), are similar to those of the Urahoro and Ombetsu faunas, including *Yoldia*, *Portlandia*, *Conchocele*, *Cyclocardia*, *Profulvia*, *Clinocardium*, and *Macoma*.

In addition, it is remarkable that there are many cold water genera in the Urahoro and Ombetsu faunas, including *Portlandia*, *Yoldia*, *Cyclocardia*, *Mya*, *Neptunea*, *Buccinum*, *Clinocardium*, *Conchocele*, *Liocyma*, and *Margarites*, which are widespread today in the northern Pacific. *Neverita* (s.s.) is essentially a northern temperate subgenus and lives in temperate and arctic waters of the eastern Pacific and elsewhere (Marincovich, 1977). On the other hand, there are a few warm water taxa, including *Geloina cf. G. takaoi* (Nagao and Ôtatume).

Clinocardium and *Neptunea* are considered to have originated during the Oligocene in North Japan and Sakhalin (Kafanov, 1974; Nelson, 1978), and *Mya* during the late Eocene or early Oligocene in Japan (MacNeil, 1965). Moreover, *Conchocele bisecta* is one of the earliest representatives of the genus, which appeared during the Oligocene in the northern Pacific, and *Nemocardium* (*Arctopratulum*) *ezoense* is one of the earliest representatives of the subgenus, which appeared during the Oligocene in Japan and Sakhalin.

The Urahoro and Ombetsu faunas have many genera and subgenera in common with Miocene faunas of Japan, including *Hataiella*, *Yoldia*, *Portlandia*, *Acila* (s.s), *Cyclocardia*, *Lucinoma*, and *Clinocardium*, as well as with Oligocene faunas of the Nishisonogian Stage of Kyushu, southern Japan (Mizuno, 1962b). The Urahoro and Ombetsu faunas have a few species that not only range into the Miocene of Japan, but still live in the northern Pacific (Table 21), including *Conchocele bisecta* and *Portlandia* (*Megayoldia*) *thraciaeformis* (Storer).

It is of further interest that these faunas have many species in common with Paleogene faunas of Hokkaido, Honshu, Sakhalin, Kamchatka, and the Koryak Upland, including *Yoldia laudabilis*, *Portlandia watasei*, *Cyclocardia tokunagai*, and *Periploma besshoense* (Table 21), as well as some related to or identical with species in Northwest America, including *Cyclocardia laxata*, *C. tokunagai*, *Profulvia harrimani*, *Conchocele bisecta*, *Yoldia laudabilis*, *Neverita asagaiensis*, *Turritella importuna* and *T. tokunagai* (Hatai and Kamada, 1950).

In contrast, the Urahoro and Ombetsu faunas have only a few species in common with Paleogene faunas of Kyushu, southern Japan. These species are *Y. laudabilis*, *Y. sobrina* Takeda, *Periploma besshoense*, *Orectospira wadana*, and *T. tokunagai* (Table 13), which are representatives of the Poronaian fauna, and which in Kyushu are restricted to

Table 13. Species of the Ombetsu Group in common with other regions where the Poronaian fauna (or correlative faunas) have been recorded. 1, Machigar, northern Sakhalin (Makiyama, 1934); 2, Maoka Series (Oligocene), southern Sakhalin (Takeda, 1953; Slodkewitsch, 1967); 3, Mallenian Stage (Oligocene) of the Koryak Upland, eastern USSR (exclusive of gastropods and scaphopods; Volobueva, 1980, 1986); 4, Poronai Formation (Shimokawara, 1963; Takeda, 1953: Matsui, 1959; Nagao and Huzioka, 1941); 5, Momijiyama Formation (Shimokawara, 1963; Ohara, 1966a; Matsui, 1959; Kanno and Ogawa, 1964; Hayasaka and Uozumi, 1954); 6, Tappu Group (Ohara, 1966b); 7, Asagai Formation, Joban coal field, Northeast Japan (Kamada, 1962; and others); 8, Muro Group of the Kii Peninsula, Southwest Japan (Mizuno, 1973; Kishu Shimanto Research Group, 1976); 9, Nishisonogian Stage of Kyushu (Mizuno, 1964a).

SPECIES	1	2	3	4	5	6	7	8	9
Malletia poronaica				+		+		+	
Saccella pseudoscissurata		+							
Yoldia laudabilis	+	+		+	+	+	+	+	+
Y. sobrina				+	+	+		+	+
Portlandia watasei watasei			+	+	+	+		+	
P. watasei semiovata				+					
P. ovata				+	+	+			
P. yotsukurensis	+						+		
Acila elongata				+	+			+	
A. brevis		+		+	+	+		+	
A. kusiroensis								+	
A. picturata				+	+	+			
Delectopecten ikushyunbetsuense				+					
Propeamussium kusiroense				+		+			
Ostrea eorivularis		+							
Cyclocardia takedai		+		+					
C. poronaiensis, new name				+		+			
C. laxata	+		+		+	+	+		
C. akagii				+	+	+		+	
C. expansa		+	+	+					
C. tokudai			+	+	+	+			
C. orbica			+					+	
C. tokunagai			+	?	+		+	+	
C. ezoensis		+		+					
Conchocele bisecta		+				+	+		
Nemocardium ezoense		+							
N. yokoyamai		+				+			
N. iwakiense	+								
Profulvia harrimani	+		+			+	+		
Trachycardium kinsimarae	+								
Liocyma terrena							+		
L. furtiva	+		+				+		
Macoma sejugata	+	+				+	+		
M. optiva								+	
Mya grewingki	+	+	+			+	+		
Periploma besshoense		+	+	+	+	+	+		+
P. ezoense				+					
Cardiomya makiyamai							+		
"Minolia" funiculata				+					
Turcicula sakhalinensis		+							
Machaeroplax eos							+		
Margarites makiyamai							+		
Orectospira wadana		+		+	+	+		+	+
Turritella poronaiensis				+	+				
T. tokunagai	+						+	+	+
T. importuna	+						+		
Neverita asagaiensis	+			+	+	+	+		
Crepidula matajiroi							+		
Trominina japonica		+		+					
T. hokkaidoensis					+				
T. ishikariensis					+				
T. umbelliformis					+				
Neptunea dispar		+							
N. ezoana		+							
N. modestoidea		+		+		+			
N. ogasawarai, n. sp.							+		
Pliscofusus ishijimai							+		
Fulgoraria antiquior		+		+					
Olivella ezoana				+					
Eocylichna multistriata		+		+					
E. ezoana				+	+				
Dentalium nunomae		+		+		+			
TOTAL	11	22	10	30	19	22	20	13	5

the Nishisonogian Stage (Mizuno, 1964a).

Yoldia laudabilis was essentially a cold-water species, which lived on upper neritic fine sand bottoms, as shown by its occurrence predominantly in sandy rocks and only rarely in muddy ones in northern Japan, whereas it only occurs in muddy ones of southern Japan, being associated with cold-water species (Mizuno, 1954). In Kyushu, the molluscan fauna in sandy rocks is represented by *Crassatellites* (*Eucrassatella*) *yabei* Nagao, *Glycymeris cisshuensis* Makiyama, and *Septifer nagaoi* Oyama, as

replacements for *Y. laudabilis* that occurs in sandy strata of northern Japan (Mizuno, 1954).

Species of the Ombetsu Group in common with faunas in other regions where the Poronaian fauna (or correlative faunas) has been recorded are shown in Table 13, and a map indicating these regions is shown in Fig. 7.

FAUNAL ANALYSIS OF THE URAHORO AND OMBETSU GROUPS

In the Ombetsu district, specimens were collected in as large numbers as possible in order to understand molluscan assemblages. In most cases specimens produced several tens of individuals. In addition, the author regards material from the Tokomuro, Akan and Kamicharo districts (Coll. Yui, 1975MS; Yanagisawa, 1979MS; and Kaiho, 1977MS), as having been collected in nearly the same way, because it contains a great number of specimens and also is comprised of assemblages that are similar to those of the Ombetsu district.

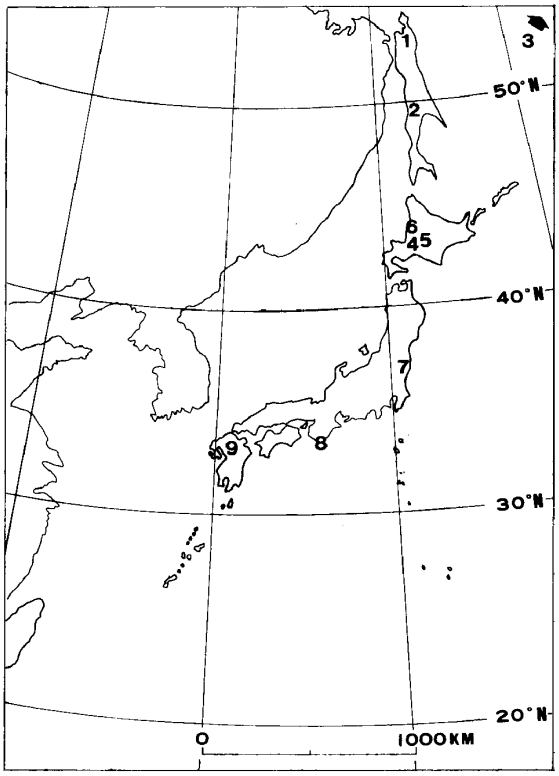


Fig. 7. Map indicating regions where the Poronaian fauna (or correlative faunas) have been recorded. For 1, 2, 3, . . ., 9, *see* Table 13.

Based on the frequency of individuals*, a total of nine molluscan assemblages are discriminated in the Urahoro Group, 11 in the Omagari Formation and nine in the Charo and Nuibetsu Formations of the Ombetsu Group (Table 18).

Honda (1986a, b) discriminated at the species level a total of nine molluscan assemblages in the Urahoro Group, 18 in the Omagari Formation and 14 in the Charo and Nuibetsu Formations. But the author has combined herein these species-defined assemblages into generic (or subgeneric) ones, because there are no essential differences between species assemblages belonging to the same genus or subgenus.

These genus-level assemblages occur repeatedly at various stratigraphic horizons. They are shown in Tables 14–17, and their stratigraphic distribution is summarized in Table 18. The frequency of individuals is represented in the following way:

VA: very abundant (20 or more individuals)
A: abundant (10 to 19 individuals)
C: common (5 to 9 individuals)
F: few (2 to 4 individuals)
R: rare (one individual)

* One individual is considered herein to consist of more than half of a separated valve or a conjoined pair of bivalves, and more than half of a complete gastropod or scaphopod specimen.

Table 14. Molluscan assemblages in the Urahoro Group. cgl, conglomerate; vc, very coarse-grained sandstone; cs, coarse-grained sandstone; fs, fine-grained sandstone; vfs, very fine-grained sandstone; sl, siltstone; ms, mudstone.

Molluscan Assemblages	Associated Species	Lithology	Localities
Corbicula assemblage (u)	Melanoides? sp., Mytilus sp., Ostrea sp.	fs	YB-01, 02, 03, 04, 05, 06, 10, 11, B, D; YBY-2; SB-02, 06, L, N; SBY-1, 2, 3, 4, 5, 6
		ms	SB-05, 07, E, J, Q, T, U
		vfs	SB-C, I, K, M, S
		cs	YB-13
		cgl	YB-B
Batissa assemblage (u)	O. eorivularis, Mytilus mabuchii, Chlamys shitakaraensis, Nemocardium ezoense, Neverita asagaiensis	fs	YB-C; YBY-1, 3, 4; B-13; SK-56, 57; B-06, 07; SK1-2; SK3-3; SB-01, 01*, 03, 04, D, F, P
		cgl	RN-02; SK-29; SB-A, B, G, H, R; SBK-11
		cs	RN-01; SB-O
Ostrea assemblage (u)	N. ezoense, Chlamys shitakaraensis, Corbicula sitakaraensis, M. mabuchii	fs	YB-09; SK-05, 19, 23, 32, 34, 35, 35*, 36, 47, 58, 59, 61; B-09; SK1-1; SK2-2, 4, 6, 11; SK3-8; SKK-3, 4, 7, 9, 10, 12, 16, 19, 21
		cgl	YB-07, 12; SK-06, 09, 20, 22, 24, 28, 30, 33, 37, 37*, 43, 44, 47, 55, 60, 62, 5729; SB-08
Nemocardium ass. (u)	Chlamys shitakaraensis, O. eorivularis, Mya grewingki kusiroensis, Periploma besshoense	fs	SK-02, 03, 07, 12, 13, 14, 15, 16, 17, 18, 38, 39, 40*, 41, 45, 46, 49, 50, 51, 52, 53, 54, A, B, C, D, E; SK2-16, 17; SKK-2, 5, 6, 11, 13, 17, 22
		cgl	SK-01, 08, 11, 40, 42
Chlamys assemblage (u)	O. eorivularis, N. ezoense	fs	SK-04, 10, 21, 26
		cgl	SK-27, 48
		vc	SK-31
Yoldia ass. (u)	Macoma sp., N. ezoense	fs	SK3-1, 2, 4, 6, 7; SKK-8
Portlandia ass. (u)	Conchocele biseca, P. besshoense, Neverita asagaiensis	vfs	SK2-13
Cyclocardia ass. (u)	Ostrea eorivularis, N. ezoense, Mya grewingki kusiroensis	vfs	SK1-3; SK2-5, 10, 12
Mya assemblage (u)	O. eorivularis, Neptunea modestoidea, Cyclocardia sp., Conchocele bisecta, Neverita asagaiensis, Portlandia watasei, Yoldia laudabilis	fs	B-05; SK2-3, 8; SK3-5
		sl	SK2-9, 15; SK3-9

I. Urahoro Group

A total of nine molluscan assemblages are discriminated at 173 localities of the Urahoro Group in the Tokomuro, Ombetsu, Kamicharo, and Akan districts (Table 14): *Corbicula* assemblage (u), *Batissa* assemblage (u), *Ostrea* assemblage (u), *Nemocardium* assemblage (u), *Chlamys* assemblage (u), *Yoldia* assemblage (u), *Portlandia* assemblage (u), *Cyclocardia* assemblage (u) and *Mya* assemblage (u). (u) following the assemblage names refers to the Urahoro Group where they are defined.

The *Corbicula* assemblage (u) is characterized by the dominant occurrence of *Corbicula* (s.s.) *tokudai* (or *C.* (s.s.) *kotakai* Honda), and is rarely associated with *Melanoides ?* sp., *Mytilus* sp., or *Ostrea* sp. This assemblage occurs in fine-grained sandstone, mudstone, very fine- and coarse-grained sandstone, and conglomerate at 35 localities of the Yubetsu and Shakubetsu Formations, where coal seams are frequently intercalated.

It is inferred that this assemblage indicates a brackish or fresh water environment, because *Corbicula* (s.s.) lives now

Table 15. Molluscan assemblages in the Omagari Formation of the Tokomuro district. cgl, conglomerate; med, medium-grained sandstone; fs, fine-grained sandstone; vfs, very fine-grained sandstone; sl, siltstone.

Molluscan Assemblages	Associated Species	Lithology	Localities
Clinocardium assemblage (O)	Portlandia watasei, Yoldia laudabilis, Cyclocardia spp., Neverita asagaiensis, Neptunea ezoana	fs vfs	OM-01, 02, 08, 29 OM-03, 15, 21, 32
Cyclocardia assemblage (O)	P. watasei, Nucula omagariensis, n. sp., Y. laudabilis, Periploma besshoense, Turritella poronaiensis, Clinocardium omagariense, Acila brevis	vfs sl	OM-04, 05, 06, 13, 16, 30 OM-26, 27
Portlandia-Yoldia assemblage (O)	Neverita asagaiensis, Clinocardium omagariense, Cyclocardia tokudai, Conchocele bisecta	fs vfs	OM-07, 17, 19, 22, 25, 28 OM-14, 24
Acila-Cyclocardia assemblage (O)	Nucula omagariensis, n. sp., Portlandia watasei	vfs sl	OM-10, 18 OM-11, 12
Conchocele assemblage (O)	Cyclocardia poronaiensis, new name Periploma besshoense	vfs	OM-09, 23
Mya assemblage (O)	.....	med	OM-31
Neptunea assemblage (O)	Neverita asagaiensis, Turritella importuna, Cyclocardia poronaiensis, new name	cgl	OM-20

Table 16. Molluscan assemblages in the Omagari Formation of the Ombetsu and Akan districts (partly the Charo and the Nuibetsu Formation). fs, fine-grained sandstone; vfs, very fine-grained sandstone; sl, siltstone.

Molluscan Assemblages	Associated Species	Lithology	Localities
Clinocardium assemblage (O′)	Trachycardium kinsimarae, Dentalium nunomae	fs sl	OMH-3, 6, 8, 9, 10, 12, G, H CH-49, NB-65
Nemocardium assemblage (O′)	.....	fs	OMH-B
Yoldia assemblage (O′)	Mya grewingki kusiroensis, Macoma sejugata, Dentalium sp.	fs	OMH-2, 4, 7, 10*, A, D, E, F
Conchocele assemblage (O′)	.....	vfs	OMH-1
Ostrea assemblage (O′)	Corbicula tokudai	fs	OMY-2, 3
Batissa assemblage (O′)	.....	fs	OMY-1

in brackish water as well as in fresh water in the Japanese Islands (Habe, 1977), and *C. tokudai* is associated with such fresh water or shallow sea dwellers as *Melanoides ?* sp., *Mytilus* sp., and *Ostrea* sp.

The *Batissa* assemblage (u) is characterized by the dominant occurrence of *Corbicula* (*Batissa*) *sitakaraensis*, and is associated with *Ostrea eorivularis*, *Mytilus mabuchii*, *Chlamys shitakaraensis*, *Nemocardium ezoense*, and *Neverita asagaiensis*. This assemblage occurs in conglomerate and fine- and coarse-grained sandstone at 28 localities of the Rushin, Yubetsu, Shitakara, and Shakubetsu Formations.

This assemblage can be considered to indicate a brackish water environment, because *Batissa* lives today in brackish water, south of the Philippines (Suzuki, 1949), and also because *C. sitakaraensis* is associated with such brackish or shallow water dwellers as *Ostrea eorivularis*,

Table 17. Molluscan assemblages in the Charo and Nuibetsu Formations of the Ombetsu and Akan districts. sl, siltstone.

Molluscan Assemblages	Associated Species	Lithology	Localities
Cyclocardia assemblage (c)	Dentalium spp., Yoldia spp., Turritella spp., Eocylichna multistriata, Orectospira wadana	sl	CH-02, 03, 04, 05, 06, 07, 10, 13, 19, 20, 26, 33, 34, 35, 39, 40, 42, 45, 47, 51, 53, 55, 58, 59, 60, 62, 63, 71, 72, 73, 79, 81, 84, 88, B, C, H; CHY-2, 5, 9, 13, 18, 20, 21, 22, 23, 24, 26, 28, 31; NB-03, 05, 09, 11, 12, 13, 22, 23, 25, 26, 30, 34, 38, 40, 42, 43, 44, 48*, 66, 68, 70, 74, 75, 79, A, H, J, R; NBY-2, 4, 8, 10, 11, 12, 13, 17
Cyclocardia-Turritella assemblage (c)	E. multistriata, Phaxas sp., Lucinoma sp., Dentalium sp.	sl	CH-21, 66, 77; NB-31, 48, 54, 71; NBY-1, 9
Turritella assemblage (c)	Dentalium spp., Cyclocardia spp., Orectospira wadana, Yoldia spp., Acila sp.	sl	CH-11, 14, 18, 22, 25, 27, 28, 29, 36, 46, 48, 50, 52, 56, 64, 65, 74, 75, 76, 87; CHY-4, 6, 7, 8, 33; NB-06, 07, 16, 17, 24, 27, 28, 29, 33, 35, 39, 41, 47, 49, 52, 60, 62, 64, 67, 72, 76, 77, D, F, d, f, h; NBY-15
Dentalium assemblage (c)	E. multistriata, Turritella sp., O. wadana, Portlandia spp., Acila sp.	sl	CH-01, 12, 15, 38, 44, 54, 57, 68, 70, 80, 82, 86, E, G; CHY-15; NB-08, 10, 15, 20, 29, 32, 46, 50, 69, B, C, E, G, K, L, N, P, Q, e
Portlandia assemblage (c)	Turritella spp., Cyclocardia spp., E. multistriata, Yoldia laudabilis	sl	CH-43, 78; CHY-11, 12, 16, 27, 29, 30, 32, 34; NB-19, 36, 61, 78, I, M, O, g
Orectospira assemblage (c)	Cyclocardia sp., Malletia poronaica, Dentalium sp.	sl	CH-09, 67, 83, 85; CHY-1; NB-01, 02, 63
Eocylichna assemblage (c)	Dentalium sp., Yoldia laudabilis	sl	CH-F; NB-04, 45, 51
Yoldia assemblage (c)	Cyclocardia ezoensis, Dentalium sp.	sl	CH-30, 32, 69; NB-21, 55

M. mabuchii, *N. ezoense*, and *Chlamys shitakaraensis*.

The *Ostrea* assemblage (u) is characterized by the dominant occurrence of *O. eorivularis* or *Ostrea* sp., and is associated with *N. ezoense*, *Chlamys shitakaraensis*, *Corbicula sitakaraensis*, and *M. mabuchii*. This assemblage occurs in conglomerate and fine-grained sandstone at 49 localities of the Yubetsu, Shitakara, and Shakubetsu Formations. There are abundant occurrences of *O. eorivularis* and *Corbicula sitakaraensis* at Loc. YB-09; very abundant *O. eorivularis* and *Mytilus mabuchii* at Loc. SK-22; rare *O. eorivularis* and *N. ezoense* at Loc. SK-32; rare *O. eorivularis*, *Chlamys shitakaraensis*, and *N. ezoense* at Loc. SK-33; and few *O. eorivularis* and *N. ezoense* at Loc. SK-35*. But the faunas of these localities are included in the *Ostrea* assemblage (u).

The *Nemocardium* assemblage (u) is characterized by the dominant occurrence of *N. ezoense*, and is associated with *Chlamys shitakaraensis*, *O. eorivularis*, *Mya grewingki kusiroensis*, and *Periploma besshoense*. This assemblage occurs in fine-grained sandstone and conglomerate at 41 localities of the Shitakara Formation. There are rare occurrences of *N. ezoense*, *Chlamys shitakaraensis*, and *Ostrea* sp. at Loc. SK-40; and rare *N. ezoense*, *Mya grewingki* (s.s), *Periploma besshoense*, and *Thracia shitakaraensis*, new species at Loc. SK-50. But the faunas of these localities are included in the *Nemocardium* assemblage

Table 18. Stratigraphic distribution of molluscan assemblages in the Urahoro and Ombetsu Groups. RN, Rushin Formation; YB, Yubetsu Fm.; SK, Shitakara Fm.; SB, Shakubetsu Fm.; OM, Omagari Fm. (or Omagari Sandstone Member of the Charo Fm.); CH, Charo Fm.; NB, Nuibetsu Fm. I, Tokomuro district; II, Ombetsu district; III, Kamicharo district; IV, Akan district.

	URAHORO GROUP											OMBETSU GROUP						
MOLLUSCAN ASSEMBLAGES	RN		YB			SK				SB			OM		CH		NB	
	II	I	II	IV	I	II	III	IV	II	III	IV	I	II	IV	II	IV	II	IV
Corbicula assemblage			+	+					+		+							
Batissa assemblage	+	+	+	+	+	+		+	+	+				+				
Ostrea assemblage			+		+	+	+	+	+					+				
Nemocardium assemblage						+	+	+					+					
Chlamys assemblage						+												
Mya assemblage					+			+				+						
Clinocardium assemblage												+	+		+		+	
Portlandia-Yoldia ass.												+						
Acila-Cyclocardia ass.												+						
Conchocele assemblage												+	+					
Neptunea assemblage												+						
Yoldia assemblage							+	+					+		+		+	
Portlandia assemblage								+							+	+	+	
Cyclocardia assemblage								+				+			+	+	+	+
Cyclocardia-Turritella ass.															+		+	+
Turritella assemblage															+	+	+	+
Dentalium assemblage															+	+	+	
Orectospira assemblage															+	+	+	
Eocylichna assemblage															+		+	

(u).

The *Chlamys* assemblage (u) is characterized by the dominant occurrence of *C. shitakaraensis*, and is associated with *O. eorivularis* and *N. ezoense*. This assemblage occurs in fine- and very coarse-grained sandstone, and conglomerate at seven localities of the Shitakara Formation. There is only one individual each of *C. shitakaraensis* and *O. eorivularis* at Loc. SK-21; few *C. shitakaraensis*, *O. eorivularis*, and *Mytilus mabuchii* at Loc. SK-26; and rare *C. shitakaraensis*, *O. eorivularis*, and *N.* sp. at Loc. SK-31. But the faunas of these localities are included in the *Chlamys* assemblage (u).

The *Ostrea*, *Nemocardium* and *Chlamys* assemblages have common occurrences of such dominant or associated species as *O. eorivularis*, *N. ezoense*, and *C. shitakaraensis*. It is inferred that these assemblages indicate an upper neritic marine environment, because *Ostrea*, *Nemocardium* and *Chlamys* live today at a maximum depth of several tens of meters (Habe, 1977).

The *Yoldia* assemblage (u) is characterized by the dominant occurrence of *Y. laudabilis*, and is associated with *Macoma* sp., *N. ezoense*, and other species. This assemblage occurs in fine-grained sandstone at six localities of the Shitakara Formation, and is restricted to the Akan and the Kamicharo district. There are abundant occurrences of *Y. laudabilis* and *Macoma* sp., at Loc. SK3-4, but the locality is considered to be within the distribution of the *Yoldia* assemblage (u).

The *Portlandia* assemblage (u) is characterized by the dominant occurrence of *P. watasei*, and is associated with *Conchocele bisecta*, *Periploma besshoense*, and *Neverita asagaiensis*. This assemblage occurs in very fine-grained sandstone at one locality of the Shitakara Formation of the Akan district.

The *Cyclocardia* assemblage (u) is characterized by the dominant occurrence of *Cyclocardia* sp., and is associated

with *Ostrea eorivularis*, *Nemocardium ezoense*, and *Mya grewingki kusiroensis*. This assemblage occurs in very fine-grained sandstone at four localities of the Shitakara Formation of the Akan district. There is only one individual each of *Cyclocardia* sp., *O. eorivularis* and *N. ezoense* at Loc. SK1-3; and one individual each of *C.* sp., *O. eorivularis* and *M. grewingki kusiroensis* at Loc. SK2-10. But the faunas of these localities are included in the *Cyclocardia* assemblage (u).

It is inferred that the *Yoldia*, *Portlandia* and *Cyclocardia* assemblages indicate a deeper sea environment than the others, because these genera live today in deeper water than *Ostrea*, *Chlamys* and associated taxa (Habe, 1977). Because of their common taxa (*Yoldia*, *Portlandia* and *Cyclocardia*), these assemblages seem to be related to the "C assemblage" of Iwasaki and Ono (1977), which is characterized by *P. watasei*, *Y. laudabilis*, *Cyclocardia tokunagai*, *Trominina japonica* (Takeda), and *Fulgoraria* (*Musashia*) *prevostiana* (Crosse), and is found on mud bottoms at a depth of about 200 m in the Setogawa stage of Central Japan.

The *Mya* assemblage (u) is characterized by the dominant occurrence of *M. grewingki kusiroensis*, and is associated with such various species as *Ostrea eorivularis*, *Neptunea modestoidea*, *Cyclocardia* sp., *Corbicula sitakaraensis*, *Macoma* sp., *Conchocele bisecta*, *Neverita asagaiensis*, *P. watasei*, and *Y. laudabilis*. This assemblage occurs in fine-grained sandstone and siltstone at seven localities of the Shitakara Formation of the Akan and Tokomuro districts. It is considered that this assemblage indicates an upper sublittoral environment, because *Mya* lives now at a maximum depth of 20 m in the Japanese Islands (Habe, 1977).

This assemblage seems to correspond to the *Mya-Turritella* assemblage, containing *T.* spp., *Mya grewingki*, *Cyclocardia tokunagai*, *Nucula* (*Ennucula*) *yotsukurensis* Hirayama, *Y. laudabilis*, *Profulvia harrimani*, *Liocyma* spp., *Margarites makiyamai* Hirayama, and *Neverita asagaiensis*, which is found in fine- to medium-grained sandstone of the Asagai Formation of the Joban coal field, Northeast Japan (Nemoto and O'Hara, 1979), because the *Mya* assemblage (u) includes taxa in common with the *Mya-Turritella* assemblage. The relationship between lithology and paleobathymetry of the molluscan assemblages is shown in Fig. 8.

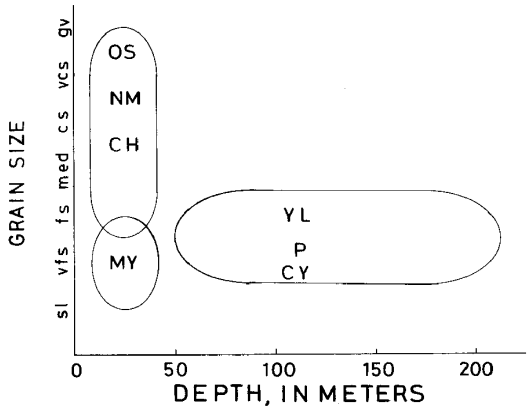


Fig. 8. Relationship between lithology and paleobathymetry of the molluscan assemblages in the Urahoro Group. OS, *Ostrea* assemblage; NM, *Nemocardium* ass.; CH, *Chlamys* ass.; MY, *Mya* ass.; YL, *Yoldia* ass.; P, *Portlandia* ass.; CY, *Cyclocardia* ass. sl, silt; vfs, very fine sand; fs, fine sand; med, medium sand; cs, coarse sand; vcs, very coarse sand; gv, gravel.

II. Ombetsu Group

1. Omagari Formation in the Tokomuro district

Seven molluscan assemblages are discriminated at 32 localities of the Omagari Formation in the Tokomuro district (Table 15): *Clinocardium* assemblage (o), *Cyclocardia* assemblage (o), *Portlandia-Yoldia* assemblage (o), *Acila-Cyclocardia* assemblage (o), *Conchocele* assemblage (o), *Mya* assemblage

(o) and *Neptunea* assemblage (o). (o) following the assemblage names refers to the Omagari Formation in the Tokomuro district where they are defined.

The *Clinocardium* assemblage (o) is characterized by the dominant occurrence of *C. omagariense*, and is associated with *Portlandia watasei*, *Yoldia laudabilis*, *Cyclocardia* spp., *Neverita asagaiensis*, and *Neptunea ezoana* Takeda. This assemblage occurs in fine- and very fine-grained sandstone at eight localities.

The *Cyclocardia* assemblage (o) is characterized by the dominant occurrence of *Cyclocardia* spp., and is associated with *P. watasei*, *Nucula omagariensis*, n. sp., *Y. laudabilis*, *Periploma besshoense*, *Turritella poronaiensis*, *Clinocardium omagariense*, and *Acila brevis*. This assemblage occurs in very fine-grained sandstone and siltstone at eight localities. Although *N. omagariensis*, n. sp. is more dominant than *Cyclocardia tokudai* at Loc. OM-06, the fauna of this locality is assigned to the *Cyclocardia* assemblage.

The *Portlandia-Yoldia* assemblage (o) is characterized by the dominant occurrence of *P. watasei* and *Y.* spp., and is associated with *Neverita asagaiensis*, *Clinocardium omagariense*, *Cyclocardia tokudai*, and *Conchocele bisecta*. This assemblage occurs in fine- and very fine-grained sandstone at eight localities. There are very abundant occurrences of *P. watasei*, *Y.* spp. and *Clinocardium omagariense* at Loc. OM-14; and very abundant *Y.* spp. and common *P. watasei* and *Neverita asagaiensis* at Loc. OM-19. But the faunas of these localities are included in the *Portlandia-Yoldia* assemblage (o).

The *Acila-Cyclocardia* assemblage (o) is characterized by the dominant occurrence of *A.* spp. (or *A. brevis*) and *Cyclocardia* spp. (or *C. laxata*), and is associated with *Nucula omagariensis*, new species, and *P. watasei*. This assemblage occurs in very fine-grained sandstone and siltstone at four localities. There is a close resemblance between the assemblages of *Clinocardium*, *Cyclocardia*, *Portlandia-Yoldia*, and *Acila-Cyclocardia*, which are characterized by the dominant or associated occurrence of *Clinocardium omagariense*, *Cyclocardia* spp., *Portlandia watasei*, *Yoldia* spp., and/or *Acila* spp. It is inferred that these assemblages indicate a sublittoral environment, because *Clinocardium* and *Yoldia* are neritic-zone inhabitants, although *Acila*, *Portlandia* and *Cyclocardia* have wide bathymetric ranges that extend from shallow to great depths (Habe, 1977).

These four assemblages seem to correspond to the "C assemblage" of the Setogawa stage (Iwasaki and Ono, 1977), which is characterized by *P. watasei*, *Y. laudabilis*, *Cyclocardia tokunagai*, *Trominina japonica*, and *Fulgoraria prevostiana*, because they have several taxa in common with the "C assemblage". Moreover, they also seem to correspond to the molluscan fauna of the Muro Group of the Kii Peninsula, Southwest Honshu, that is characterized by *Acila elongata*, *A. kushiroensis* Nagao and Huzioka, *Y. laudabilis*, and *Cyclocardia akagii* (Mizuno, 1973), because they also have several taxa in common with the Muro group.

The *Conchocele* assemblage (o) is characterized by the dominant occurrence of *C. bisecta* (*C. nipponica* (Yabe and Nomura)), and is associated with *Cyclocardia poronaiensis*, new name, and *Periploma besshoense*. This assemblage occurs in very fine-grained sandstone at two localities. It is inferred that this assemblage indicates a sublittoral environment, because *C. bisecta* lives today in neritic depths, although *Periploma* and *Cyclocardia* live in shallow to deep sea (Habe, 1977).

The *Mya* assemblage(o) is characterized by the dominant occurrence of *M. grewingki* (s.s.), and is associated with no

other molluscan species. This assemblage occurs in medium-grained sandstone at one locality. It is inferred that this assemblage indicates an upper neritic environment, because *Mya* lives today in seas at a maximum depth of 20 m in the Japanese Islands (Habe, 1977).

The *Neptunea* assemblage (o) is characterized by the dominant occurrence of *N. ezoana*, and is associated with *Neverita asagaiensis*, *Turritella importuna*, and *Cyclocardia poronaiensis*, new name. It occurs in conglomerate at one locality. It is inferred that this assemblage indicates a shallow to deep sea environment, because *Neptunea*, *Neverita*, *Turritella*, and *Cyclocardia* live today in the shallow to deep sea (Habe and Ito, 1965; Marincovich, 1977; Habe and Kosuge, 1967; Habe, 1977).

2. Omagari Formation in the Ombetsu and Akan districts

Six assemblages are discriminated at 21 localities of the Omagari Formation (and at two of the Charo and Nuibetsu Formations) in the Ombetsu (A-D below) and Akan (E-F below) districts (Table 16): A. *Clinocardium* assemblage (o′), B. *Nemocardium* assemblage (o′), C. *Yoldia* assemblage (o′), D. *Conchocele* assemblage (o′), E. *Ostrea* assemblage (o′) and F. *Batissa* assemblage (o′). (o′) following the assemblage names refers to the Omagari Formation in the Ombetsu and Akan districts where they are defined.

The *Clinocardium* assemblage (o′) is characterized by the dominant occurrence of *Clinocardium* sp., and is associated with *Trachycardium kinsimarae* (Makiyama) and *Dentalium nunomae*. This assemblage occurs in fine-grained sandstone at eight localities of the Omagari Formation, and in siltstone at two localities of the Charo and Nuibetsu Formations. There are rare occurrences of *Clinocardium* sp., *Lucinoma hannibali* (Clark), *Turritella tokunagai*, and *D. nunomae* at Loc. OMH-3; rare *Clinocardium* sp. and *Dentalium* sp. at Loc. OMH-6; few *Periploma besshoense* and rare *Clinocardium* sp. and *Turritella* sp. at Loc. OMH-10; rare *Clinocardium* sp., *Macoma sejugata*, and *Neptunea* sp. at Loc. OMH-H; and rare *Clinocardium* sp., *Cyclocardia* sp., and *Turritella* sp. at Loc. NB-65. But the faunas of these localities are included in the *Clinocardium* assemblage. It is inferred that this assemblage indicates a sublittoral environment, because *Clinocardium* lives today in shallow seas, although, *Turritella*, *Dentalium*, *Periploma* and *Cyclocardia* are shallow to deep water inhabitants (Habe, 1977; Habe and Kosuge, 1967).

The *Nemocardium* assemblage (o′) is characterized by the rare occurrence of *N. ezoense*, and is associated with no other molluscan species. This assemblage occurs in fine-grained sandstone at one locality. This assemblage may indicate a sublittoral environment, because *Nemocardium* lives today in shallow seas (Habe, 1977).

The *Yoldia* assemblage (o′) is characterized by the dominant occurrence of *Y. laudabilis* (or *Y. sobrina*), and is associated with *Mya grewingki kusiroensis*, *Macoma sejugata*, and *Dentalium* sp. This assemblage occurs in fine-grained sandstone at eight localities. Although there are common occurrences of *Y. laudabilis* and *M. grewingki kusiroensis* at Loc. OMH-D, and few *Y. laudabilis* and *Neverita asagaiensis* at Loc. OMH-10*, the faunas of these localities are included in the *Yoldia* assemblage. It is inferred that this assemblage indicates a shallow sea environment, because *Y. laudabilis* lived on upper neritic fine sand bottoms in northern Japan (Mizuno, 1954), although *Yoldia*, *Mya*, *Macoma* and *Dentalium* live today in the shallow to deep sea (Habe, 1977).

The *Conchocele* assemblage (o′) is char-

acterized by the dominant occurrence of *C. bisecta*, and is associated with no other molluscan species. This assemblage occurs in very fine-grained sandstone at one locality. It is inferred that this assemblage indicates a shallow sea environment, because *C. bisecta* lives today at depths of 4 to 139 m (Habe, 1977).

The *Ostrea* assemblage (o′) is characterized by the dominant occurrence of *O. eorivularis*, and is associated with *Corbicula tokudai*. This assemblage occurs in fine-grained sandstone at two localities. It is inferred that this assemblage indicates a tidal or upper neritic environment, because *Ostrea* lives now in the tidal zone or in upper neritic depths (Habe, 1977).

The *Batissa* assemblage (o′) is characterized by the dominant occurrence of *Corbicula (Batissa) sitakaraensis*, and is associated with no other molluscan species. This assemblage occurs in fine-grained sandstone at one locality. It is inferred that this assemblage indicates a brackish water environment, because *Batissa* lives now in brackish waters of Southeast Asia (Suzuki, 1949).

3. Charo and Nuibetsu Formations

A total of eight assemblages are discriminated at 217 localities of the Charo and Nuibetsu Formations in the Ombetsu and Akan districts (Table 17): *Cyclocardia* assemblage (c), *Cyclocardia-Turritella* assemblage (c), *Turritella* assemblage (c), *Dentalium* assemblage (c), *Portlandia* assemblage (c), *Orectospira* assemblage (c), *Eocylichna* assemblage (c) and *Yoldia* assemblage (c). (c) following the assemblage names refers to the Charo and Nuibetsu Formations where they are defined.

The *Cyclocardia* assemblage (c) is characterized by the dominant occurrence of *Cyclocardia* sp., and is associated with *Dentalium* spp., *Yoldia* spp., *Turritella* spp., *Eocylichna multistriata*, and *Orectospira wadana*. This assemblage occurs in siltstone at 50 localities of the Charo, and 36 of the Nuibetsu Formation. *Cyclocardia* spp. occur in the same frequency as other species (i.e., not dominant) at Locs. CH-03, 19, 35, 45, 55, C; CHY-2, 13, 31; NB-03, 05, 11, 22, 66, 74, 79, H, R; and NBY-8, but the faunas of these localities are included in the *Cyclocardia* assemblage (c). The *Cyclocardia-Turritella* assemblage (c) is characterized by the dominant occurrence of *Cyclocardia* spp. and *Turritella* spp., and is rarely associated with *Eocylichna multistriata*, *Phaxas* sp., *Lucinoma* sp., and *Dentalium* sp. This assemblage occurs in siltstone at three localities of the Charo, and six of the Nuibetsu Formation. Although there are few occurrences of *Cyclocardia* sp., *Turritella* sp. and *Dentalium* sp. at Loc. NB-31, the fauna of this locality was included in the *Cyclocardia-Turritella* assemblage (c).

The *Turritella* assemblage (c) is characterized by the dominant occurrence of *Turritella* spp., and is associated with *Dentalium* spp., *Cyclocardia* spp., *Orectospira wadana*, *Yoldia* spp., and *Acila* sp. This assemblage occurs in siltstone at 25 localities of the Charo Formation, and 28 localities of the Nuibetsu Formation. *Turritella* spp. occur with the same frequency as other species at Locs. CH-14, 29, 36; CHY-6, 33; NB-27, 35, 39, 49, f; and NBY-15, but the faunas of these localities are included in the *Turritella* assemblage (c).

The *Dentalium* assemblage (c) is characterized by the dominant occurrence of *Dentalium* sp. (or *D. nunomae*), and is associated with *Eocylichna multistriata*, *Turritella* sp., *Orectospira wadana*, *Portlandia* spp., and *Acila* sp. This assemblage occurs in siltstone at 15 localities of the Charo Formation, and 19 of the Nuibetsu Formation. *Dentalium* sp. (or *D. nunomae*) occurs with the same frequency as other species at Locs. CH-86; NB-10, 69, B, C, L, and Q. There

are few *Lucinoma* sp., and rare *Dentalium* sp. and *Eocylichna multistriata* at Loc. NB-K. Still the faunas of these localities are included in the *Dentalium* assemblage (c).

The *Portlandia* assemblage (c) is characterized by the dominant occurrence of *Portlandia* spp., and is associated with *Turritella* spp., *Cyclocardia* spp., *E. multistriata*, and *Yoldia laudabilis*. This assemblage occurs in siltstone at ten localities of the Charo Formation, and eight localities of the Nuibetsu Formation. *Portlandia watasei* (s.s.) occurs with the same frequency as other species at Locs. NB-78 and NB-0, but the faunas of these localities are included in the *Portlandia* assemblage (c).

The *Orectospira* assemblage (C) is characterized by the dominant occurrence of *O. wadana*, and is associated with *Cyclocardia* sp., *Malletia poronaica* (Yokoyama), and *Dentalium* sp. This assemblage occurs in siltstone at five localities of the Charo Formation, and three localities of the Nuibetsu Formation. *Orectospira wadana* occurs with the same frequency as *Trominina japonica* (Takeda) at Loc. CH-85, *M. poronaica* at Loc. NB-01, and as *Molopophorus kusiroensis* Takeda at Loc. NB-63, but the faunas of these localities are included in the *Orectospira* assemblage (c).

The *Eocylichna* assemblage (c) is characterized by the dominant occurrence of *E. multistriata*, and is associated with *Dentalium* sp. and *Yoldia laudabilis*. This assemblage occurs in siltstone at one locality of the Charo Formation and three localities of the Nuibetsu Formation. The *Yoldia* assemblage (c) is characterized by the dominant occurrence of *Yoldia* spp., and is associated with *Cyclocardia ezoensis* and *Dentalium* sp. This assemblage occurs in siltstone at three localities of the Charo Formation, and two localities of the Nuibetsu Formation. *Yoldia laudabilis* occurs with the same frequency as *Crenella nuibetsuensis*, n. sp., at Loc. CH-30, but the fauna of this locality is included in the *Yoldia* assemblage (c).

All the assemblages discriminated in the Charo and Nuibetsu Formations, described above, are characterized by the dominant or associated occurrence of *Cyclocardia* spp., *Turritella* spp., *Dentalium* spp., *Portlandia* spp., *Orectospira wadana*, *Eocylichna multistriata*, and/or *Yoldia* spp. It is inferred that the assemblages variously indicate lower sublittoral to bathyal environments, based on the occurrence of these genera today in shallow to deep seas (Habe, 1961, 1977; Habe and Kosuge, 1967; Urata, 1961).

These northern Japanese assemblages from eastern Hokkaido seem to correspond to the molluscan fauna of the Muro Group of the Kii Peninsula, southwest Honshu, which are characterized by *Acila elongata*, *A. kusiroensis*, *Y. laud-*

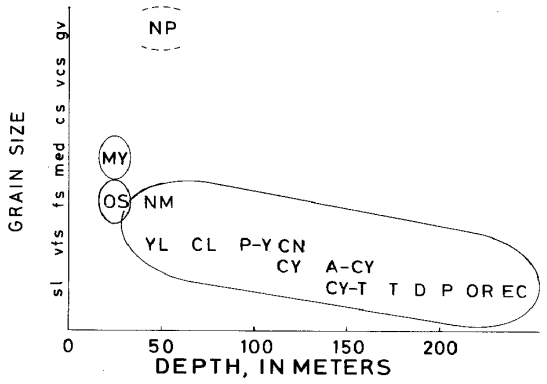


Fig. 9. Relationship between lithology and paleobathymetry of the molluscan assemblages in the Ombetsu Group. NP, *Neptunea* assemblage; MY, *Mya* ass.; OS, *Ostrea* ass.; NM, *Nemocardium* ass.; YL, *Yoldia* ass.; CL, *Clinocardium* ass.; P-Y, *Portlandia-Yoldia* ass.; CY, *Cyclocardia* ass.; A-CY, *Acila-Cyclocardia* ass.; CN, *Conchocele* ass.; CY-T, *Cyclocardia-Turritella* ass.; T, *Turritella* ass.; D, *Dentalium* ass.; P, *Portlandia* ass.; OR, *Orectospira* ass.; EC, *Eocylichna* ass. For sl, ..., gv, *see* Fig. 8.

abilis, *P. watasei*, *Cyclocardia akagii*, *O. wadana*, and *Turritella tokunagai* (Mizuno, 1973), and include several taxa in common. These eastern Hokkaidan assemblages also seem to correspond to the "C assemblage" of Iwasaki and Ono (1977), which is characterized by *P. watasei*, *Y. laudabilis*, *Cyclocardia tokunagai*, *Trominina japonica*, and *Fulgoraria prevostiana* in the Setogawa stage of Central Japan, and includes several taxa in common. The relationship between lithology and paleobathymetry of these Ombetsu Group molluscan assemblages is shown in Fig. 9.

Shuto and Shiraishi (1971) recorded a total of 11 molluscan assemblages from the Ashiya Group (Oligocene, Nishi-

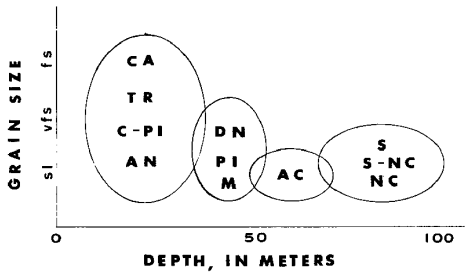


Fig. 10. Relationship between lithology and paleobathymetry of the molluscan assemblages in the Kishima Formation. CA, *Cardium* assemblage; TR, *Turritella* ass.; C-PI, *Cardium-Pitar* ass.; AN, *Angulus* ass.; DN, *Dentalium* ass.; PI, *Pitar* ass.; M, Mixed ass.; AC, *Acila* ass.; S, *Saccella* ass.; S-NC, *Saccella-Nucula* ass.; NC, *Nucula* ass. For fs, vfs, sl, *see* Fig. 8 (From Inoue, 1972).

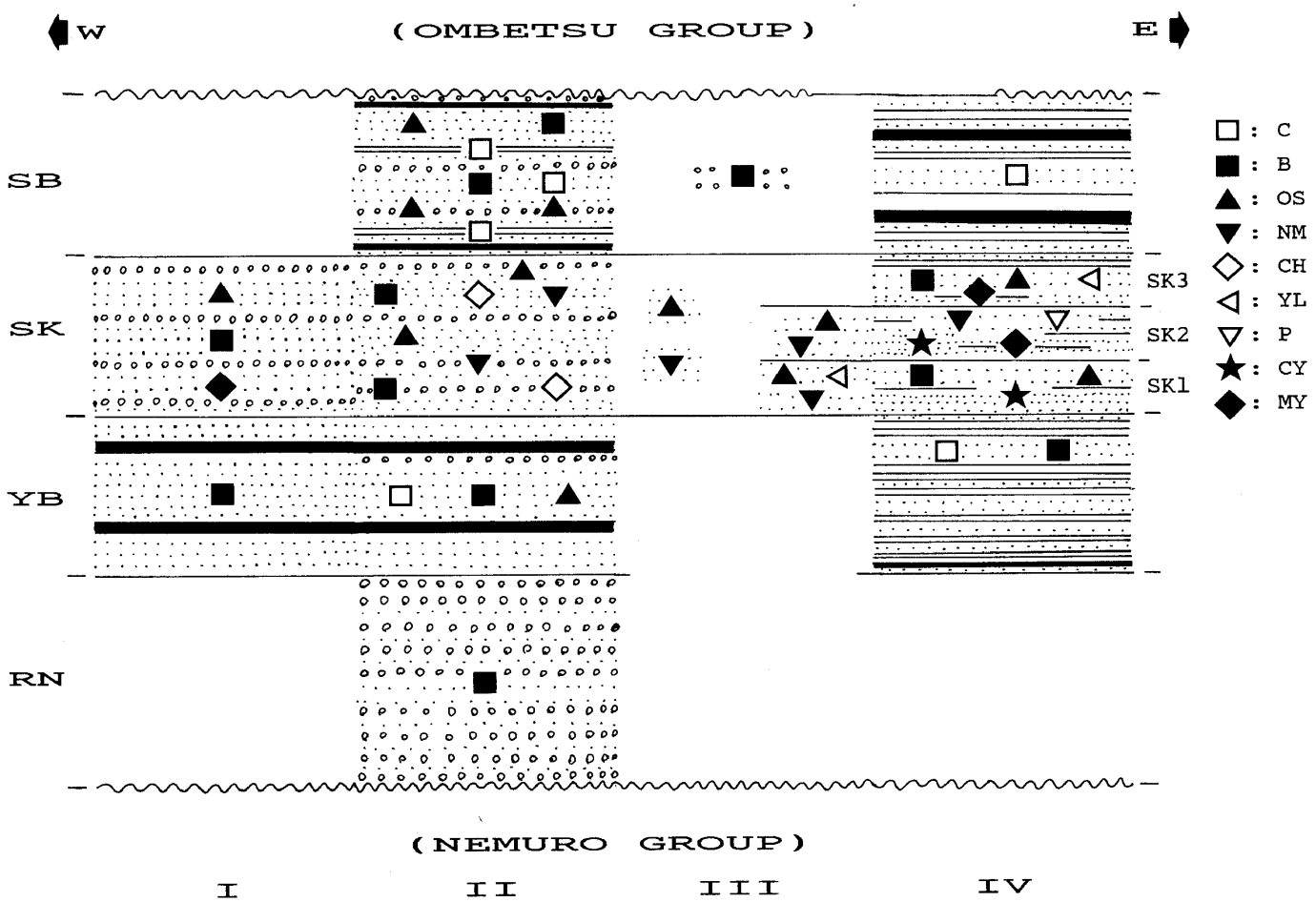


Fig. 11. Schematic vertical and lateral distribution of molluscan assemblages in the Urahoro Group. For OS, NM, ..., CY, MY, *see* Fig. 8. C, *Corbicula* assemblage; B, *Batissa* ass. For RN, YB, SK, SB, I, II, III, IV, *see* Table 18. SK1, SK2 and SK3; lower, middle and upper parts of the Shitakara Formation, respectively.

sonogian Stage) of Kyushu, southern Japan: 1) *Angulus maximus*, 2) *A. maximus-Phaxas izumoensis*, 3) *A. maximus-Lucinoma nagaoi*, 4) *L. nagaoi*, 5) *Solen connectens*, 6) *Dosinia chikuzenensis*, 7) *Glycymeris cisshuensis*, 8) *G. cisshuensis-Pitar matsumotoi*, 9) *Diloma* sp.-*Venericardia subnipponica*, 10) *V. subnipponica-Acila ashiyaensis*, and 11) *A. ashiyaensis-Portlandia* sp. In addition, Inoue (1972) recorded a total of 12 molluscan assemblages from the Kishima Formation (Oligocene) of Kyushu: 1) *Nucula*, 2) *Saccella*, 3) *Saccella-Nucula*, 4) *Pitar*, 5) *Cardium*, 6) *Cardium-Pitar*, 7) Mixed, 8) *Angulus*, 9) *Dentalium*, 10) *Acila*, 11) *Turritella*, and 12) *Ostrea*. Furthermore, Fuse and Kotaka (1986) recorded a total of eight molluscan assemblages from the Hioke Group (late Oligocene or early Miocene) of Yamaguchi Prefecture, southwest Honshu: 1) *Venericardia-Acila*, 2) *Venericardia-Periploma*, 3) *Venericardia*, 4) *Glycymeris-Dosinia*, 5) *Meretrix-Spisula*, 6) *Siliqua*, 7) *Crassostrea*, and 8) *Corbicula*.

Conseqently, the molluscan assemblages of the Urahoro and the Ombetsu Group are very different from those of Kyushu and Yamaguchi Prefecture, southern Japan, in both generic and specific composition. The relationship between lithology and paleobathymetry of the assemblages of the Kishima Formation (Inoue, 1972) is shown in Fig. 10. Schematic vertical and lateral distribution of the molluscan assemblages from the Urahoro and the Ombetsu Group are shown in Figs. 11 and 12.

The above descriptions of the molluscan assemblages and their environments of the Urahoro and the Ombetsu Group are summarized below. The Rushin

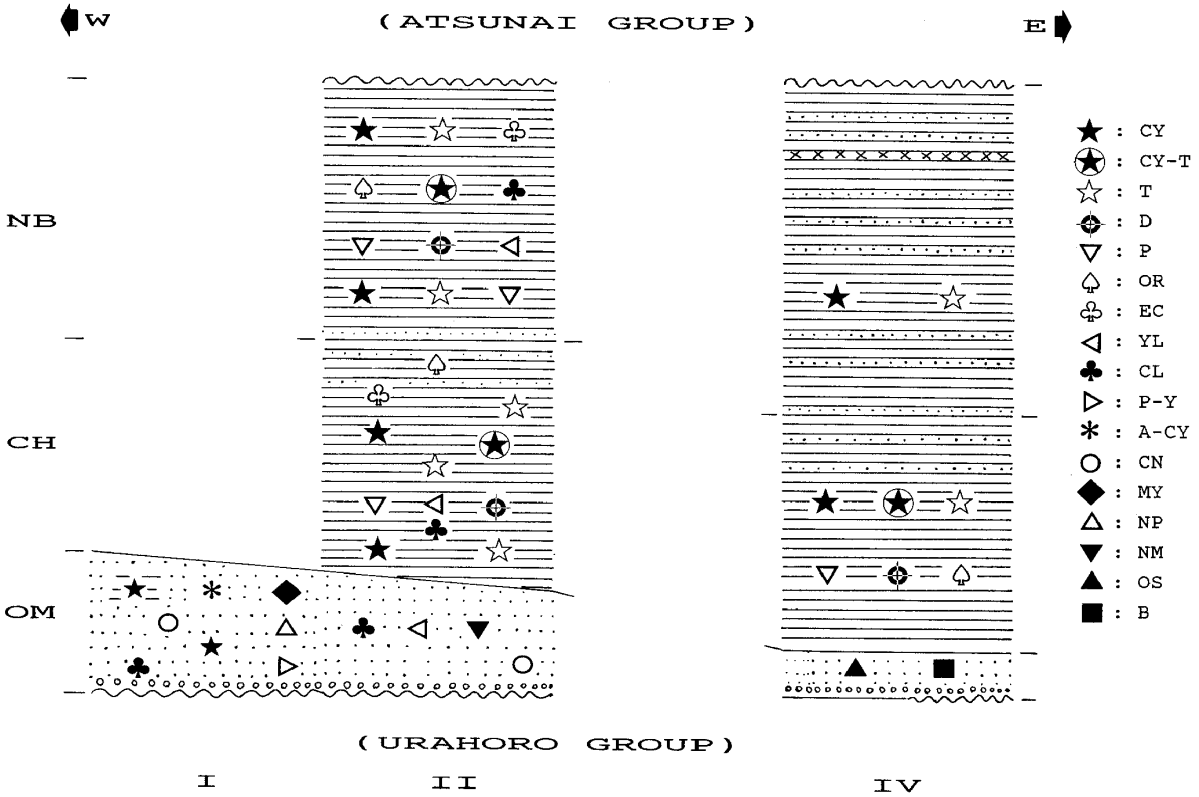


Fig. 12. Schematic vertical and lateral distribution of molluscan assemblages in the Ombetsu Group. For CY, CY-T, ..., NM, OS, *see* Fig. 9. B, *Batissa* assemblage. For OM, CH, NB, I, II, IV, *see* Table 18.

Formation only yields *Mytilus mabuchii*, *Ostrea eorivularis* and *Corbicula* (*Batissa*) *sitakaraensis*, indicating upper neritic or brackish-water environments. The Yubetsu Formation yields *Corbicula* (s.s.) *tokudai*, *C. sitakaraensis*, and *O. eorivularis*, indicating fresh-, brackish-water or upper neritic marine environments.

In contrast, the Shitakara Formation of the Urahoro Group yields very numerous and diverse assemblages, indicating upper neritic marine or brackish-water environments, and also includes the assemblages of *Yoldia*, *Portlandia* and *Cyclocardia*, indicating deeper marine environments than the others. These assemblages are restricted to the Akan and the eastern part of the Kamicharo district, where the formation gets finer in grain size and thicker than in the Ombetsu and Tokomuro districts (Matsui, 1962). The Shakubetsu Formation yields *C. tokudai*, *C. sitakaraensis*, and *O. eorivularis*, indicating fresh-, brackish-water or upper neritic marine environments.

The Charo and Nuibetsu Formations yield molluscan assemblages indicating sublittoral to upper bathyal environments, as well as foraminiferal assemblages indicating shallow to deep sea environments (Uchio, 1965). The Omagari Formation yields molluscan assemblages indicating a neritic marine environment, except for the assemblages of *Ostrea* and *Batissa* that indicate subtidal or brackish-water environments, from the Akan district, where the strata are only 6 to 60 m in thickness.

CLIMATIC IMPLICATIONS

As already stated, there are many cold-water genera in the Urahoro and Ombetsu Groups, including *Portlandia*, *Yoldia*, *Cyclocardia*, *Mya*, *Neptunea*, *Buccinum*, *Clinocardium*, *Conchocele*, *Liocyma*, and *Margarites*, which are widespread at present in the northern Pacific. In addition, *Neverita* (*Neverita*) is essentially a northern temperate subgenus and lives in temperate and arctic waters of the eastern Pacific and elsewhere (Marincovich, 1977). However, there are a few warm-water (tropical or subtropical) taxa in the Urahoro and Ombetsu Groups, including *Geloina* cf. *G. takaoi*.

Modern latitudinal distributions of the Urahoro and Ombetsu molluscs around the Japanese Islands are shown in Tables 19, 20 and Fig. 13. It is notable that, among 64 genera (and subgenera) of Urahoro and Ombetsu molluscs, 39 occur in the seas off (or in nonmarine waters of) the Amami Islands and southward (region I, herein); 57 occur from Kyushu to the Boso Peninsula of Honshu (region II); 52 occur from Northeast Honshu to Hokkaido (region III); and 38 occur in the Sea of Okhotsk and northeastward (region IV). Therefore, a great majority of Urahoro and Ombetsu genus-level taxa have modern equivalents living in modern regions II and III.

The above four regions have been subdivided into various marine climatic zones (or provinces) by several workers; for example: the tropical, subtropical, warm temperate, temperate, sub-frigid, and frigid zones of Inoue (1972); the inner tropical, outer tropical, warm temperate, mild temperate, cool temperate, and cold zones of Hall (1964); and, the subtropical, warm temperate, mild temperate, cool temperate, and subpolar zones of Nishimura (1981). The Urahoro and Ombetsu faunas are considered to the temperate from an overall aspect. The faunas have much more numerous cold-water genera than tropical or subtropical ones, and so they are neither tropical nor boreal ones. This conclusion is consistent with the occurrences of

Table 19. Modern latitudinal distributions of northwestern Pacific bivalves in the Urahoro and Ombetsu faunas (*Adapted from*: Habe, 1977; Suzuki, 1949; Kosuge, 1979; Habe and Ito, 1965; Kuroda, Habe and Oyama, 1971). I, the Amami Islands and areas to the southward; II, Kyushu to the Boso Peninsula of Honshu; III, Northeast Honshu to Hokkaido; IV, Sea of Okhotsk and areas to the northeastward.

GENERA (SUBGENERA)	I	II	III	IV
Acharax		*	*	*
Malletia	*	*		
Saccella	*	*		
Yoldia	*	*	*	*
Portlandia	*	*	*	*
Megayoldia			*	*
Ennucula		*	*	*
Acila	*	*	*	*
Crenella		*	*	*
Mytilus	*	*	*	*
Modiolus	*	*	*	*
Brachidontes	*	*		
Delectopecten	*	*	*	*
Propeamussium	*	*		
Chlamys	*	*	*	*
Acesta	*	*	*	
Ostrea	*	*	*	
Margaritifera		*	*	*
Anodonta			*	*
Cyclocardia		*	*	*
Geloina	*			
Batissa	*			
Corbicula	*	*	*	*
Lucinoma		*	*	*
Conchocele		*	*	*
Nemocardium	*	*		
Keenaea	*	*	*	
Clinocardium		*	*	*
Profulvia	*	*	*	
Callista	*	*	*	*
Liocyma			*	*
Clementia	*	*		
Mactra	*	*	*	*
Mactromeris	*	*	*	*
Macoma		*	*	*
Peronidea		*	*	*
Siliqua	*	*	*	*
Phaxas	*	*		
Solen	*	*	*	*
Mya		*	*	*
Myadora	*	*	*	
Periploma	*	*		
Thracia			*	*
Cardiomya	*	*	*	*
TOTAL	29	38	34	29

Table 20. Modern latitudinal distributions of northwestern Pacific gastropods and scaphopods in the Urahoro and Ombetsu faunas (*Adapted from*: Higo, *ed.*, 1973: Kuroda and Habe, 1952; Habe, 1977; Kuroda, 1963; Habe and Ito, 1965; Habe and Kosuge, 1967). For I, ...IV, *see* Table 19.

GENERA (SUBGENERA)	I	II	III	IV
Minolia		*	*	*
Machaeroplax		*	*	*
Ginebis	*	*	*	
Margarites		*	*	*
Sinotaia		*	*	
Cipangopaludina		*	*	
Orectospira		*		
Turritella	*	*	*	*
Semisulcospira	*	*	*	*
Melanoides	*			
Cerithidea	*	*	*	
Crepidula		*	*	*
Neptunea		*	*	*
Siphonalia	*	*	*	
Buccinum		*	*	*
Fulgoraria	*	*	*	
Olivella	*	*	*	
Eocylichna	*	*	*	
Cylichna		*	*	*
Dentalium	*	*	*	
TOTAL	10	19	18	9

warm-temperate to temperate floras from the Urahoro Group (Tanai, 1970), a pollen flora from the Beppo Formation that is comparable with that of the modern deciduous forest zones of central Honshu (Okazaki, 1957), and a cool-temperate pollen flora from the Ombetsu Group (Sato, 1984).

PALEOBIOGEOGRAPHY

As mentioned above, the Urahoro and Ombetsu Groups yield only a few species in common with Paleogene faunas of the Nishisonogian Stage of Kyushu, southern Japan (Table 13). However, as shown in Table 21, there are many species in the

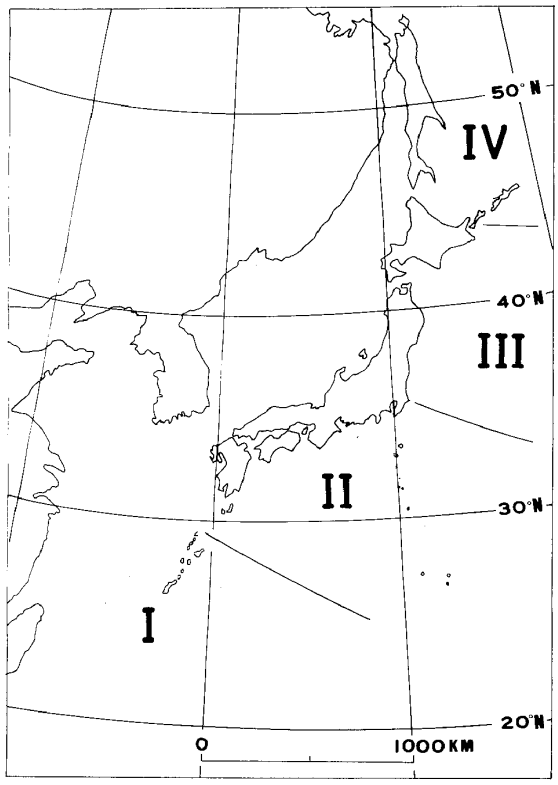


Fig. 13. Map of Japan indicating biogeographic provinces of living molluscan genera and subgenera. For I, II, III, and IV, *see* Table 19.

Urahoro and Ombetsu faunas that have Eocene to Recent records in the North Pacific region: Japan, Sakhalin, Kamchatka, the Koryak Upland of eastern USSR, Alaska, and Northwest America.

It is notable that there are more Oligocene species in common among Japan, Sakhalin, Kamchatka, and the Koryak Upland than among Japan, Alaska and Northwest America. Moreover, there are many Oligocene bivalve species in the Koryak Upland in common with those of Japan and Sakhalin, including *Nucula yotsukurensis* Hirayama, *Malletia inermis* (Yokoyama), *Yoldia caudata* Khomenko, *Portlandia watasei*, *P. tokunagai*, *Lucinoma acutilineata* (Conrad), *Cyclocardia tokunagai*, *Profulvia harrimani*, *Clinocardium asagaiense* (Makiyama), *Liocyma furtiva* (Yokoyama), *Mya grewingki* (s.l.), and *Periploma besshoense* (Volobueva, 1980). But, there are only a few Oligocene bivalves which are common to these areas and Northwest America, including *Conchocele clarki* (Krishtofovich) and *Thracia condoni* (Dall) (Volobueva, 1980).

In contrast, there are no Eocene bivalves in the Koryak Upland in common with those of Japan and Sakhalin (Volobueva, 1980). However, many are common to both the Koryak Upland and Northwest America, including *Acila* (*Truncacila*) *decisa* (Conrad), *Modiolus* cf. *ornatus* Gabb, *Venericardia* (*Pacificor*) *hornii* Gabb, *Eucrassatella stillwaterensis* (Weaver and Palmer), *Spisula rushi aragoensis* Turner, *S. acutirostrata* Packard, *Solen* (*Eosolen*) *eugenensis* Clark, *Tivela crowderi* (Weaver), *T. aragoensis* (Turner), and *Eucrassatella perrini* (Dickerson) (Volobueva, 1980).

These occurrences are consistent with the view that there were two zoogeographic provinces in Japan and adjacent regions during Paleogene time: the Northeast (North) Japan-Okhotsk and the Formosa-Southwest (West) Japan Province, and that it was cooler in the former province than in the latter (Mizuno, 1965, 1977). This paleobiogeographic division is also shown by the distribution of the Paleogene Naticidae of Japan (Honda, 1983), and by Paleogene floral occurrences of Japan (Tanai and Huzioka, 1967).

It is also notable that Poronaian molluscs are present in several Paleogene faunas in central and western Japan. For instance, Matsumoto (1964) described such Poronaian bivalves as *Yoldia laudabilis*, *Portlandia yotsukurensis* Uozumi, *Cyclocardia tokudai*, *Liocyma furtiva*, and *Periploma besshoense*, from the Ôga Formation of Shizuoka Prefecture, Central Japan. In addition, Iwasaki and Ono (1977) described a molluscan fauna from the Setogawa Group of Shizuoka Prefecture that is allied to the Asagai-Poronai fauna.

Table 21. Occurrences in the northern Pacific region of molluscs from the Urahoro and Ombetsu Groups. E, Eocene; O, Oligocene; M, Miocene (to Pleistocene); R, Recent; EO, Eocene and Oligocene?; E′, Eocene or Oligocene; O′, late Oligocene or earliest Miocene. °, compared species; #, occurrences of *D. peckhami* (*see* Masuda, 1962; Slodkewitsch, 1938b; Kanno, 1971), or *C. asagaiense* (*see* Makiyama, 1934; Kafanov and Savitsky, 1982; Devyatilova and Volobueva, 1981; Hirayama, 1973; O'Hara and Nemoto, 1983). *, *see* Honda (1981), Devyatilova and Volobueva (1981). **, *see* Oyama, Mizuno and Sakamoto (1960), Masuda and Noda (1976), MacNeil (1965).

SPECIES (GENERA OR SUBGENERA)	JAPAN				SAKHALIN				KAMCHATKA				ALASKA					NW AMERICA			
	E	O	M	R	E	O	M	R	E	O	M	R	E′	O	O′	M	R	EO	O	M	R
Solemya dalli		°	+		+	+	+		+					+					+		
Malletia poronaica		+	+						+												
Saccella pseudoscissurata		+				+															
Yoldia laudabilis		+	+			+															
Portlandia watasei		+	+			+	+		+	+	+										
P. yotsukurensis		+				+															
P. thraciaeformis		+	+	+			+	+			+	+					+				+
Acila praedivaricata		°				+				+											
A. brevis		+	+			+															
Delectopecten ikushyunbetsuense		#	#							#	#									#	
Ostrea eorivularis	+	+				+															
Cyclocardia takedai		+				+															
C. laxata		+	+			+				+											
C. expansa		+				+				+											
C. tokudai		+								+											
C. orbica		+	+							+											
C. tokunagai		+	+							+	+				°						
C. ezoensis		+				+	+		+	+				+							
Corbicula sitakaraensis*		+				+				+											
Batissa**		+	+			+				+								+			
Lucinoma hannibali		+	+																+		
Conchocele bisecta		+	+	+			+			+	+	?					?			+	+
C. nipponica		+	+				+														
Clinocardium omagariense		#				#				#											
Nemocardium ezoense		+				+															
N. yokoyamai		+				+															
N. iwakiense		+				+				+											
Trachycardium kinsimarae		+				+															
Profulvia harrimani		+	+			+				+	+		+								
Liocyma furtiva		+	+			+				+	+										
Macoma sejugata		+	+			+															
M. optiva		+	+				+				+				°	+				+	
Mya grewingki (s. s.)		+	+			+				+				°	+						
Mya grewingki kusiroensis		+												+					+		
Periploma besshoense	+	+	+			+	+			+	+			+	+	+					
Turcicula sakhalinensis		+				+															
Cipangopaludina**		+	+	+										+							
Orectospira wadana		+	?			+			+												
Turritella poronaiensis		+								+											
T. tokunagai		+	+			+															
T. importuna		+				+															
Neverita asagaiensis		+				+															
Trominina japonica		+								+											
T. hokkaidoensis		+								+											
Neptunea dispar		+				+															
N. ezoana		+				+															
N. modestoidea		+				+				+											
Fulgoraria antiquior		+	+			+															
Eocylichna multistriata	+	+				+															
Dentalium nunomae		+	+			+															
TOTAL	3	50	24	3	1	35	8	1	5	22	9	1	1	6	4	2	1	1	3	3	2

However, Matsumoto (1971) reported *Pitar matsuraensis* (Nagao) from the Setogawa Group, which is also known in the Funazuan and Mazean Stages (Oligocene) of Kyushu (Mizuno, 1964a).

Furthermore, there are many Poronaian molluscs in the Muro Group of the Kii Peninsula, southwest Honshu, including *Malletia poronaica*, *Acila elongata*, *A. kusiroensis*, *Y. laudabilis*, *Y. sobrina*, *Portlandia watasei*, *Cyclocardia akagii*, *C. tokunagai*, *Orectospira wadana*, and *Turritella tokunagai* (Mizuno, 1973). Katto and Masuda (1978) also described such Poronaian molluscs as *P. watasei* and *Neverita asagaiensis* from the Tanami Formation (Oligocene), which unconformably overlies the "Upper Muro Group."

From the Shijujiyama Formation (late Oligocene to early Miocene) of Shikoku, Taira *et al.* (1980) recorded such Poronaian bivalves as *Y. laudabilis*, *P. watasei* and *Cyclocardia takedai* (Honda), as well as *Venericardia* (*Venericor?*) *subnipponica* (Nagao), which is restricted to the Mazean and Nishisonogian Stages (Oligocene) of Kyushu (Mizuno, 1964a). Matsumoto and Terashima (1976) also described such Poronaian bivalves as *Periploma besshoense* and *Liocyma furtiva* from the Muroto Formation of Shikoku.

These faunas from central and western Japan belong to the Formosa-Southwest (West) Japan Province according to Mizuno (1965, 1977), but they are regarded here as transitional faunas that are situated between the Northeast (North) Japan-Okhotsk and the Formosa-Southwest (West) Japan Province. Iwasaki and Ono (1977) also regarded the Setogawa Group as being situated in a faunal transitional area between Hokkaido and Kyushu.

It is worth pointing out that several genera in the Urahoro and Ombetsu faunas evidently originated during the late Eocene or Oligocene in Japan and Sakhalin. These are *Neptunea* (*fide* Nelson, 1978), *Clinocardium* (*fide* Kafanov, 1974), and *Mya* (*fide* MacNeil, 1965). These genera are now widespread throughout the northern Pacific. This suggests that other taxa might have migrated eastward from the northwestern Pacific to Alaska and Northwest America. This paleobiogeographic relationship is evidenced in the northeastern Pacific, where Paleogene molluscan faunas in the western Gulf of Alaska contain 25% Asiatic species, whereas coeval faunas in the eastern Gulf of Alaska contain only 12% Asiatic species (Marincovich and McCoy, 1984).

FAUNA AND CORRELATION

Many genera and subgenera in the Urahoro and Ombetsu Groups are also commonly found in Neogene strata of Japan: *Hataiella*, *Fulgoraria*, *Yoldia*, *Portlandia*, *Acila* (s.s.), *Cyclocardia*, *Lucinoma*, and *Clinocardium*. These taxa also appeared in the Nishisonogian Stage (Oligocene) of Kyushu (Mizuno, 1962b). In addition, *Clinocardium* and *Neptunea* are considered to have originated during the Oligocene in North Japan and Sakhalin (Kafanov, 1974; Nelson, 1978). Also *Mya* (*?Arenomya*) *ezoensis* Nagao and Inoue from the Wakkanabe Formation (Eocene) of the lower part of the Ishikari Group is the earliest known *Mya* (MacNeil, 1965).

Maiya, Akiba and Ichinoseki (1981b) recorded foraminiferal fossils from the Kamicharo Formation, which is correlative with the Tokomuro Formation of the Atsunai Group, and assigned the strata a late Eocene to early Oligocene age. On the other hand, Kaiho (1983) recorded planktonic foraminifera from the upper part of the Kamicharo Forma-

tion and related them with the *Globorotalia opima* zone or P21 (late Oligocene) of Blow (1979). However, the Tokomuro and Atsunai Formations of the Atsunai Group yield Miocene molluscs (Mizuno, Sumi and Yamaguchi, 1969; Amano, 1983), and the Atsunai Group does not range down into the Paleogene according to molluscan evidence (Honda, 1984). Taken together, these various lines of molluscan evidence suggest that the Urahoro and Ombetsu faunas should be assigned an Oligocene age rather than an Eocene age.

This conclusion is consistent with the occurrence of Oligocene floras from the Urahoro Group (Tanai, 1970; latest Eocene to Oligocene; Tanai, 1986, *oral commun.*), and with the presence of late Oligocene silicoflagellates in the Nuibetsu Formation (Sawamura and Otowa, 1979), although Kaiho (1984a, b) assigned the Urahoro and Ombetsu Groups a late Eocene to early Oligocene age.

As shown in Table 13, there are many species from the Ombetsu Group that also occur in several other Paleogene faunas of Hokkaido and Honshu. For instance, a total of 67 species have been recorded from the Poronai Formation of central Hokkaido (Shimokawara, 1963; Takeda, 1953; Matsui, 1959; Nagao and Huzioka, 1941), of which 30 are common to the Ombetsu Group. Ohara (1966b) recorded a total of 31 species from the Tappu Group of the Rumoi coal field, central Hokkaido, of which 22 also occur in the Ombetsu and Tappu Groups. Kamada (1962) recorded a total of 40 species from the Asagai Formation of the Joban coal field, of which 20 are common to the Ombetsu Group. Moreover, a total of 24 species have been recorded from the Muro Group of the Kii Peninsula, southwest Honshu (Mizuno, 1973; Kishu Shimanto Research Group, 1976), of which 13 are common to the Ombetsu Group.

Consequently, the Ombetsu Group is correlated with the Poronai Formation or with the Poronai and overlying Momijiyama Formations, because there are also many species in the Momijiyama Formation in common with those of the Ombetsu Group (Table 13). Kaiho (1984a, b) correlated the Ombetsu Group with the upper part of the Poronai Formation and the Momijiyama Formation. The Ombetsu Group is also correlated with the Asagai Formation, and with the Muro Group, based on the co-occurrence of common species. The Ombetsu Group has also been correlated with strata of the Nishisonogian Stage (Oligocene) of Kyushu, southern Japan (Mizuno, 1964b), based on the co-occurrence of molluscan species (Table 13), although no other Ombetsu Group species are present in other Paleogene stages of Kyushu (Mizuno, 1964a).

Furthermore, the Ombetsu Group is correlated with strata at Machigar, northern Sakhalin; with the Maoka Series of southern Sakhalin; and with the Mallenian Stage of the Koryak Upland, eastern USSR, because of many common species (Table 13).

On the other hand, there are a few warm-water (tropical to subtropical) taxa in the Urahoro and Ombetsu Groups, including *Geloina* cf. *G. takaoi*. The Wakkanabe Formation composing the lower part of the Ishikari Group contains even more warm water taxa including *Glycymeris*, *Pitar*, *Dosinia*, *Cyclina*, *Venericor*, and *Geloina* (Shimokawara, 1963). Accordingly, the Urahoro Group is correlated with the upper part of the Ishikari Group, in view of the molluscan faunal sequences of the Kushiro coal field and the Ishikari coal field. Kaiho (1984a, b), however, correlated the Urahoro Group with the lower to middle part of the Poronai Formation, based on foraminiferal evidence. This correlation based upon molluscs is reinforced by placement of the Eocene/Oligocene boundary between

the Bibai and the Akabira Formation (lower to middle parts of the Ishikari Group), which is supported by floral studies and recognition of the so-called terminal Eocene event of Wolfe (1978) by Tanai (1983).

In addition, it is notable that there are many Poronaian molluscs in the Hikokubo Group of the Chichibu Basin, Saitama Prefecture, Central Japan (Kanno, 1960), in addition to a few species characteristic in the Nishisonogian Stage of Kyushu (Mizuno, 1964a). The Poronaian species are *Portlandia watasei*, *Yoldia laudabilis*, *Propeamussium kusiroense* (Takeda), *Cyclocardia tokunagai*, *Macoma sejugata*, and *Mya grewingki*. Furthermore, Hatai and Koike (1957) recorded Poronaian molluscs from the Hota Group of the Boso Peninsula, Central Japan, including *Acila elongata*, *Portlandia watasei*, and *Periploma besshoense*. Strata from both areas were assigned an Oligocene age (Kanno, 1960; Hatai and Koike, 1957), but they have been accepted as being of late early Miocene age (Tsuchi, ed., 1981). Tsuchi (1986) tentatively concluded that the Poronaian fauna extended into the early Miocene. However, the characteristics of these younger faunas yielding supposed Poronaian molluscs must be further studied.

SYSTEMATIC DESCRIPTIONS

The following abbreviations are used in the systematic description.

H, height of the shell; L, Length of the shell; W, width of the shell; HL, hinge-length; AHL, anterior hinge-length; PHL, posterior hinge-length; AA, apical angle; D, diameter; RR, number of radial ribs; RS, number of radial striae; NW, number of whorls; IGPS, Institute of Geology and Paleontology, Tohoku University, Sendai, Japan.

Phylum Mollusca
Class Bivalvia
Family Solemyidae
Genus *Solemya* Lamarck, 1818
Subgenus *Acharax* Dall, 1909
Solemya (*Acharax*) cf. *S.* (*A.*) *dalli* Clark, 1925

Compared with:

Solemya ventricosa Conrad; Reagan, 1909, p. 174, pl. 1, fig. 1 on page 176.

Solemya dalli Clark, 1925, p. 73, pl. 22, fig. 3; Slodkewitsch, 1938b, p. 58, pl. 9, figs. 12–15; Devyatilova and Volobueva, 1981, p. 30, pl. 18, fig. 6.

Solemya tokunagai Yokoyama, 1925a, p. 31, pl. 6, figs. 1–3.

Solemya (*Acharax*) *dalli* Clark; Tegland, 1933, p. 103, pl. 4, figs. 1–10; Weaver, 1942, p. 20, pl. 4, figs. 6–8, pl. 5, figs. 4–8; Kanno, 1960, p. 186, pl. 31, fig. 1; Kanno, 1971, p. 42, pl. 1, fig. 1.

Remarks: Only one incomplete left valve (not suitable for illustration) was collected from gray siltstone of the Nuibetsu Formation. The present species was originally described by Clark (1925) from the Oligocene of Northwest America. *Solemya* (*Acharax*) *tokunagai* Yokoyama, 1925a, from the Miocene Kamenoo Formation of the Joban coal field, Northeast Japan, was once treated as a different species (Kanehara, 1937c; Kanno, 1960). But Kanno (1971) synonymized *S. tokunagai* with *S. dalli*, because the former is similar to the latter in height/length ratio.

Reagan (1909) described *Solemya ventricosa* Conrad from the Blakeley Formation of Northwest America. But his specimen is allocated here to *S. dalli*, as was done by Tegland (1933) and Kanno (1971). The present species has also been recorded from the Ushikubitoge Formation of the Hikokubo Group of the Chichibu Basin, Saitama Prefecture, Central Japan (Kanno, 1960); the Oligo-

cene and Miocene of Sakhalin (Slodkewitsch, 1938b); the Poul Creek Formation of southern Alaska (Kanno, 1971); and the late Eocene of Kamchatka (Kovatschian Stage) and Sakhalin (Takaradayan and Machigarian Stages) (Devyatilova and Volobueva, 1981).

Associated fauna: The present species is associated with *Yoldia sobrina* and *Cyclocardia tokudai*.

Locality and Formation: D-16, Nuibetsu Formation.

Family Malletiidae
Genus *Malletia* des Moulins, 1832
Malletia poronaica (Yokoyama, 1890)

Pl. 1, Figs. 1, 2, 3, 6

Nucula poronaica Yokoyama, 1890, p. 195, pl. 25, figs. 3a-c.

Malletia poronaica (Yokoyama); Kanehara, 1937c, p. 159, pl. 15, figs. 1-4; Uozumi, 1952, p. 212, pl. 16, figs. 122-124; Takeda, 1953, p. 72, pl. 8, figs 2-10.

Neilonella poronaica (Yokoyama); Oyama, 1951b, pl. 6, fig. 1 (reproduced from Kanehara, 1937c); Kishu Shimanto Research Group, 1970, pl. 6, fig. 8.

Malletia (*Minomalletia*) *poronaica* (Yokoyama); Shikama and Kase, 1976, p. 15, pl. 1, fig. 3.

Malletia (*Malletia*) *poronaica* (Yokoyama); Devyatilova and Volobueva, 1981, p. 20, pl. 8, fig. 5.

Dimensions (in mm):

IGPS coll cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
95259	D-39	13.1	21.0	62.4	—	—	Right
97100	NB-79	14.6	23.5	62.1	4.3	18.3	Right
95193	D-19	14.7	25.0	58.8	—	—	Right*
95193	D-19	13.8	24.0	57.5	—	—	Left*

* matching valves

Remarks: About 20 specimens were collected from gray siltstone at 17 localities of the Charo and Nuibetsu Formations. The present species was originally described by Yokoyama (1890) from the Poronai Formation. It resembles *Malletia inermis* (Yokoyama, 1925b, p. 9, pl. 2, figs. 1-6) from the Kamenoo Formation (Miocene of the Joban coal field, Northeast Japan), but it is distinguished from the latter by having a more inflated shell.

The present species has also been recorded from the Chokubetsu Formation (Takeda, 1953); The Tappu Group (Ohara, 1966b); the Yamami Formation of the Morozaki Group of the Chita Peninsula, Central Japan (Shikama and Kase, 1976); the Muro Group of the Kii Peninsula, Southwest Honshu (Kishu Shimanto Research Group, 1970); and the Olchovian Stage (late Eocene) of the Koryak Upland, eastern USSR (Volobueva, 1980; Devyatilova and Volobueva, 1981).

Associated fauna: The present species is associated with *Portlandia watasei watasei*, *Cyclocardia* spp., and *Dentalium* sp.

Locality and Formation: CH-a, e, D-05, 36, 39, CHY-30, Charo Formation; NB-01, 17, 39, 76, 79, b, c, h, D-19, 44, NBK-42, Nuibetsu Formation.

Family Nuculanidae
Genus *Saccella* Woodring, 1925
Saccella pseudoscissurata (Takeda, 1953)

Nuculana pseudoscissurata Takeda, 1953, p. 67, pl. 6, figs. 19, 20.

Saccella psudoscissurata (Takeda); Oyama, Mizuno and Sakamoto, 1960, p. 89, pl. 19, figs. 5a-b (reproduced from Takeda, 1953).

Dimensions (in mm):

Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
CHY-2	13.2	24.6+	53.7	7.1/2	14.6	Both

Remarks: Only one specimen was collected from gray siltstone of the Charo Formation. The present species was originally described by Takeda (1953) from the Shitakara, the Omagari and the Charo Formation; and the Nisisakutan and the Aragai Bed of southern Sakhalin.

The present species resembles *Saccella nagaoi* (Takeda, 1953, p. 65, pl. 6, figs. 9, 11, 16, 18, 21, 22), originally described

from the Poronai Formation. But it differs from the latter by having a more compressed shell and no development of the ridge running from umbo to posteroventral corner. It also resembles *Saccella hokkaidoensis* Oyama and Mizuno (1958, p. 595), originally described from the Hiragishi Formation of the Ishikari Group. But it differs from the latter in having a more narrowly rounded anterior margin.

Associated fauna: The present species is associated with *Cyclocardia expansa*.

Locality and Formation: CHY-2, Charo Formation.

Genus *Yoldia*, Möller, 1842
Subgenus *Yoldia* s.s.
Yoldia (*Yoldia*) *laudabilis* Yokoyama, 1924

Pl. 1, Fig. 15

Yoldia sp.; Yabe, 1887, p. 604, text-fig. "*ha*."
Yoldia laudabilis Yokoyama, 1924, p. 22, pl. 4, figs. 11, 12; Kanno and Ogawa, 1964, pl. 3, figs. 2, 3; Kishu Shimanto Research Group, 1970, pl. 6, fig. 7; Kanno and Akatsu, 1972, pl. 8, fig. 2; Nemoto and O'Hara, 1979, pl. 1, fig. 3.
Non Yoldia laudabilis Yokoyama; Makiyama, 1934, p. 131, pl. 3, figs. 2, 5, 6; Minato and Uozumi, 1951a, p. 123, pl. 11, figs. 94a-b, 96.
Yoldia sp., indet. b; Nagao, 1928b, p. 24, pl. 2, figs. 5, 6, 6a, 9.
Yoldia asagaiensis Makiyama, 1934, p. 129, pl. 3, figs. 1, 3, 4.
Yoldia (*Yoldia*) *asagaiensis* Makiyama; Watanabe, Arai and Hayashi, 1950, pl. 1, fig. 5; Shikama, 1954, pl. 4, fig. 3; Hirayama, 1955, p. 80, pl. 1, figs. 16, 17, 21.
Yoldia (*Yoldia*) *sagittaria* Yokoyama; Watanabe, Arai and Hayashi, 1950, pl. 1, fig. 9.
Yoldia (*Yoldia*) *laudabilis* Yokoyama; Mizuno, 1954, p. 404, pl. 1, figs. 8-21; Uozumi, 1955a, p. 466, pl. 23, figs. 185a-b; Uozumi, 1957, p. 547, pl. 5, figs. 1, 1a, 4, 5, 9, 9a, pl. 7, fig. 22 (pl. 5, figs. 9, 9a, reproduced from Yokoyama, 1924; pl. 7, fig. 22, from *Yoldia asagaiensis* Makiyama, 1934); Kanno, 1960, p. 199, pl. 31, figs. 18-20; Kamada, 1962, p. 56, pl. 2, figs. 13, 14; Matsumoto, 1964, p. 101, pl. 2, figs. 1, 2; Hirayama, 1973, p. 171, pl. 15, fig. 2.
Non Yoldia (*Yoldia*) *laudabilis* Yokoyama; Watanabe, Arai and Hayashi, 1950, pl. 1, fig. 8; Shikama, 1954, pl. 4, figs. 4, 5; Hirayama, 1955, p. 79, pl. 1, figs. 20, 22.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
95731-1	OM-32	19.6	35.6	55.1	10.0/2	14.0	Both
95731-2	OM-32	15.0	34.4	43.6	7.7	22.4	Left
95731-3	OM-32	14.4	28.0	51.4	6.9/2	12.5	Both

Remarks: Several hundred specimens are at hand. They generally occur closely packed in groups, in fine- and very fine-grained sandstone and siltstone of the Omagari Formation; and occur rarely in fine-grained sandstone of the Shitakara Formation and siltstone of the Charo and Nuibetsu Formations. This species shows fairly variable outlines, but it is characterized by its elongate, elliptical shell with pointed posterior end and weakly inflated anterior part, and a feeble ridge running from umbo to posteroventral corner.

Yabe (1887, p. 604, text-fig. "*ha*") described *Yoldia* sp. from the Poronai Formation, but it is allocated here to *Y. laudabilis*, as was treated by Hatai and Nisiyama (1952). Makiyama (1934, p. 129, pl. 3, figs. 1, 3, 4) described *Yoldia asagaiensis* from the Asagai Formation, but it has generally been regarded as a junior synonym of *Y. laudabilis* (Mizuno, 1954; Uozumi, 1957; Kamada, 1962; and others).

Nagao (1928b, p. 24, pl. 2, figs. 5, 6, 6a, 9) described *Yoldia* sp., indet. b, from the Yamaga Formation (Oligocene) of the Ashiya Group of Kyushu, southern Japan. It is allocated here to *Y. laudabilis*, as was treated by Mizuno (1954). Uozumi (1957, p. 579, pl. 1, figs. 3, 4; pl. 7, fig. 13) proposed *Portlandia* (*Megayoldia*) *yotsukurensis* for *Y. laudabilis* of Makiyama (1934, p. 131, pl. 3, figs. 2, 5, 6) from the Asagai Formation.

Mizuno (1954, p. 407, pl. 1, figs. 6, 7) described *Y. laudabilis h-matsuii*, n. var. from the Iwaki and the Asagai Formation, but it is conspecific with *Y.* (*Yol-*

dia) *yabei* (Yokoyama, 1924) from the Asagai Formation (Kamada, 1962). Watanabe, Arai and Hayashi (1950, pl. 1, fig. 9) illustrated *Y.* (s.s.) *sagittaria* Yokoyama, 1925 from the Akahira Formation of the Chichibu Basin, Saitama Prefecture, Central Japan. But it is allocated here to *Y. laudabilis*, as was treated by Mizuno (1954).

Yoldia laudabilis of the following authors is regarded as *Portlandia* spp.: Minato and Uozumi (1951a, p. 123, pl. 11, figs. 94a-b, 96) from the Poronai Formation; Watanabe, Arai and Hayashi, 1950, pl. 1, fig. 8) from the Matsuida Formation (Miocene) of the Chichibu Basin; Shikama (1954, pl. 4, figs. 4, 5) from the Yonekawa Formation of the Tomikusa Group (Miocene) of Nagano Prefecture, Central Japan; and Hirayama (1955, p. 79, pl. 1, figs. 20, 22) from the Asagai Formation, as was treated by Mizuno (1954), Uozumi (1957) or Masuda and Noda (1976).

The present species resembles *Y.* (*Yoldia*) *yabei* (Yokoyama, 1924), but differs in having a larger shell and finer concentric growth lines on the surface (Kamada, 1962). It also resembles *Y.* (*Orthoyoldia*) *sagittaria* Yokoyama, 1925b, originally described from the Mizunoya Formation (Miocene) of the Joban coal field, but it differs from the latter by having a smaller shell. It also resembles *Y.* (*Yoldia*) *akanensis* Uozumi (1957, p. 550, pl. 4, figs. 1, 1a, 2, 3, 10) from the Ombetsu Group, but it differs by having a larger and more compressed shell.

The present species has also been recorded from the Oligocene and Miocene strata of Japan and Sakhalin: horizon 4 at Machigar, northern Sakhalin (Makiyama, 1934); the Naibuti Formation of southern Sakhalin, the Poronai Formation, the Asagai and the Shirasaka Formation of the Joban coal field, the Ushikubitoge, the Iwadonozawa, and the Tsuneko Formation of the Chichibu Basin, and the Yamaga Formation of Kyushu (Mizuno, 1954); the Hiragishi and the Poronai Formation (Shimokawara, 1963); the Momijiyama Formation (Kanno and Ogawa, 1964); the Shimokine Formation of the Tappu Group (Ohara, 1966b); the Yudoro Formation of Hokkaido (Amano, 1983); the Biroo Group of Hokkaido (Kanno and Akatsu, 1972); the Matsuida Formation (Watanabe, Arai and Hayashi, 1950); the Ushikubitoge Formation and the Nenokami Sandstone of the Hikokubo Group (Kanno, 1960); the Hiranita Formation of the Chichibu Basin (Hirayama, 1973); the Tomikusa Group of Nagano Prefecture, Central Japan (Shikama, 1954); the Ôga Formation of Shizuoka Prefecture, Central Japan (Matsumoto, 1964); and the Muro Group of the Kii Peninsula (Kishu Shimanto Research Group, 1970).

Associated fauna: The present species is commonly associated with *Portlandia watasei watasei*, *Clinocardium omagariense*, *Neverita asagaiensis*, and *Cyclocardia* spp., in fine- and very fine-grained sandstone and siltstone of the Omagari Formation of the Tokomuro district. It is also associated with *Mya grewingki kusiroensis*, *Corbicula sitakaraensis*, *Ostrea eorivularis*, and *Macoma* sp., in fine-grained sandstone of the Shitakara Formation in the Akan and the Kamicharo district, and the Omagari Formation of the Ombetsu district.

The present species is also associated with *P. watasei watasei* and *Cyclocardia* sp., in siltstone of the Charo Formation; and with *Dentalium* sp., *Portlandia* spp., and *Cyclocardia* spp., in siltstone of the Nuibetsu Formation. It is also associated with *Macoma sejugata* and *M. grewingki kusiroensis* in fine-grained sandstone of the Omagari Formation, and with *P. watasei*, *Turcicula* sp., and *Beringius hobetsuensis* (Matsui), in siltstone of the Charo Formation (Mizuno, 1954).

Locality and Formation: SK2-3, SK3-1, 2, 4, 6, 7, SKK-8, 20, Shitakara

Formation ; OMH-2, 4, 7, 10*, A, D, F, OM-06, 07, 11, 14, 15, 16, 17, 19, 21, 22, 24, 25, 28, 29, 30, 32, Omagari Formation ; CH-30, 32, 69, H, 13, 16, 30, 34, Charo Formation ; NB-07, 11, 17, 19, 21, 45, 49, 55, B, e, Nuibetsu Formation.

Subgenus *Tepidoleda* Iredale, 1939
Yoldia (Tepidoleda) sobrina Takeda, 1953

Yoldia cf. *sagittaria* Yokoyama ; Minato and Uozumi, 1951a, p. 124, pl. 11, figs. 97-101.
Yoldia sobrina Takeda, 1953, p. 69, pl. 6, figs. 13-15 ; pl. 7, figs. 1-4 ; Matsui, 1957, pl. 8, fig. 8 ; Kanno and Ogawa, 1964, pl. 3, figs. 4, 5.
Yoldia (s.s.) *sobrina* Takeda (MS) ; Hayasaka and Uozumi, 1954, p. 397, pl. 25, fig. 6.
Yoldia (Tepidoleda) sobrina Takeda ; Uozumi, 1955a, p. 466, pl. 23, figs. 186, 188 ; Uozumi, 1957, p. 560, pl. 5, fig. 7, 8, 10-13 ; Honda, 1986b, pl. 1, fig. 3.

Dimensions (in mm) :

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
97115	CH-29	ca. 13.9	34.8	39.9	11.3	32.5	Left

Remarks : More than ten specimens were collected from very fine- and fine-grained sandstone at five localities of the Omagari Formation, and from siltstone at nine localities of the Charo and Nuibetsu Formations. The present species was originally described by Takeda (1953) from the Poronai Formation. It shows a fairly variable outline, but it is characterized by its elongate, elliptical shell and low umbonal area. *Yoldia* cf. *Y. sagittaria* of Minato and Uozumi (1951a, p. 124, pl. 11, figs. 97-101) from the Poronai Formation is assigned here to *Y. sobrina*, as was treated by Uozumi (1957).

The present species has also been recorded from the Shitakara Formation (Matsui, 1962) ; the "Momijiyama Transitional Formation" (Hayasaka and Uozumi, 1954) ; the Momijiyama Formation (Kanno and Ogawa, 1964) ; the Tappu Group (Ohara, 1966b) ; the Muro Group of the Kii Peninsula (Mizuno, 1973) ; and the Nishisonogian Stage (Oligocene) of Kyushu (Mizuno, 1964a).

Associated fauna : The present species is associated with *Portlandia watasei watasei*, *Acila brevis*, and *Cyclocardia ezoensis*.

Locality and Formation : OMH-E, OM-02, 14, 18, 24, Omagari Formation ; CH-29, D-09, 10, 21, 26, 42, Charo Formation ; NB-H, D-15, 16, Nuibetsu Formation.

Genus *Portlandia* Mörch, 1857
Subgenus *Portlandella* Stewart, 1930
Portlandia (Portlandella) watasei watasei (Kanehara, 1937)

Pl. 1, Figs. 4, 10, 13, 14, 16-18, 24

Yoldia sp. ; Yabe, 1887, p. 604, text-fig. "*i*".
Yoldia (Yoldia) watasei Kanehara, 1937c, p. 158, pl. 15, figs. 5-9 ; Watanabe, Arai and Hayashi, 1950, pl. 1, fig. 7.
Yoldia watasei Kanehara ; Tagami, 1941, p. 1005, pl. 50, figs. 1h-i ; Minato and Uozumi, 1951a, p. 123, pl. 11, figs. 92, 93, 95 ; Takeda, 1953, p. 71, pl. 6, figs. 3, 6.
Yoldia laudabilis Yokoyama ; Minato and Uozumi, 1951a, p. 123, pl. 11, figs. 94a-b, 96.
Portlandia (Portlandella) watasei (Kanehara) ; Mizuno, 1954, pl. 1, figs. 3a-b, 5 (figs. 3a-b, reproduced from Kanehara, 1937c ; fig. 5, from Minato and Uozumi, 1951a) ; Uozumi, 1955a, p. 465, pl. 23, figs. 184a-b ; Uozumi, 1957, p. 563, pl. 3, figs. 4, 4a, 6-8, 12 ; Tanaka, 1959b, p. 71, pl. 1, figs. 14-18 ; Kanno, 1960, p. 194, pl. 31, figs. 12-16 ; Kishu Shimanto Research Group, 1972, pl. 2, figs. 8-10 ; Hirayama, 1973, p. 170, pl. 15, figs. 3, 4 ; Katto and Masuda, 1978, p. 106, pl. 2, figs. 7, 8 ; *non* Ogasawara, 1955, p. 28, text-fig. 3 ; *non* Narita and Omi, 1975, pl. 3, figs. 1a-b.
Portlandia (Portlandella) sp. ; Mizuno, 1954, pl. 1, fig. 4 (reproduced from *Yoldia laudabilis* of Minato and Uozumi, 1951a).
Portlandia watasei (Kanehara) ; Matsui, 1957, pl. 8, fig. 7 ; Kishu Shimanto Research Group, 1970, pl. 6, fig. 5 ; Kishu Shimanto Research Group, 1976, pl. 2, figs. 6a-c ; Ujihara and Shibata, 1972, pl. 5, fig. 9.
Non Portlandia watasei (Kanehara) ; Hirayama, 1955, p. 82, pl. 1, fig. 18 ; Narita and Omi, 1975, pl. 1, fig. 3 ; Itoigawa, Shibata, Nishimoto, and Okumura, 1981 (1982, p. 12), pl. 1, figs. 21, 22.
Portlandia (Portlandella) cf. *watasei* (Kanehara) ;

Hashimoto, 1961, p. 77, pl. 8, figs. 8-14.
Portlandia (*Portlandella*) *watasei* Kanehara; Matsumoto, 1966, p. 372, pl. 11, figs. 1-10.
Portlandia yotsukurensis Uozumi; Kishu Shimanto Research Group, 1970, p. 93, pl. 6, figs. 4a-b, 6.
Yoldia (*Portlandella*) *watasei* Kanehara; Gladenkov, 1972, p. 214, pl. 4, figs. 1-15, pl. 8, figs. 9-10.
Portlandia (*Portlandia*) *watasei* (Kanehara); Devyatilova and Volobueva, 1981, p. 28, pl. 21, figs. 17-20.
Portlandia (*Portlandella*) *watasei watasei* (Kanehara); Honda, 1986b, pl. 1, figs. 5a-c.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
	SK3-9	19.7	35.0	56.3	11.8/2	16.9	Both
95152	OM-07	19.0	30.3	62.7	12.7/2	21.1	Both
95210	OM-21	16.0	28.6	55.9	3.7	12.9	Left
97126	CH-78	21.6	35.9	60.2	12.4/2	17.3	Both
	NB-78	ca.25.5	—	—	5.7	—	Left
97139	NBK-32	19.6	33.8	58.0	11.0/2	16.3	Both
97135	NBK-72	27.3	35.5	76.9	16.0/2	22.5	Both

Remarks: Several hundred specimens were collected from fine-grained sandstone at two localities of the Shitakara Formation; fine- and very fine-grained sandstone and siltstone at 20 localities of the Omagari Formation; and siltstone at 39 localities of the Charo and Nuibetsu Formations. The present species was originally described by Kanehara (1937c) from the Poronai Formation.

Yabe (1887, p. 604, text-fig. "*i*") described *Yoldia* sp. from the Poronai Formation, but it is allocated here to *P. watasei watasei*, as was treated by Uozumi (1957). Minato and Uozumi (1951a, p. 123, pl. 11, figs. 94a-b, 96) described *Yoldia laudabilis* from the Poronai Formation, but it is also allocated here to *P. watasei watasei*, on the basis of its more inflated shell and obliquely truncated posterior margin, as was done by Masuda and Noda (1976).

Ogasawara (1955, p. 28, text-fig. 3) illustrated *P.* (*Portlandella*) *watasei* from the Hiragishi Formation of the Ishikari Group, but it is allocated here to *P. watasei ogasawarai* Uozumi (1957), as was done by Oyama, Mizuno and Sakamoto (1960). Hirayama (1955, p. 82, pl. 1, fig. 18) described *P. watasei* from the Asagai Formation, but it is allocated here to *P.* (*Megayoldia*) *yotsukurensis* Uozumi (1957), as was done by Uozumi (1957).

Hashimoto (1961, p. 77, pl. 8, figs. 8-14) described *P.* (*Portlandella*) cf. *watasei* from the Kadogawa Formation (Nishisonogian Stage) of Kyushu, but it is assigned here to *P. watasei watasei*, as was done by Katto and Masuda (1978). Kishu Shimanto Research Group (1970, p. 93, pl. 6, figs. 4a-b, 6) described *P. yotsukurensis* from the Muro Group, but it is allocated here to *P. watasei watasei*, in their outlines.

Shibata *in* Itoigawa, Shibata and Nishimoto (1974, p. 50, pl. 2, fig. 11) described *P.* (*Portlandella*) *watasei* subsp., from the Oidawara Formation of the Mizunami Group, Central Japan. But the specimen is allocated here to *P.* (*Megayoldia*) *thraciaeformis* (Storer), as was done by Masuda and Noda (1976). Narita and Omi (1975, pl. 1, fig. 3, pl. 3, figs. 1a-b) illustrated *P. watasei* from the Tokoro Formation of Hokkaido, but it is allocated here to *P. thraciaeformis*.

The present species resembles *P.* (*Portlandella*) *watasei semiovata* (Uozumi) from the Ombetsu Group, but it is distinguished from the latter by having a more irregularly rounded ventral margin. It also resembles *P.* (*Portlandella*) *watasei ogasawarai* Uozumi (1957, p. 567, pl. 1, figs. 9-11) from the Akahira and the Hiragishi? Formation of the Ishikari Group, but it differs from the latter by having a larger and more compressed shell.

The present species is allied also to *Yoldia* (*Yoldia*) *laudabilis* Yokoyama, but differs in having a more inflated shell and more rounded posterior margin. *Portlandia watasei watasei* was probably descended from *P. watasei ogasawarai*, as was discussed by Mizuno (1964b).

The present species has also been recorded from the Eocene to Miocene strata of Japan, Sakhalin and Kamchatka; the Wakkanabe and the Akahira Formation of the Ishikari Group (Shimokawara, 1963); the Momijiyama Formation (Ohara, 1966a); the Tappu Group (Ohara, 1966b); the Pepeshiru Formation (Oligocene) of Hokkaido (Matsui, 1957); the Akahira, the Ushikubitoge and the Hiranita Formation of the Chichibu Basin (Watanabe, Arai and Hayashi, 1950; Kanno, 1960; Hirayama, 1973); the Hota Group of the Boso Peninsula, Central Japan (Hatai and Koike, 1957); the Aoki Formation of Nagano Prefecture, Central Japan (Tanaka, 1959b); the Muro Group of the Kii Peninsula (Matsumoto, 1966; Kishu Shimanto Research Group, 1970, 1972, 1976); the Kumano Group of the Kii Peninsula (Ujihara and Shibata, 1982); upper Oligocene(?) to lower Miocene of Sakhalin, Japan, Kamchatka, and the Koryak Upland (Gladenkov, 1972); upper Eocene and Oligocene strata of the Koryak Upland (Volobueva, 1980); the Amaninian Horizon (Oligocene) of Northeast Asia (Gladenkov, 1980); and the Oligocene (Aluginian Stage) of eastern Kamchatka (Plonina and Berson, 1978).

Associated fauna: The present species is associated with *Conchocele bisecta*, *Periploma besshoense*, *Neverita* sp., and *Dentalium* sp., in the Shitakara Formation; *Yoldia laudabilis*, *Clinocardium omagariense*, *N. asagaiensis*, *Cyclocardia* spp., *P. besshoense*, etc., in the Omagari Formation; and *Cyclocardia* spp., *Turritella* spp., *Dentalium* sp., *Portlandia watasei semiovata*, etc., in the Charo and Nuibetsu Formations.

Locality and Formation: SK2-13, SK3-9, Shitakara Formation; OM-02, 06, 07, 10, 11, 12, 14, 15, 16, 17, 18, 19, 21, 22, 24, 25, 26, 27, 28, 32, Omagari Formation; CH-78, a, D-01, 03, 09, 10, CHY-11, 12, 16, 27, 28, 29, 30, 31, 32, 34, Charo Formation; NB-09, 17, 19, 6, 46, 61, 76, 78, C, I, O, P, a, g, h, D-44, NBY-14, NBK-12, 32, 70, 71, 72, Nuibetsu Formation.

Portlandia (*Portlandella*) *watasei semiovata* Uozumi, 1957

Portlandia (*Portlandella*) *watasei* var. *semiovata* Uozumi, 1957, p. 566, pl. 3, figs. 5, 9.

Remarks: Only five specimens were collected from siltstone at one locality of the Charo Formation. The present species was originally described by Uozumi (1957) from the Poronai Formation and the Ombetsu Group. It resembles *P.* (*Portlandella*) *ovata* (Takeda), but differs in having a lower and more rounded shell (Uozumi, 1957).

Associated fauna: The present species is associated with *P. watasei* (s.s.) and *Crepidula* sp.

Locality and Formation: CHY-32, Charo Formation.

Portlandia (*Portlandella*) *ovata* (Takeda, 1953)

Yoldia ovata Takeda, 1953, p. 70, pl. 6, figs. 17, 23, 24, pl. 7, figs. 5-9.

Portlandia (*Portlandella*) *ovata* Takeda (MS.); Hayasaka and Uozumi, 1954, p. 397, pl. 25, fig. 9.

Portlandia (*Megayoldia*) *ovata* (Takeda); Uozumi, 1957, p. 577, pl. 3, figs. 1-3, 14, 15, 15a.

Portlandia ovata Takeda; Kanno and Ogawa, 1964, pl. 3, fig. 1.

Portlandia ovata (Takeda); Shibata *in* Itoigawa, Shibata and Nishimoto, 1974, p. 50, pl. 2, fig. 10.

"*Neilonella*" *ovata* (Takeda); Itoigawa, Shibata, Nishimoto, and Okumura, 1981 (1982, p. 7), pl. 1, fig. 10.

Neilonella ovata (Takeda); Shibata and Ina, 1983, pl. 1, figs. 9, 10.

Remarks: Several specimens were collected from siltstone at four localities of the Omagari and Nuibetsu Formations. The present species was originally described by Takeda (1953) from the Poronai, the Charo and the Nuibetsu Formation. It shows a fairly variable outline, but it is characterized by its

small and ovate shell with well-rounded ventral margin. Itoigawa *et al.* (1982) discussed the generic position of this species, and tentatively placed it in the genus *Neilonella* Dall, 1881. In addition, Shibata and Ina (1983) placed it in the genus *Neilonella*.

The present species has also been recorded from Oligocene and Miocene strata of Japan; the Tappu Group in Central Hokkaido (Ohara, 1966b); the "Momijiyama Transitional Formation" (Hayasaka and Uozumi, 1954); the Momijiyama Formation (Kanno and Ogawa, 1964); the Oidawara Formation of the Mizunami Group, Central Japan (Shibata *in* Itoigawa, Shibata and Nishimoto, 1973; Itoigawa *et al.*, 1981); and the Shidara Group of Aichi Prefecture, Central Japan (Shibata and Ina, 1983).

Associated fauna: The present species is associated with *Yoldia laudabilis*, *Portlandia watasei* (s.s.), *Cyclocardia laxata*, *Clinocardium omagariense*, *Periploma besshoense*, and *Neverita asagaiensis*, in the Omagari Formation; and *Y. laudabilis*, *Cyclocardia* sp., *Acila brevis*, and *A. picturata*, in the Nuibetsu Formation.

Locality and Formation: OM-32, Omagari Formation; NB-11, M, NBK-63, Nuibetsu Formation.

Subgenus *Megayoldia* Verrill and Bush, 1897
Portlandia (*Megayoldia*) *yotsukurensis* Uozumi, 1957

Pl. 1, Fig. 20

Yoldia laudabilis Yokoyama; Makiyama, 1934, p. 131, pl. 3, figs. 2, 5, 6.

Non Yoldia laudabilis Yokoyama, 1924, p. 22, pl. 4, figs. 11, 12.

Portlandia watasei (Kanehara); Hirayama, 1955, p. 82, pl. 1, fig. 18.

Non Yoldia (*Yoldia*) *watasei* Kanehara, 1937c, p. 158, pl. 15, figs. 5–9.

Portlandia (*Megayoldia*) *yotsukurensis* Uoz. (MS.); Uozumi, 1955a, p. 467, pl. 23, fig. 180 (invalid).

Portlandia (*Megayoldia*) *yotsukurensis* Uozumi, 1957, p. 579, pl. 1, figs. 3, 4, pl. 7, fig. 13 (pl. 1, fig. 3, reproduced from Uozumi, 1955a; pl. 7, fig. 13, from Makiyama, 1934); Tanaka, 1959b, p. 73, pl. 1, figs. 20, 22–24, 26; Kamada, 1962, p. 54, pl. 2, figs. 7, 8; Matsumoto, 1964, p. 103, pl. 2, figs. 4, 5.

Non Portlandia yotsukurensis Uozumi; Kishu Shimanto Research Group, 1970, p. 93, pl. 6, figs. 4a-b, 6.

Remarks: Several specimens were collected from siltstone at five localities of the Charo and Nuibetsu Formations. Uozumi (1955a, p. 467, pl. 23, fig. 180) described *Portlandia* (*Megayoldia*) *yotsukurensis*, based on *Yoldia laudabilis* Yokoyama of Makiyama (1934, p. 131, pl. 3, figs. 2, 5, 6), from the Asagai Formation. But the new name is invalid under the International Code of Zoological Nomenclature, because there are no statements in Makiyama (1934) or Uozumi (1955a), that differenciate these two species. Subsequently, Uozumi (1957, p. 579, pl. 1, figs. 3, 4, pl. 7, figs. 13) established *P.* (*Megayoldia*) *yotsukurensis*, based on *Yoldia laudabilis* Yokoyama of Makiyama (1934). The present species is characterized by its medium-sized, subquadrate and rather inflated shell with numerous concentric growth lines (Uozumi, 1957).

Portlandia watasei (Kanehara) of Hirayama (1955, p. 82, pl. 1, fig. 18) from the Asagai Formation is assigned here to *P. yotsukurensis*, as was done by Uozumi (1957). The Kishu Shimanto Research Group (1970, p. 93, pl. 6, figs. 4a-b, 6) reported *P. yotsukurensis* from the Muro Group, but these specimens are allocated here to *P. watasei* (s.s), due to their outlines. The present species has also been recorded from horizon 4 at Machigar in northern Sakhalin (Makiyama, 1934); the Aoki Formation (Miocene) of Nagano Prefecture, Central Japan (Tanaka, 1959b); and the Ôga Formation of Shizuoka Prefecture, Central Japan (Matsumoto, 1964).

Associated fauna: The present species is associated with *P. watasei* (s.s.)

and *Trominina* spp.

Locality and Formation: D-01, 22, 25, 40, Charo Formation; D-19, Nuibetsu Formation.

Portlandia (*Megayoldia*) *thraciaeformis* (Storer, 1838)

Pl. 1, Fig. 19

Nucula thraciaeformis Storer, 1838, p. 122 (*fide* Hanley, 1866).

Leda (*Yoldia*) *Thraciaeformis* (Storer); Hanley, 1866, p. 143, species 66, pl. 1, figs. 4, 13.

Yoldia thraciaeformis Storer; Sowerby, 1871, Species 1, pl. 1, figs. a-c; Oldroyd, 1924, p. 27, pl. 5, fig. 1, ; Grant and Gale, 1931, p. 127, pl. 1, fig. 12; Otuka, 1934, p. 609, pl. 47, fig. 16; Khomenko, 1934, p. 40, pl. 7, figs. 4-6 (*fide* Khomenko, 1937); Nomura, 1935c, p. 33, pl. 4, fig. 10; Khomenko, 1937, p. 16, pl. 3, figs. 11-17, pl. 4, figs. 1-4; Yamana, 1966, p. 35, pl. 1, fig. 7.

Megayoldia thraciaeformis (Storer); Verrill and Bush, 1897, p. 55, fig. 17 (*fide* Petrov, 1982); Habe, 1977, p. 26, pl. 3, figs. 14, 15 on page 18; Scarlato, 1981, p. 190, fig. 103, photos 97-99; Shimamoto and Koike, 1986, pl. 4, figs. 23, 24.

Yoldia gratiosa Yokoyama, 1923, p. 8, pl. 2, figs. 5a-b; Yokoyama, 1925b, p. 125, pl. 15, fig. 13.

Yoldia scapha Yokoyama, 1926b, p. 247, pl. 31, figs. 7-11; Yokoyama, 1929, p. 394, pl. 75, figs. 5, 6; Khomenko, 1931, p. 63, pl. 3, fig. 10; Khomenko, 1934, p. 41, pl. 7, fig. 8 (*fide* Khomenko, 1937); Khomenko, 1937, p. 18, pl. 4, figs. 5-15 (figs, 5, 6, reproduced from Yokoyama, 1929); Slodkewitsch, 1938b, p. 99, pl. 5, figs. 3-6; Ilyina, 1963, p. 116, pl. 51, fig. 9 (*fide* Krishtofovich, 1969); *non* Yokoyama, 1926c, p. 309, pl. 35, fig. 6.

Yoldia thraciaeformis Storer var. *scapha* Yokoyama; Kanehara, 1937b, p. 20, pl. 5, fig. 4.

Yoldia cf. *gratiosa* Yokoyama; Khomenko, 1937, p. 19, pl.5, figs. 6, 7 (reproduced from *Y. gratiosa* Yokoyama, 1925b).

Yoldia thraciaeformis (Storer); Slodkewitsch, 1938b, p. 100, pl. 5, figs. 8, 8a, 9, 10, 11; Ilyina *in* Krishtofovich and Ilyina, 1954, p. 208, pl. 2, figs. 1, 1a, 2, 3.

Yoldia (*Megayoldia*) cf. *thraciaeformis* Storer; Watanabe, Arai and Hayashi, 1950, pl. 1, fig. 6.

Yoldia thraciaeformis Stores [sic]; Minato and Uozumi, 1951a, p. 124, pl. 11, figs. 102, 103.

Portlandia (*Megayoldia*) *thraciaeformis* (Storer); Habe 1951, p. 26, figs. 24, 25; Uozumi, 1955a, p. 465, pl. 23, figs. 189a-b; Uozumi, 1957, p. 574, pl. 1, figs. 5, 5a, 7, 8, 8a, pl. 7, figs. 23, 28 (figs. 23, 28, reproduced from *Y. scapha* Yokoyama, 1926b); Aoki, 1959, p. 263, pl. 1, figs. 5, 7; Kanno, 1960, p. 197, pl. 31, fig. 29; Kotaka, 1962, p. 144, pl. 34, figs. 8, 9; Kamada, 1962, p. 53, pl. 2, figs. 6a-b; Iwai, 1965, p. 23, pl. 13, fig. 2; Narita and Omi, 1975, pl. 1, fig. 9; Ogasawara, 1977 p. 87, pl. 5, fig. 4; Masuda, Amano, Katsura, and Ito, 1981, pl. 5, figs. 5, 7; Noda and Amano, 1985, pl. 4, figs. 3-5; Honda, 1986b, pl. 1, fig. 8.

Yoldia (*Megayoldia*) *thraciaeformis* Storer; Abbott, 1954, p. 340, pl. 27, fig. e; Abbott, 1974, p. 418, fig. 4918 on page 417.

Non Yoldia thraciaeformis scaph [sic] Yokoyama; Utashiro, 1957a, pl. 4, figs. 1, 2.

Portlandia (*Megayoldia*) *gratiosa* (Yokoyama): Uozumi, 1957, p. 591, pl. 7, fig. 20 (reproduced from Yokoyama, 1923); Suehiro, 1979, p. 73, pl. 10, figs. 6a-c.

Portlandia (*Megayoldia*) cf. *gratiosa* (Yokoyama); Uozumi, 1957, p. 581, pl. 2, figs. 10, 10a, 14, 14a; Aoki, 1959, p. 264, pl. 1, fig. 6.

Yoldia (*Megayoldia*) *thraciaeformis* (Storer); Kira, 1959, p. 108, pl. 41, fig. 14; Shikama, 1964, p. 38, pl. 19, fig. 16; Habe and Ito, 1965, p. 102, pl. 33, fig. 7; Zhidkova *et al.*, 1968, p. 78, pl. 14, figs. 5, 6, pl. 20, fig. 4; Gladenkov, 1972, p. 224, pl. 7, figs. 1-6; Shibata *in* Itoigawa, Shibata and Nishimoto, 1974, p. 52, pl. 2, figs. 12-14.

Portlandia thraciaeformis (Storer); Takayasu, 1962, pl. 1, figs. 15, 16; Hashimoto *et al.*, 1967, pl. 8, fig. 2.

Yoldia (*Portlandella*) *scapha* Yokoyama; Krishtofovich, 1964, p. 10, figs. 2, 4 (*fide* Krishtofovich, 1969); Zhidkova *et al.*, 1968, p. 76, pl. 8, figs. 16, 17, pl. 10, figs. 8, 9; Krishtofovich, 1969, p. 181, pl. 2, figs. 1-3.

Megayoldia (*Megayoldia*) *thraciaeformis* (Storer); Zhidkova *et al.*, 1972, p. 98, pl. 1, fig. 19, pl. 14, figs. 5-8; Petrov, 1982, p. 72, pl. 11, figs. 1, 3.

Megayoldia (*Megayoldia*) cf. *thraciaeformis* (Storer); Zhidkova *et al.*, 1972, pl. 8, figs. 14, 15.

Megayoldia (*Portlandella*) *scapha* (Yokoyama); Zhidkova *et al.*, 1972, pl. 10, figs. 19, 20.

Portlandia (*Portlandella*) *watasei* Kanehara subsp.; Shibata *in* Itoigawa, Shibata and Nishimoto, 1974, p. 50, pl. 2, fig. 11.

Portlandia watasei (Kanehara); Narita and Omi, 1975, pl. 1, fig. 3.

Portlandia (*Portlandella*) *watasei* (Kanehara); Narita and Omi, 1975, pl. 3, figs. 1a-b.

Megayoldia thraciaeformis (Störer) [sic]; Itoigawa, Shibata, Nishimoto, and Okumura, 1981 (1982, p. 12), pl. 1, fig. 25; Shibata and Ina, 1983, p. 35, pl. 1, fig. 20.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	Valve
97109	NB-07	10.8	15.7	68.8	Left

Remarks: Only five specimens were collected from siltstone at four localities of the Nuibetsu Formation. The present species was originally described by Storer (1838) from off Point Race of Massachusetts Bay in the western Atlantic. The description by Sowerby (1871, Species 1, pl. 1, figs. a-c) is as follows: "Shell oblong-subquadrate, very ventricose, smooth with a strong olive epidermis; very pale rose within, cartilaginiferous pit large; posterior side angular, obtusely truncated above area below; dorsal margin depressed, subconcave, impressed and wide, defined; anterior side rather short, rather cuneate."

The present species shows a fairly variable outline, but it is characterized by its small shell with broadly truncated posterior margin, by which it is distinguished from other *Portlandia* species. Yokoyama (1923, p. 8, pl. 2, figs. 5a-b) proposed *Yoldia gratiosa* from the Fujina Formation (Miocene) of Shimane Prefecture, Southwest Japan. But it is regarded here as a junior synonym of *P. thraciaeformis*.

Yokoyama (1926b, p. 247, pl. 31, figs. 7-11) proposed *Yoldia scapha* from the Beds C (Miocene) of Hokkaido. But it is also regarded as a junior synonym of *P. thraciaeformis* (Otuka, 1934; Uozumi, 1957; Aoki, 1959; Kamada, 1962). Yokoyama (1926c, p. 309, pl. 35, fig. 6) described *Y. scapha* from the Sawane Formation (Pliocene) of Sado Island of Niigata Prefecture, Central Japan, but it is assigned here to *P.* (*Portlandella*) *lischkei* (Smith, 1885), as was done by Kuroda (1929).

Watanabe, Arai and Hayashi (1950, pl. 1, fig. 6) illustrated *Y.* (*Megayoldia*) cf. *thraciaeformis* from the Akahira Formation of the Chichibu Basin, Central Japan but it is allocated here to *P. thraciaeformis*. Utashiro (1957a, pl. 4, figs. 1, 2) illustrated *Yoldia thraciaeformis scaph* [sic] from the Asôgima Formation (Pliocene) of Niigata Prefecture, Central Japan, but it is allocated here to *Portlandia* sp.

Uozumi (1957, p. 581, pl. 2, figs. 10, 10a, 14, 14a) described *Portlandia* (*Megayoldia*) cf. *P.* (*M.*) *gratiosa* from the Morai Formation (Miocene) of Hokkaido. But it is also allocated here to *P. thraciaeformis*. Aoki (1959, p. 264, pl. 1, fig. 6) described *P.* (*Megayoldia*) cf. *P.* (*M.*) *gratiosa* from the Takahoko Formation (Miocene) of Aomori Prefecture, Northeast Japan. But it is also allocated here to *P. thraciaeformis*. Zhidkova *et al.* (1972, pl. 8, figs. 14, 15) illustrated *Megayoldia* (*Megayoldia*) cf. *M.* (*M.*) *thraciaeformis* from the Alehinskaja Formation (Pliocene) of the Kurile Islands. But it is also allocated here to *P. thraciaeformis*.

The present species resembles *Portlandia* (*Portlandella*) *hirosakiensis* Iwai (1959, p. 53, pl. 2, figs. 10-12), originally described from the Higashimeya Formation (Pliocene) of Aomori Prefecture, Northeast Honshu. But *P. thraciaeformis* differs from *P. hirosakiensis* by having two weak but more distinct ridges running from umbonal area to posteroventral corner. It also resembles *P.* (*Portlandella*) *lischkei*, living in seas off Japan, but differs in having a more rounded shell.

P. thraciaeformis has also been recorded from the upper Oligocene to Recent of Japan (Oyama, Mizuno and Sakamoto, 1960), and the upper Miocene to Recent of Sakhalin and Kamchatka (Slodkewitsch, 1938a, b). It lives on mud bottoms at a depth of 20 to 200 m in the Arctic Ocean, off of northern Alaska, as well as in the Bering Sea, Hokkaido, Northeast Honshu, western Canada, and California (Habe and Ito, 1965).

Associated fauna: The present spe-

cies is associated with *Turritella* spp. and *P. watasei* (s.s.).

Locality and Formation: NB-07, 35, 76, d, Nuibetsu Formation.

Family Nuculidae
Genus *Nucula* Lamarck, 1799
Subgenus *Ennucula* Iredale, 1931
Nucula (Ennucula) omagariensis
Honda, n. sp.

Pl. 1, Figs. 5, 7–9, 11, 12

Description: Shell small (about 2 cm in both height and length), ovately rounded, moderately inflated and rather thick. Antero- and posterodorsal margins arched, and ventral margin well-rounded. Beaks situated posteriorly, moderately elevated, incurved, and opisthogyrate. Height a little shorter than length. Surface sculptured with many, rather strong, round-topped, and somewhat irregular concentric lines of growth. Teeth numerous and strong. Inner surface unknown.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
95576-1 (Holotype)	OM-06	18.5	19.4	95.4	5.2	26.8	Right
95160-1 (Paratype)	OM-06	19.5	20.6	94.7	4.4	21.4	Left
95564-1	OM-10	16.7	17.4	96.0	9.5/2	27.6	Both

Repository: Holotype (IGPS coll. cat. no. 95576-1) and one paratype (IGPS coll. cat. no. 95160-1) in the Institute of Geology and Paleontology, Tohoku University, Sendai, Japan.

Comparison: The present new species resembles *Nucula hokkaidoensis* Mizuno and Inoue (1969, p. 652, pl. 30, figs. 4, 5) from the Poronai Formation, but it differs from the latter by having a more inflated shell and stronger concentric growth lines. It also resembles *N. (Ennucula) yotsukurensis* Hirayama (1958, p. 96) from the Asagai Formation, but differs from the latter in having a more rounded shell.

The present new species is also similar to *N. (Ennucula) praenipponica* (Kamada, 1962, p. 42, pl. 1, figs. 8–11) from the Honya Formation (Miocene) of the Joban coal field, but differs from the latter in having a more rounded shell and a less strongly arched posterior margin. It is allied also to *Nucula milnei* Yokoyama (1890, p. 195, pl. 22, figs. 2a-c, 3) from the Poronai Formation, but differs from that species in having a more rounded shell without radial striae on the surface.

Remarks: About 70 specimens were collected closely packed in groups from siltstone and very fine-grained sandstone at six localities of the Omagari Formation, and sporadically from siltstone at five localities of the Charo and Nuibetsu Formations. Most specimens are closed valves and have olive brown, original shell material.

Associated fauna: The new species is associated with *Cyclocardia* spp. and *Acila (Acila)* spp.

Locality and Formation: OM-04, 06 (type locality), 10, 11, 12, 13, Omagari Formation; D-06, 09, 26, CHK-4, Charo Formation; NBK-36, Nuibetsu Formation.

Genus *Acila* H. & A. Adams, 1858
Subgenus *Acila* s.s.
Acila (Acila) cf. *A. (A.) praedivaricata*
Nagao and Huzioka, 1941

Compared with:
Acila (Acila) praedivaricata Nagao and Huzioka, 1941, p. 137, pl. 31, figs. 5–8; Devyatilova and Volobueva, 1981, p. 16, pl. 20, figs. 10–12.

Remarks: A total of 63 specimens with closed valves were collected from very fine-grained sandstone and siltstone at four localities of the Omagari Formation. *Acila (Acila) praedivaricata* was originally described by Nagao and Huzioka (1941) from the Upper Nisisakutan Beds (Oligocene, *vide* Oyama, Mizuno and Sakamoto, 1960, p. 104) of southern Sakhalin. It has also been recorded

from the Oligocene of the Koryak Upland and southern Sakhalin (Arakai Formation) (Devyatilova and Volobueva, 1981), and the Oligocene (Alugian Stage) of eastern Kamchatka (Plonina and Berson, 1978).

Associated fauna: The present species is associated with *Acila brevis*, *Portlandia watasei* (s.s.), and *Cyclocardia laxata*.

Locality and Formation: OM-10, 12, 18, 26, Omagari Formation.

Acila (*Acila*) *elongata* Nagao and Huzioka, 1941

Pl. 2, Figs. 2-4

Acila (*Acila*) *vigilia* Schenck var. *elongata* Nagao and Huzioka, 1941, p. 130, pl. 31, figs. 1-4; Zhidkova *et al.*, 1972, p. 89, pl. 1, figs. 1-2.
Acila (s.s.) *elongata* Nagao and Huzioka; Hayasaka and Uozumi, 1954, p. 398, pl. 25, fig. 7.
Acila (*Acila*) *elongata* Nagao and Huzioka; Harata, Tokuoka and Matsumoto, 1963, pl. 1, figs. 4a-b; Uozumi, 1966, p. 126, pl. 10, figs. 7a-b.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
97148	NBK-35	29.2	35.5	82.3	14.7/2	20.8	Both

Remarks: Four specimens, all with closed valves, were collected from siltstone at four localities in the Omagari, Charo and Nuibetsu Formations. The present species was originally described by Nagao and Huzioka (1941) from the Kawabata Formation (Miocene) of the Ishikari coal field. It resembles *A.* (*Acila*) *brevis* Nagao and Huzioka, 1941, but differs in having a more elongated shell.

The present species has also been recorded from the Lovcovskaja Formation (Miocene) of the Kurile Islands (Zhidkova *et al.*, 1972); the Poronai (Shimokawara, 1963); the Momijiyama (Hayasaka and Uozumi, 1954), and the Asahi (Miocene; Uozumi, 1966) Formation of the Ishikari coal field; the Hota Group of the Boso Peninsula, Central Japan (Hatai and Koike, 1957); and the Muro Group of the Kii Peninsula, Southwest Honshu (Harata, Tokuoka and Matsumoto, 1963).

Associated fauna: The present species is associated with *Acila* cf. *A. praedivaricata*, *Cyclocardia tokudai*, and *A. brevis*.

Locality and Formation: OM-18, Omagari Formation; CHK-22, Charo Formation; NBK-35, 39, Nuibetsu Formation.

Acila (*Acila*) *brevis* Nagao and Huzioka, 1941

Pl. 1, Fig. 25

Acila (*Acila*) *vigilia* Schenck var. *brevis* Nagao and Huzioka, 1941, p. 130, pl. 30, figs. 1-4.
Acila (*Acila*) *brevis* Nagao and Huzioka; Oyama, Mizuno and Sakamoto, 1960, p. 105, pl. 22, figs. 1a-f (reproduced from Nagao and Huzioka, 1941); Slodkewitsch, 1967, p. 33, pl. 5, figs. 1-7.
Acila brevis Nagao and Huzioka; Kanno and Ogawa, 1964, pl. 3, figs. 6-7.
Acila brevis Nagao; Kishu Shimanto Research Group, 1976, pl. 2, figs. 2a-b.

Remarks: Abundant specimens, most of which are closed valves, were collected from very fine-grained sandstone and siltstone at 10 localities of the Omagari, Charo and Nuibetsu Formations. This species resembles *A.* (*Acila*) *kusiroensis* Nagao and Huzioka, 1941, but differs in having a more inflated shell. *Acila brevis* has also been recorded from the Momijiyama Formation (Kanno and Ogawa, 1964), the Tappu Group (Ohara, 1966b); the Muro Group (Kishu Shimanto Research Group, 1976); and the Arakai Formation of southern Sakhalin (Slodkewitsch, 1967).

Associated fauna: The present species is associated with *Acila* cf. *praedivaricata*, *Cyclocardia laxata*, *Nucula omagariensis*, n. sp., and *Portlandia watasei* (s.s.) in the Omagari Formation; *Malletia poronaica*, *Yoldia sobrina* and *P. watasei* (s.s.) in the Charo Formation; and *P. watasei* (s.s.), *P. ovata*, *A. kusiro-*

ensis, and *A. picturata* in the Nuibetsu Formation.

Locality and Formation: OM-10, 11, 12, 13, 18, 26, 30, Omagari Formation; D-10, Charo Formation; NB-19, NBK-63, Nuibetsu Formation.

Acila (*Acila*) *kusiroensis* Nagao and Huzioka, 1941

Pl. 1, Figs. 21, 23, Pl. 2, Figs. 1a-c

Acila (*Acila*) *kusiroensis* Nagao and Huzioka, 1941, p. 135, pl. 31, figs. 10, 10a, 11, 11a-b; Honda, 1986b, pl. 1, figs. 2a-c.

Acila (*Acila*) *kusiroensis* (Nagao and Huzioka); Slodkewitsch, 1967, p. 64, pl. 12, figs. 1-2 (reproduced from Nagao and Huzioka, 1941).

Acila kusiroensis Nagao et Huzioka; Kishu Shimanto Research Group, 1972, pl. 2, figs. 7a-b.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
97124	NB-19	ca. 19.5	29.9+	65.2	11.5/2	19.4	Both
96796	NB-78	31.1	—	—	15.6/2	—	Both

Remarks: Abundant specimens with closed valves were collected from fine-grained sandstone and siltstone at 10 localities of the Omagari, Charo and Nuibetsu Formations. The present species was originally described by Nagao and Huzioka (1941) from the Charo Formation.

Associated fauna: The present species is associated with *Cyclocardia tokudai*, *Dentalium nunomae*, *Portlandia watasei* (s.s.), and *Acila brevis*.

Locality and Formation: OM-04, Omagari Formation; D-09 27, 35, CH-41, d, Charo Formation; NB-19, 75, 78, G, Nuibetsu Formation.

Subgenus *Truncacila* Schenck, 1931
Acila (*Truncacila*) *picturata* (Yokoyama, 1890)

Nucula picturata Yokoyama, 1890, p. 194, pl. 25, figs. 1, 2.

Acila (*Truncacila*) *picturata* (Yokoyama); Schenck, 1936, p. 87, pl. 4, figs. 10, 12, fig. 9 of text-fig. 8 on page 28; Uozumi, 1952, p. 212, pl. 16, figs. 125, 126; Takeda, 1953, p. 63, pl. 6, figs. 1, 2, 4, 5.

Acila (*Truncacila*) *pictulata* [sic] (Yokoyama); Nagao and Huzioka, 1941, p. 127, pl. 29, figs. 1-4; Tanaka, 1960, p. 135, fig. 6 on page 148.

Remarks: Only one specimen was collected from siltstone of the Nuibetsu Formation. The present species was originally described by Yokoyama (1890) from the Poronai Formation, and it has been recorded from the Charo Formation (Mizuno, 1964b); the Momijiyama Formation (Kanno and Ogawa, 1964); the Tappu Group (Ohara, 1966b); and the Uchimura Formation (Miocene) of Nagano Prefecture, Central Japan (Tanaka, 1960).

Associated fauna: The present species is associated with *Portlandia ovata*, *Acila brevis*, and *Turritella nuibetsuensis*, n. sp.

Locality and Formation: NBK-63, Nuibetsu Formation.

Family Mytilidae
Subfamily Crenellinae
Genus *Crenella* Brown, 1827
Subgenus *Megacrenella* Habe and Ito, 1965
Crenella (*Megacrenella*) *nuibetsuensis* Honda, n. sp

Pl. 4, Figs. 4, 17

Description: Shell small, ovately rounded, moderately convex, inequilateral, nacreous, and thin. Height longer than length. Beaks situated anteriorly. Antero- and posterodorsal margins nearly straight. Anteroventral margin broadly rounded, and posteroventral margin rounded. Surface finely sculptured with more than 125, flat-topped radial ribs, which slightly diverge on the antero- and posteroventral corner. Ventral margin minutely crenulated. Hinge area and inner surface unknown.

Dimensions (in mm) :

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
97096 (Holotype)	NB-08	12.8	10.8	118.5	3.5	32.4	Right
	NB-27	12.5	11.7	106.8	1.7	14.5	Right
95125-1	D-09	11.1	8.6	129.1	2.4	27.9	Right
99274	NB-e	11.1	8.4	132.1	2.6	31.1	Right

Repository : Holotype (IGPS coll. cat. no. 97096) in the Institute of Geology and Paleontology, Tohoku University, Sendai, Japan.

Comparison : This new species is similar to *Crenella* (*Megacrenella*) *columbiana* Dall, 1897, which is living in seas from Hokkaido northward to the Aleutian Islands and then southward to Mexico (Abbott, 1974 ; Habe, 1977). But it differs from the latter in having a more ovately rounded shell.

Remarks : About 10, somewhat deformed specimens were collected from siltstone at 11 localities of the Charo and Nuibetsu Formations.

Associated fauna : The new species is associated with *Dentalium* sp., *Turritella* sp., *Cyclocardia* sp., *Dentalium nunomae*, and *Eocylichna multistriata*.

Locality and Formation : CH-30, D-09 Charo Formation ; NB-08, 10, 14, 27, 62, 79, D, e, h, Nuibetsu Formation.

Crenella (*Megacrenella*) *shitakaraensis* Honda, n. sp.

Pl. 4, Fig. 18

Description : Shell small, mytiliform, inflated, somewhat inequilateral, and thin. Height about 1.3 times as long as length. Beaks situated anteriorly, elevated, incurved, and prosogyrate. Antero- and posterodorsal margins arcuate, ventral margin well-rounded. Surface finely sculptured with more than 60 rounded radial ribs. Hinge area and inner surface unknown.

Dimensions (in mm) :

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
97111 (Holotype)	SK-46	27.6+	ca. 20.0	138	6.7	33.5	Right

Comparison : The new species resembles *Crenella* (*Megacrenella*) *columbiana* Dall, 1897 and *C.* (*Megacrenella*) *nuibetsuensis*, n. sp., but it differs therefroms by having a more triangulary ovate shell.

Remarks : Only one incomplete right valve was collected from fine-grained sandstone of the Shitakara Formation.

Associated fauna : The new species is associated with *Nemocardium ezoense*, *Ostrea eorivularis*, and *Chlamys shitakaraensis*.

Locality and Formation : SK-46, Shitakara Formation.

Subfamily Mytilinae
Genus *Mytilus* Linné, 1758
Mytilus mabuchii Oyama and Mizuno, 1958

Pl. 2, Fig. 8(C), Pl. 3, Figs. 2a-b

Mytilus mabuchii Oyama and Mizuno, 1958, p. 597, pl. 3, figs. 8, 9 ; Honda, 1986b, pl. 2, fig. 1.

Dimensions (in mm) :

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
97128	SK-22	65.9	37.8	174.3	21.0/2	27.8	Both

Remarks : Abundant specimens were collected in groups from iron-stained, coarse- and fine-grained sandstone bearing pebbles and granules at six localities of the Rushin, Shitakara and Shakubetsu Formations. This species resembles *Mytilus luciferus* Yokoyama (1924, p. 19, pl. 4, fig. 4) from the Iwaki Formation of the Joban coal field, but differs in having a more rounded shell with a prominent ridge running from umbo to ventral corner, as was mentioned by Oyama and Mizuno (1958) and Kamada (1962). It also resembles *M. ogawaensis* Hatai and Nisiyama (1949, p. 89, pl. 24, fig. 17) from the Iwaki Formation, but it is discriminated from the latter in having a more elongated shell. *Mytilus mabuchii* also occurs rarely in the Wakkanabe Formation (Eocene) of the Ishikari Group (Oyama and Mizumo, 1958).

Associated fauna: The present species is associated with *Ostrea eorivularis*, *Corbicula sitakaraensis*, *Nemocardium ezoense*, and *Mya grewingki kusiroensis*.

Locality and Formation: RN-01, Rushin Formation; SK-22, 26, SK3-5, Shitakara Formation; SB-D, P, Shakubetsu Formation.

Family Pectinidae
Subfamily Camptonectinae
Genus *Delectopecten* Stewart, 1930
Delectopecten ikushyunbetsuense (Utashiro, 1963)

Palliolum peckhami; Utashiro, 1957b, p. 162–173, pl. 3, figs. 1, 2 (in part).
Palliolum (*Delectopecten*) *ikushyunbetsuensis* Utashiro, 1959, p. 133 (invalid).
Palliolum (*Delectopecten*) *ikushyunbetsuense* Utashiro *emend.*, 1963, p. 171, pl. 2, figs. 2, 3 (reproduced from *Palliolum peckhami*, Utashiro, 1957b, pl. 3, figs. 1, 2).
Delectopecten ikushyunbetsuense (Utashiro); Honda, 1986b, pl., fig. 1.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	HL	AHL	PHL	AHL/PHL (%)	AA	Valve
95635	D-54	17.3	17.5	98.9	9.0	4.7	4.4	107	110°	Left

Remarks: Several specimens were collected from siltstone at nine localities of the Charo and Nuibetsu Formations. Utashiro (1957, p. 133) described *Palliolum* (*Delectopecten*) *ikushyunbetsuensis* from the Poronai Formation. But the new species is invalid, under the International Code of Zoological Nomenclature, because he gave no illustrations of *P.* (*Delectopecten*) *ikushyunbetsuensis*. This species is characterized by its small shell with numerous, rather fine concentric lines of growth and obsolete radials on the external surface.

The present species resembles *Delectopecten poronaiense* (Utashiro, 1963, p. 171, pl. 1, figs. 1–11, pl. 2, figs. 1, 4–11, pl. 3, figs. 1–10, pl. 9, figs. 1–3) from the Poronai Formation. But, it is distinguished from the latter by having stronger concentric lines of growth and weaker radials. It is allied also to *D. peckhami* (Gabb, 1869, p. 59, pl. 16, figs. 19, 19a, *fide* Arnold, 1906), which has widely been recorded from Japan, Sakhalin, Kamchatka, Alaska, and Northwest America in strata ranging in age from Oligocene to Pliocene. But *D. ikushyunbetsuense* is distinguished from the latter by having closely spaced, regular concentric lines of growth.

Associated fauna: The present species is associated with *Cyclocardia* spp., and *Turritella* spp.

Locality and Formation: CH-C, D, D-05, 09, 54, CHY-18, Charo Formation; NB-03, NBY-18 NBK-71, Nuibetsu Formation.

Subfamily Propeamussinae
Genus *Propeamussium* de Gregorio, 1884
Propeamussium kusiroense (Takeda, 1953)

Amussium (*Propeamussium*) *kusiroense* Takeda, 1953, p. 73, pl. 6, figs. 7, 8.
Ctenamusium (*Micramussium*) *kusiroensis* (Takeda); Kanno, 1960, p. 212, pl. 32, figs. 5–7.
Ctenamusium kusiroense (Takeda); Oyama, Mizuno and Sakamoto, 1960, p. 118, p. 27, figs. 4a-b (reproduced from Takeda, 1953); Masuda, 1962, p. 154; Honda, 1986b, pl. 1, fig. 7.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	RS	Valve
97097	CH-36	12.9	ca. 13.2	97.7	9	Right

Remarks: About 10 specimens were collected from dark gray siltstone at nine localities of the Charo and Nuibetsu Formations. The present species is characterized by its small shell with about nine radial striae on right valve, and by radial striae not extending to the ventral margin. Takeda (1953) described this species as having no byssal notch on the right anterior ear, but there is a rather distinct byssal sinus on the left valve,

which corresponds to the byssal notch of the right valve (Masuda, 1962).

The present species resembles *Ctenamusium inouei* Omori (1955, p. 15, pl. 1, fig. 7) from the Sakasegawa Formation (Eocene) of Kyushu but it differs from the latter by having a higher shell with fewer radial striae. It also resembles *Propeamussium tateiwai* Kanehara, 1936, descrided from the Ennichi Formation (Miocene) of Korea. But it is discriminated from the latter by having a somewhat more narrowly rounded ventral margin.

The present species has also been recorded from the Poronai Formation (Shimokawara, 1963); and the Nenokami Sandstone of the Chichibu Basin (Kanno, 1960).

Associated fauna: The present species is associated with *Cyclocardia* spp.

Locality and Formation: CH-36, 45, A, C, D-05, CHY-9, 23, 25, Charo Formation; NBY-7, Nuibetsu Formation.

Family Limidae
Genus *Lima* Brugière, 1797
Subgenus *Acesta* H. & A. Adams, 1858
Lima (*Acesta*) sp., indet.

Dimensions (in mm):

Loc. no.	H	L	H/L (%)	Valve
CHY-5	92.5+	78.6	118	Left

Remarks: An outer mold of a left valve was collected from fine-grained sandstone of the Charo Formation. Shell large, obliquely oval, moderately inflated, and inequilateral. Height greater than length. Antero- and posterodorsal margins widely rounded, and ventral margin well-rounded. Surface finely sculptured with numerous radials intersecting concentric lines of growth. Auricles small.

The present form resembles *L.* (*Acesta*) *jsuzukii* Takeda (1953, p. 75, pl. 13, figs. 1-4) from the Poronai Formation, but differs in having a more rounded shell.

Associated fauna: The present species is associated with *Cyclocardia expansa* and *Neptunea dispar* Takeda.

Locality and Formation: CHY-5, Charo Formation.

Family Ostreidae
Subfamily Ostreinae
Genus *Ostrea* Linné, 1758
Ostrea eorivularis Oyama and Mizuno, 1958

Pl. 3, Figs. 1, 3-6

Ostrea cf. *gigas* Thunberg; Yokoyama, 1924, p. 20, pl. 5, figs. 1, 2.

Non Ostrea gigas Thunberg, 1793, p. 140, pl. 6, figs. 1-3 (*fide* Lischke, 1869).

Ostrea eorivularis Oyama and Mizuno, 1958, p. 598, pl. 2, figs. 1-3; Honda, 1980a, pl. 30 figs. 4a-b; Honda, 1986b, pl. 2, fig. 2.

Ostrea (*Ostrea*) *yokoyamai* Kamada, 1962, p. 68, pl, 4, fig. 1.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
96787	SK-20	ca. 123.9	75.0	165.2	0	0	Right*
96787	SK-20	126.6	92.8	136.4	26.3	28.2	Left*
96782-1	SK-37	ca. 134.3	ca. 130.4	103.0	ca. 32.3	24.8	Left
96782-2	SK-37	ca 106.9	73.1	146.2	ca. 32.2	22.0	Left
96251**	SK-40	ca. 77.3	ca. 65.0	118.9	—	—	Right
96786	SK-B	ca. 62.8	58.1	108.1	—	—	Left
96785	SK-B	54.0	46.4	116.4	—	—	Right
96116-2	5729	—	67.8	—	—	—	Right
96116-1	5729	106.8	75.3	141.8	—	—	Left
	B-01	70	45	156	—	—	Left

* matching valves, ** figured specimen in Honda (1980a, pl. 30, figs. 4a-b)

Description: Shell, large, moderately thick, elongately to roundly ovate (elongately ovate in general), inequilateral, inequivalve, and nacreous. Height longer than length (height/length ratio varies from about 110 to 140 percent). Anterodorsal margin arched, posterodorsal margin nearly straight, and ventral margin rounded. Right valve almost flat or concave, and left valve moderately convex. Umbones obtuse and opisthogyrate. Concentric lamellar sculptures developed on external surface.

Ligamental area small and with

prominent annula growth layers, attaining about 10 in number in almost matured specimens of about more than 10 cm in height. Umbonal cavity of left valve almost absent. Adductor muscle scar large, concentrically sculptured, and situated postero-ventrally near the subcentral portion of the internal surface. The ventral margin of the adductor muscle scar is parallel to the postero-ventral margin. Chomata present along the dorsal margin, somewhat conspicuous, and attain about 20 number along the antero- and the posterodorsal valves of the dorsal margin, respectively.

Remarks: Numerous specimens were collected from granular to pebbly conglomerate and fine-grained sandstone, often bearing pebbles and granules, at 76 localities of the Rushin, Yubetsu, Shitakara, Shakubetsu, Omagari, and Charo Formations. They often form beds attaining about several tens of cm to 2 meters in thickness. Oyama and Mizuno (1958) mentioned that *O. eorivularis* resembles *Crassostrea ariakensis* (Fujita, 1913) (="*rivularis*" auct.), living in seas off southern Japan, but it differs from *C. ariakensis* by having chomata.

Kamada (1962, p. 68, pl. 4, fig. 1) proposed *O.* (*O.*) *yokoyamai* from the Iwaki Formation of the Joban coal field, and mentioned that it resembles *O. eorivularis*. In addition, Mizuno (1964b) mentioned that *Ostrea* sp. from the Iwaki Formation is probably referable to *O. eorivularis*. *Ostrea yokoyamai* considered to be synonymous with *O. eorivularis* in general features of the shell, such as the outline of the shell, characteristics of external surface sculpture and ligamental areas, and the chomata being more than 10 in number (according to the author's investigation of the holotype specimen (IGPS coll. cat. no. 79378)). *Ostrea* cf. *gigas* of Yokoyama (1924, p. 20 pl. 5, figs. 1, 2) from the Iwaki Formation, is allocated here to *O. eorivularis*, however, Kamada (1962) assigned it to *O. yokoyamai*.

The present species probably includes the following undescribed specimens which were reported under some invalid names: *O. praegravitesta* Nagao from the Naibuti series and the Nisisakutan bed of the Maoka Group of southern Sakhalin, "Yubetsu, Tenneru, Harutori, and Beppo Beds", and the Shitakara Formation (Takeda, 1953); and *O. praegravitesta* Takeda (or *O. paleogravitesta*) from the Yubetsu, the Shitakara, the Omagari, the Charo, and the Nuibetsu Formation (Matsui, 1962). *Ostrea eorivularis* has also been recorded from the Wakkanabe, the Bibai and the Akabira Formation of the Ishikari Group (Mizuno, 1964b); and the Sôun Member of the Chorobetsu Formation (Mabuti, 1962).

Associated fauna: The present species is commonly associated with *Nemocardium ezoense*, *Chlamys shitakaraensis*, *Corbicula sitakaraensis*, and *Mya grewingki kusiroensis*; and rarely with *Cyclocardia* sp., *Neverita asagaiensis*, *Balanus* sp., and *Mytilus mabuchii*.

Locality and Formation: RN-02, Rushin Formation; YB-09, 12, YBY-3, 4, Yubetsu Formation; SK-01, 02, 05, 09, 09*, 14, 19, 20, 21, 22, 23, 26, 27, 29, 31, 32, 33, 34, 35*, 37, 37*, 40, 40*, 41, 42, 44, 47, 48, 53, 55, 58, 59, 60, 61, 62, B, 5729, B-01, 02, 09, SK1-1, 2, 3, SK2-2, 3, 4, 6, 7, 8, 10, 11, 15, SK3-5, 8, 9, SKK-2, 3, 4, 5, 7, 12, 16, 27, 29, Shitakara Formation; SB-08, P, Shakubetsu Formation; OM-01, 05, OMY-2, 3, Omagari Formation; CH-08, Charo Formation.

Family Unionidae
Subfamily Anodontinae
Genus *Anodonta* Lamarck, 1799
Anodonta subjapanensis yokoyamai Suzuki, 1941

Nodularia cf. *biwae* Kobelt; Yokoyama, 1932, p. 243, pl. 4, fig. 4.

Non Nodularia biwae Kobelt, 1879, p. 141, pl. 23,

figs. 2-4 (*fide* Yokoyama, 1932; *vide* Kuroda and Habe, 1952, p. 133).

Anodonta subjapanensis yokoyamai Suzuki, 1941c, p. 29, pl. 2, figs. 3a-c; Kanno, 1954, p. 83, pl. 6, fig. 9; Kamada, 1955b, p. 21, pl. 4, figs. 1-3.

Remarks: Only one specimen was collected from tuffaceous, iron-stained, very fine-grained sandstone of the Shakubetsu Formation. The present species was originally described by Suzuki (1941c) from the Numata Formation of the Uryu Group. It resembles *Anodonta subjapanensis* (Yokoyama, 1932, p. 242, pl. 4, fig. 3), originally described from the Upper Tachibetsu Formation of the Uryu Group. But it differs from the latter by having a more elongated shell (Suzuki, 1941c).

The present subspecies has also been recorded from the Noborikawa, the Horokabetsu, the Yubari, the Akabira, and the Hiragishi Formation of the Ishikari Group (Shimokawara, 1963); the Osawa Formation (Miocene) of the Joban coal field (Kanno, 1954); and the Iwaki Formation (Kamada, 1955b).

Associated fauna: The present species is associated with *Corbicula tokudai*, *Semisulcospira fiscina yokoyamai* Suzuki, and *Cipangopaludina isikariensis* (Suzuki).

Locality and Formation: SBY-3, Shakubetsu Formation.

Family Carditidae
Subfamily Venericardiinae
Genus *Cyclocardia* Conrad, 1867
Cyclocardia takedai (Honda, 1980)

Venericardia elliptica Takeda, 1953, p. 80, pl. 8, figs. 13, 18, pl. 11, figs. 7-12, 14-23, pl. 22, figs. 6, 20, 24.

Venericardia (*Cyclocardia*) *elliptica* Takeda; Oyama, Mizuno and Sakamoto, 1960, p. 147, pl. 43, figs. 8a-k (reproduced from Takeda, 1953).

Venericardia (*Cyclocardia*) *takedai* Honda, 1980b, p. 466.

Remarks: Only one specimen, having less than about 22 square radial ribs, was collected from siltstone of the Nuibetsu Formation. The present species was originally described by Takeda (1953) from the Poronai Formation and the Ombetsu Group. It is characterized by its elliptical shell with 10 to 20, broad, flattened radial ribs (Takeda, 1953), but Takeda's figures show more numerous radial ribs varying from about 13 to more than 22(?) in number.

Honda (1980b, p. 466) proposed a new name *Venericardia* (*Cyclocardia*) *takedai* for *Venericardia elliptica* Takeda, because the name *elliptica* is preoccupied by *Venericardia ellipitca* Douvillé (1928, p. 21, pl. 4, figs. 26-33) from the *Cardita beaumonti* Bed (Paleocene) of India. Furthermore, *V. elliptica* Douvillé is preoccupied by *Venericardia elliptica* Schafhäutl (1863, p. 164; *fide* Ruhoff, 1980, p. 257). A new name is needed for Douvillé's species.

The present species resembles *Cyclocardia yokoyamai* (Oyama and Mizuno, 1958), but it differs from the latter in having more prosogyrous beaks. It also resembles *C. laxata* (Yokoyama, 1924), but differs in having less numerous radial ribs and a more rounded shell. It has also been recorded from the Maoka Group (Takeda, 1953); and the Shijujiyama Formation (Oligocene) of Shikoku, Southwest Japan (Mizuno, 1956; Taira *et al.*, 1980).

Associated fauna: Only the present species was collected from the Nuibetsu Formation, and it is not associated with other molluscan species.

Locality and Formation: D-55, Nuibetsu Formation.

Cyclocardia poronaiensis
Honda, new name

Pl. 4, Figs. 3, 14

Venericardia compressa Yokoyama, 1890, p. 196, pl. 25, figs. 4a-b; Tagami, 1941, pl. 50, fig. 1g; Takeda, 1953, pl. 8, fig. 14.

Venericardia (*Cyclocardia*) *compressa* (Yokoyama); Uozumi, 1953a, p. 328, pl. 21, figs. 168-170.

?Venericardia compressa Yokoyama; Takeda, 1953,

pl. 12, fig. 9.

Non Cardita compressa Reeve, 1843, pl. 9, fig. 46 (*fide* Oyama and Mizuno, 1958).

Venericardia (*Cyclocardia*) *yokoyamai* Oyama and Mizuno, 1958, p. 601 [preoccupied by *Cardita yokoyamai* Slodkewitsch, 1936, p. 45 ; *fide* Slodkewitsch, 1938a, p. 319]

Remarks : Several tens of specimens were collected from conglomerate, fine- and very fine-grained sandstone, and siltstone at 10 localities of the Omagari and Charo Formations. The present species was originally described by Yokoyama (1890) under the name *Venericardia compressa* from the Poronai Formation. Oyama and Mizuno (1958, p. 601) proposed the new name *yokoyamai* for *V. compressa* Yokoyama, because the latter is preoccupied by *Cardita compressa* Reeve (1843). But the new name is preoccupied by *Cardita yokoyamai* Slodkewitsch (1936, p. 45 ; *fide* Slodkewitsch, 1938a, p. 319) proposed for *V. tokunagai* of Yokoyama (1929, p. 392, pl. 75, fig. 2) from the Pliocene ? of Sakhalin. Thus a new name *Cyclocardia poronaiensis* is proposed herein.

The present species is characterized by its roundly trigonal shell with 12 to 14, square radial ribs (Yokoyama, 1890). It resembles *Cyclocardia ezoensis* (Takeda, 1953), but differs from the latter in having a larger and less inflated shell. *Cyclocardia poronaiensis*, new name has also been recorded from the Tappu Group (Ohara, 1966b).

Associated fauna : The present species is associated with *Portlandia watasei* (s.s.), *Clinocardium omagariense*, *Neverita asagaiensis*, *Yoldia laudabilis*, and *Periploma besshoense*.

Locality and Formation : OM-02, 06, 09, 12, 15, 17, 20, 36, Omagari Formation ; D-30, 32, Charo Formation.

Cyclocardia laxata (Yokoyama, 1924)

Pl. 4, Figs. 7, 11, 12

Venericardia laxata Yokoyama, 1924, p. 19, pl. 3, figs. 16–18 ; Yokoyama, 1925b, p. 7, pl. 1, figs. 11, 12(?) ; Nemoto and O'Hara, 1979, pl. 1, fig. 6.

Venericardia (*Cyclocardia*) *laxata* Yokoyama var. ; Makiyama, 1934, p. 145, pl. 6, fig. 36.

Venericardia (*Cyclocardia*) *laxata* Yokoyama ; Makiyama, 1934, p. 145, pl. 6, figs. 37-40, 49 ; Hayasaka and Uozumi, 1954, p. 401, pl. 25, fig. 3 ; Hirayama, 1955, p. 90, pl. 2, figs. 12, 13, 15, 16 ; Kanno, 1960, p. 237, pl. 33, figs. 12a-b ; Kamada, 1962, p. 81, pl. 7, figs. 3, 4.

Venericardia (*Cyclocardia*) *laxata* by Makiyama ; Watanabe, Arai and Hayashi, 1950, pl. 2, fig. 5.

Cyclocardia (*Cyclocardia*) *laxata* Yokoyama ; Volobueva, 1986, p. 71, pl. 2, figs. 1–5.

Dimensions (in mm) :

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	RR	Valve
95169	OM-32	22.0	26.7	82.4	16.6/2	31.1	28+	Both

Remarks : About 120 specimens were collected from fine- and very fine-grained sandstone, and siltstone at 13 localities of the Omagari and Charo Formations. This species is characterized by its broadly ovate shell with 20 to 25, broad, flattish radial ribs (Yokoyama, 1924). However, there are a few specimens from northern Sakhalin, which have more than 25 radials (Makiyama, 1934) ; and also there are exceptional ones in the Asagai Formation, which have about 30 radials (Kamada, 1962).

The present species resembles *Cyclocardia tokunagai* (Yokoyama, 1924), but it is distinguished from the latter by having a more ovate shell. It has also been recorded from horizons 5 and 6 at Machigar in northern Sakhalin (Makiyama, 1934) ; the Oligocene of the Koryak Upland (Volobueva, 1980, 1986) ; the "Momijiyama Transitional Formation" (Hayasaka and Uozumi, 1954) ; the Tappu Group (Ohara, 1966b) ; the Kamenoo Formation (Miocene) of the Joban coal field (Yokoyama, 1925b) ; the Akahira (Watanabe, Arai and Hayashi, 1950) and the Ushikubitoge Formation (Kanno, 1960) of the Chichibu Basin ; and the Kaguyama Formation (Oligocene) of the Nichinan Group (Kato, 1985).

Associated fauna : The present species is associated with *Cyclocardia tokudai*, *Clinocardium omagariense*, *Acila brevis*, *Periploma besshoense*, and *Nucula omagariensis*, n. sp.

Locality and Formation : OM-04, 05, 10, 11, 12, 13, 16, 18, 25, 27, 32, 36, Omagari Formation ; CH-74, Charo Formation.

Cyclocardia akagii (Kanehara, 1937)

Pl. 4, Fig. 15

Venericardia (*Cyclocardia*) *akagii* Kanehara, 1937c, p. 159, pl. 15, fig. 13 ; Uozumi, 1953a, p. 328, pl. 21, figs. 163, 164.

Venericardia akagii Kanehara ; Kishu Shimanto Research Group, 1970, p. 93, pl. 6, figs. 12-15.

Non ? Cyclocardia (*Cyclocardia*) *akagii* (Kanehara) ; Devyatilova and Volobueva, 1981, p. 62, pl. 26, figs. 9, 10.

Remarks : A total of eight specimens were collected from fine- and very fine-grained sandstone, and siltstone at four localities of the Omagari and Charo Formations. The present species was originally described by Kanehara (1937c) from the Poronai Formation. It is characterized by its ovately rounded shell with about 26 low and rounded radial ribs (Kanehara, 1937c). However, it has a fairly variable outline, for instance it has a circular to oval shell with either 22 to 26 rounded ribs (Uozumi, 1953a) or with about 25 to 28 radials (Kishu Shimanto Research Group, 1970).

This species is allied to *Cyclocardia takamiyaensis* (Shibata, 1970, p. 64, pl. 2, figs. 3a-b) from the Ichishi Group (Miocene) of Mie Prefecture, Southwest Honshu. But *C. akagii* differs from *C. takamiyaensis* in having a more rounded shell. The present species has also been recorded from the Momijiyama Formation (Shimokawara, 1963), the Tappu Group (Ohara, 1966b), and the Muro Group (Kishu Shimanto Research Group, 1970). Devyatilova and Volobueva (1981, p. 62, pl. 26, figs. 9, 10) described *C.* (*C.*) *akagii* from the Aglikich Series (Oligocene) of eastern USSR, but theirs is probably a different *Cyclocardia* species.

Associated fauna : The present species is associated with *Yoldia laudabilis*, *Portlandia watasei* (s.s.), *Neverita asagaiensis*, and *Cyclocardia tokudai*.

Locality and Formation : OM-19, 25, 30, Omagari Formation ; D-39, Charo Formation.

Cyclocardia expansa (Takeda, 1953)

Pl. 4, Figs. 8a-b

Venericardia expansa Takeda, 1953, p. 77, pl. 8, figs. 15-17, 19-21, pl. 11, fig. 13, pl. 12, figs. 1, 2, 4, 5, 7, 8, 10-12, 14-16, 18, 19, 22, 23, 25.

Venericardia (*Cyclocardia*) *expansa* Takeda ; Oyama, Mizuno and Sakamoto, 1960, p. 148, pl. 44, figs. 2a-j (reproduced from Takeda, 1953).

Cyclocardia expansa (Takeda) ; Popov, 1983, p. 37, pl. 2, figs. 24-26.

Cyclocardia (*Cyclocardia*) *expansa* (Takeda) ; Volobueva, 1986, p. 71, pl. 1, figs. 15, 16.

Dimensions :

Specimen no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	RR	Valve
1	CHY-31	21.9	23.7	92.4	14.2/2	30.0	20	Both

Remarks : A total of 36 specimens were collected from siltstone at nine localities of the Omagari, Charo and Nuibetsu Formations. The present species was originally described by Takeda (1953) from the Poronai, the Charo and the Nuibetsu Formation, as well as from the Nisisakutan and the Aragai Beds of the Maoka Group, southern Sakhalin. It is characterized by its rounded shell with 15 to 25 broad and flattened radial ribs (Takeda, 1953) or with 23 to 30 ribs (Popov, 1983).

The present species resembles *C. tokudai* (Takeda, 1953), but differs in having a more rounded shell. *Cyclocardia expansa* has also been recorded from the Oligocene of the Koryak Upland (Volobueva, 1986).

Associated fauna: The present species is associated with *Turritella* sp. and *Acila brevis*.

Locality and Formation: OM-30, 32, Omagari Formation; CH-18, 45, CHY-2, 5, 31, Charo Formation; NB-05, NBY-9, Nuibetsu Formation.

Cyclocardia tokudai (Takeda, 1953)

Pl. 4, Figs. 10, 16

Venericardia tokudai Takeda, 1953, p. 79, pl. 12, figs. 13, 17, 21.

Venericardia (*Cyclocardia ?*) *tokudai* Takeda (MS.); Hayasaka and Uozumi, 1954, p. 400, pl. 25, fig. 4.

Venericardia (*Cyclocardia*) *tokudai* Takeda; Oyama, Mizuno and Sakamoto, 1960, p. 149, pl. 44, figs. 3a-b (reproduced from Takeda, 1953); Matsumoto, 1964, p. 104, pl. 2, figs. 9, 10.

Cyclocardia (*Cyclocardia*) *tokudai* (Takeda); Volobueva, 1986, p. 72, pl. 2, figs. 6–11.

Remarks: Abundant specimens were collected from fine- and very fine-grained sandstone at 26 localities of the Omagari, Charo and Nuibetsu Formations. The present species was originally described by Takeda (1953) from the Poronai, the Charo and the Nuibetsu Formation. It is characterized by its ovately trigonal shell with 15 to 20 broadly flattened radial ribs (Takeda, 1953).

Cyclocardia tokudai has also been recorded from the "Momijiyama Transitional Formation" (Hayasaka and Uozumi, 1954); the Tappu Group (Ohara, 1966b); the Ôga Formation of Shizuoka Prefecture, Central Japan (Matsumoto, 1964); and the Oligocene of the Koryak Upland (Volobueva, 1986).

Associated fauna: The present species is associated with *Portlandia watasei* (s.s.), *Clinocardium omagariense*, *Turritella nuibetsuensis*, n. sp., and *Lucinoma hannibali*.

Locality and Formation: OM-02, 03, 04, 05, 06, 12, 13, 16, 18, 19, 25, 26, 27, Omagari Formation; D-09, 34, 35, 36, 37, 38, 40, 41, Charo Formation; D-11, 16, 17, 44, NBK-72, Nuibetsu Formation.

Cyclocardia orbica (Yokoyama, 1925)

Venericardia orbica Yokoyama, 1925b, p. 8, pl. 1, fig. 10.

Venericardia (*Cyclocardia*) *orbica* Yokoyama; Oyama, Mizuno and Sakamoto, 1960, p. 150, pl. 44, fig. 5 (reproduced from Yokoyama, 1925b); Kamada, 1962, p. 82, pl. 7, figs. 5, 6; Shibata and Ina, 1983, p. 44, pl. 4, fig. 5.

Remarks: Only four specimens were collected from siltstone at two localities of the Omagari Formation. The present species was originally described by Yokoyama (1925b) from the Kamenoo Formation (Miocene) of the Joban coal field. It is characterized by its rather large, nearly circular shell with about 30 flattish radial ribs (Yokoyama, 1925b) or with 20 to 22 triangular ribs (Kamada, 1962).

The present species has also been recorded from the Honya Formation (Miocene) of the Joban coal field (Kamada, 1962); the Muro Group (Kishu Shimanto Research Group, 1970); the Shidara Group (Miocene) of Aichi Prefecture, Central Japan (Shibata and Ina, 1983); and the Oligocene of the Koryak Upland (Volobueva, 1980).

Associated fauna: The present species is associated with *Cyclocardia laxata*, *C. tokudai*, *Yoldia laudabilis*, *Neverita asagaiensis*, *Turritella poronaiensis*, and *Portlandia watasei* (s.s.).

Locality and Formation: OM-18, 32, Omagari Formation.

Cyclocardia tokunagai (Yokoyama, 1924)

Venericardia tokunagai Yokoyama, 1924, p. 18, pl. 3, figs. 10–12; Yokoyama, 1926a, p. 223, pl. 28, figs. 17, 18; Nomura and Hatai, 1936, p. 123, pl. 15, fig. 15; Shikama, 1954, pl. 4, fig. 20; Nemoto and O'Hara, 1979, pl. 1, fig. 7; *non* Yokoyama, 1929, p. 392, pl. 75, fig. 2; *non* Otsuka, 1937, p. 169, pl. 16, fig. 8.

Venericardia pacifera Yokoyama, 1924, p. 18, pl. 4, figs. 1, 2.

Cardita tokunagai (Yokoyama); Slodkewitsch, 1938b, p. 141, pl. 64, figs. 7–10.
Venericardia (*Cyclocardia*) *tokunagai* Yokoyama; Watanabe, Arai and Hayashi, 1950, pl. 2, fig. 7; Hirayama, 1955, p. 89, pl. 2, figs. 17, 19, 20; Kanno, 1960, p. 237, pl. 37, figs. 7a-b; Kanno, 1961, p. 76, pl. 11, figs. 1–3; Kamada, 1962, p. 80, pl. 7, figs. 1, 2; Harata, Tokuoka and Matsumoto, 1963, text-fig. 3.
Venericardia (*Cyclocardia*) *pacifera* Yokoyama; Hirayama, 1955, p. 90, pl. 2, fig. 11.
Venericardia sp.; Hirayama, 1955, p. 92, pl. 2, figs. 14, 18.
Venericardia (*Cyclocardia*) *subnipponica* Nagao; Kamada, 1962, p. 83, pl. 6, figs. 11, 12 (in part).
Cardita cf. *kamtschatica* Slodkewitsch; Ilyina, 1963, p. 100, pl. 24, figs. 4, 5 (*vide* Popov, 1983, p. 41).
Cyclocardia tokunagai (Yokoyama); Popov, 1983, p. 41, pl. 4, figs. 8, 9.

Remarks: Only three specimens were collected from siltstone at one locality of the Nuibetsu Formation. This species is characterized by its obliquely trigonal shell with a little more than 25 flattened radial ribs (Yokoyama, 1924); 23 to 25 radials (Kamada, 1972b); or with 22 to 27 radials (Popov, 1983).

Yokoyama (1924) proposed *Venericardia pacifera* from the Asagai Formation, but Kamada (1962) synonymized it with *C. tokunagai*, because the two species occur together in the Asagai Formation, and also because there are many intermediate specimens having 20 to 25 radials. Hirayama (1955, p. 92, pl. 2, figs. 14, 18) described *Venericardia* sp. from the Asagai Formation, but it was assigned to *C. tokunagai* by Kamada (1962).

Kamada (1962, p. 83, pl. 6, figs. 11–17) described *V.* (*Cyclocardia*) *subnipponica* from the Iwaki Formation of the Joban coal field, but the specimens (figs. 11, 12) are probably referable to *C. tokunagai*, as was mentioned by Kamada (1972a). Slodkewitsch (1936, p. 45; *fide* Slodkewitsch, 1938a, p. 319) proposed *Cardita yokoyamai* for *V. tokunagai* of Yokoyama (1929, p. 392, pl. 75, fig. 2) from the Pliocene ? of Sakhalin.

Otuka (1940, p. 94, pl. 11, fig. 10) established *V.* (*Cyclocardia ?*) *abesinaiensis* from the Wakkauenbetsu Formation (Miocene) of Hokkaido, and assigned *V. tokunagai* of Otuka (1937, p. 169, pl. 16, fig. 8), from the Onisipets Formation (Miocene) of Hokkaido, to the new species. *Cyclocardia tokunagai* has a more angular shell with less numerous radial ribs than *C. abesinaiensis* (Otuka, 1940).

The present species has also been recorded from the Oligocene to Miocene of Japan and Kamchatka: the Ilynskaya and the Kakertskaya Formation (early to middle Miocene) of western Kamchatka (Popov, 1983); the Mallenian Stage (Oligocene) of the Koryak Upland (Volobueva, 1980); the Poronai ? and the Momijiyama Formation (Shimokawara, 1963); the Tanagura Formation (Miocene) of Fukushima Prefecture, Northeast Japan (Nomura and Hatai, 1936); the Akahira Formation (Watanabe, Arai and Hayashi, 1950) and the Nenokami Sandstone of the Hikokubo Group (Kanno, 1960); the Tomikusa Group (Shikama, 1954); the Mizunami Group (Miocene) of Gifu Prefecture, Central Japan (Yokoyama, 1926a); and the Muro Group (Harata, Tokuoka and Matsumoto, 1963). Recently, Allison and Marincovich (1981, pl. 1, figs. 11–15) illustrated *C.* cf. *tokunagai* from the Narrow Cape Formation (late Oligocene or earliest Miocene) of Sitkinak Island, Alaska.

Associated fauna: The present species was collected only from the Nuibetsu Formation, and it is not associated with other molluscan species.

Locality and Formation: NB-79, Nuibetsu Formation.

Cyclocardia ezoensis (Takeda, 1953)

Venericardia ezoensis Takeda, 1953, p. 81, pl. 11, figs. 2, 3, 5, 6, pl. 12, fig. 3.
Cardita nairoensis Krishtofovich *in* Krishtofovich and Ilyina, 1954, p. 87, pl. 14, figs. 2, 2a.
Venericardia (*Cyclocardia*) *ezoensis* Takeda; Oyama, Mizuno and Sakamoto, 1960, p. 151, pl. 45, figs. 2a-d (reproduced from Takeda, 1953).

Cyclocardia yakatagensis (Clark); Kanno, 1971, p. 63, pl. 3, figs. 7a-b (in part).
Cyclocardia ezoensis (Takeda); Popov, 1983, p. 37, pl. 3, figs. 11-15; Honda, 1986b, pl. 1, fig. 4.

Dimensions (in mm):

Specimen no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	RR	Valve
1	NB-48	18.5	19.4	95.4	12.8/2	33.0	22	Right*
1	NB-48	—	—	—	—	—	21	Left*
2	NB-48	11.5	—	—	6.1/2	—	20?	Both
3	NB-48	—	—	—	7.7	—	—	Right*
3	NB-48	—	23.4	—	7.2	30.8	21	Left*

* matching valves

Remarks: Abundant specimens were collected from siltstone at 36 localities of the Charo and Nuibetsu Formations. The present species was originally described by Takeda (1953) from: the Poronai, the Charo and the Nuibetsu Formation; and, the Nisisakutan, the Aragai and the Hattyorei Bed of the Maoka Group. It shows a somewhat variable outline, but it is characterized by its large, obliquely ovate or ovate-trigonal shell, with 15 to 20 rounded radial ribs that are wider than or as wide as the interspaces (Takeda, 1953) or with 20 to 28 radials (Popov, 1983). The specimens from the Nuibetsu Formation, for example, have 20 to 22 radials, at Loc. NB-48.

Krishtofovich *in* Krishtofovich and Ilyina (1954, p. 87, pl. 14, figs. 2, 2a) proposed *Cardita nairoensis* from the *Papyridea matschigarica* bed (early Miocene) of southern Sakhalin. But *C. nairoensis* is considered here to be a junior synonym of *Cyclocardia ezoensis*, as was done by Popov (1983). Kanno (1971, p. 63, pl. 3, figs. 7a-b, pl. 4, figs. 9a-b) described *Cyclocardia yakatagensis* (Clark, 1932) from the Poul Creek Formation of Alaska. But the specimen shown in Kanno's pl. 3, figs. 7a-b is also assigned here to *C. ezoensis*, as was done by Popov (1983).

The present species has also been recorded from the Eocene and Oligocene of Kamchatka, and the Oligocene (Machigar Formation) of northern Sakhalin (Popov, 1983).

Associated fauna: The present species is associated with *Turritella* sp., *Dentalium* sp., *T. poronaiensis*, *Portlandia watasei* (s.s.), *Yoldia laudabilis*, and *Y. sobrina*.

Locality and Formation: CH-04, 10, 29, 33, 34, 42, 47, 59, 68, 74, 76, 77, 88, B, C, H, Charo Formation; NB-12, 19, 21, 23, 26, 34, 40, 46, 48, 48*, 52, 54, 71, 72, 74, A, H, J. R, NBY-12, Nuibetsu Formation.

Cyclocardia sp.

Remarks: Numerous specimens of *Cyclocardia* are at hand. They occur sporadically in siltstone, fine- and very fine-grained sandstone at 103 localities of the Shitakara, Charo and Nuibetsu Formations. But they were not specifically identified, because their original shell material is decorticated and it is difficult to observe their delicate radial sculpture.

Associated fauna: The present species is associated with *Turritella* sp., *Dentalium* sp, *Portlandia watasei* (s.s.), *Eocylichna multistriata*, *Orectospira wadana*, and *T. poronaiensis* in the Charo and Nuibetsu Formations; and with *Mya grewingki kusiroensis*, *Macoma* sp., and *Conchocele bisecta*, in the Shitakara Formation.

Locality and Formation: SK1-3, SK2-5, 9, 10, 12, 15, SK3-5, SKK-22, Shitakara Formation; CH-02, 03, 05, 06, 07, 13, 14, 19, 20, 21, 26, 27, 28, 35, 39, 40, 51, 53, 55, 58, 60, 62, 63, 66, 71, 72, 73, 75, 78, 79, 81, 84, 87, H, D-05, 24, 30, 32, CHY-7, 9, 12, 13, 16, 18, 20, 21, 22, 23, 24, 26, 28, 30, 34, CHK-3, 13, 16, Charo Formation; NB-01, 03, 09, 11, 13, 14, 22, 25, 30, 31, 35, 38, 42, 43, 44, 61, 62, 65, 66, 68, 70, 75, 77, 79, e, D-11, NBY-1, 2, 4, 8, 9, 10, 11, 12, 13, 17, NBK-7, 13, 19, Nuibetsu Formation.

Family Corbiculidae
Subfamily Corbiculinae
Genus *Geloina* Gray, 1842
Geloina cf. *G. takaoi* (Nagao and Ôtatume, 1943)

Pl. 5, Fig. 10

Compared with :

Polymesoda (*Geloina*) *takaoi* Nagao and Ôtatume, 1943, p. 5, pl. 2, figs. 8, 8a, pl. 3, figs. 1, 1a, 2, 3, 3a ; Minato, 1950, pl. 18, figs. 12, 12a.

Geloina takaoi Nagao and Ôtatume ; Ôtatume, 1943b, p. 291.

Dimensions (in mm) :

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
95440	B-02	25.6	25.3	101.2	5.6	22.1	Right

Remarks : Only one right valve was collected from fine-grained sandstone bearing gravels of the Shitakara Formation. The present species resembles *G. takaoi* (Nagao and Ôtatume, 1943) from the Wakkanabe Formation of the Ishikari Group, although it has a more oblique shell. *Geloina* is one of the characteristic elements of mangrove swamps of the tropical to subtropical Indo-Pacific coast (Oyama, 1950a).

Associated fuana : The present species is associated with *Corbicula sitakaraensis*, *Nemocardium ezoense*, *Ostrea eorivularis*, and *Chlamys shitakaraensis*.

Locality and Formation : B-02, Shitakara Formation.

Genus *Corbicula* Mergele von Mühlfeld, 1811
Subgenus *Batissa* Gray, 1853
Corbicula (*Batissa*) *sitakaraensis* Suzuki, 1941

Pl. 2, Figs. 7, 8 (A, B)

Corbicula sitakaraensis Suzuki, 1941a, p. 57, pl. 4, figs. 1a-b.

Batissa sitakaraensis (Suzuki) ; Ôtatume, 1943a, p. 241, pl. 5, figs. 1-10 ; Ôtatume, 1943d, p. 23, pl. 4, figs. 7-9.

Corbicula (*Batissa*) *sitakaraensis* (Suzuki) ; Minato, 1950, p. 18, figs. 13, 13a-b.

Corbicula (*Batissa*) *sitakaraensis* Suzuki ; Oyama, Mizuno and Sakamoto, 1960, p. 160, pl. 48, figs. 3a-h (figs. 3a-c, f, reproduced from Ôtatume, 1943a ; 3d-e, from Ôtatume, 1943d ; 3g-h, from Suzuki, 1941a) ; Honda, 1981, p. 18, pl. 2, figs. 11, 19, pl. 3, figs. 1-8 ; Honda, 1986b, pl. 1, figs. 10a-b.

Corbicula (*Cyanocyclas*) *sitakaraensis* (Suzuki) ; Devyatilova and Volobueva, 1981, p. 88, pl. 28, figs. 9-11.

Remarks : Several hundred specimens were collected from pebbly to granular conglomerate and poorly sorted fine-grained sandstone bearing pebbles and granules at 32 localities of the Rushin, Yubetsu, Shitakara, and Omagari Formations. The taxonomy of *C. sitakaraensis* was discussed in detail by Honda (1981).

Locality and Formation : YBY-1, 3, 4, Yubetsu Formation ; B-06, 13, SK1-2, SK2-3, SK3-3, Shitakara Formation ; SBK-11, Shakubetsu Formation ; OMY-1, Omagari Formation. Other localities within the Ombetsu district were given in Honda (1981).

Subgenus *Corbicula* s.s.
Corbicula (*Corbicula*) *tokudai* (Yokoyama, 1890)

Pl. 2, Fig. 5

Cyrena sp. ; Jimbo, 1890, p. 42, pl. 1, fig. 5 (*fide* Suzuki 1941d).

Circe tokudai Yokoyama, 1932, p. 240, pl. 2, figs. 3, 4 (*non* fig. 2).

Corbicula atrata tokudai (Yokoyama) ; Suzuki, 1941b, p. 9, text-fig. 1, 2 on page 10, pl. 1, figs. 11, 12, pl. 2, figs. 1-26 ; Suzuki, 1941c, p. 32, pl. 2, figs. 6-18.

Corbicula atrata tokudai (Yokoyama) ? ; Suzuki, 1941d, p. 524, text-figs. 1a-b on page 521 (reproduced from Jimbo, 1890)

Corbicula tokudai (Yokoyama) ; Nagao and Ôtatume, 1943, p. 7, pl. 3, figs. 4-9 ; Ôtatume, 1943c, p. 16, text-fig. 4 on page 18 ; *non* Kamada, 1955b, p. 21, pl. 4, figs. 4-9.

Corbicula (*Corbicula*) *tokudai* (Yokoyama) ; Oyama, Mizuno and Sakamoto, 1960, p. 166, pl. 50, figs. 6a-k (6a-c, reproduced from Suzuki, 1941c ; 6d-k, from Suzuki, 1941b) ; Honda, 1981, p. 20, pl. 2, figs. 1-5, 7, 8, 12-18 ; Honda, 1986b, pl. 2, fig. 3.

Remarks: Several hundred specimens were collected from fine-grained sandstone, siltstone and granular conglomerate at 32 localities of the Yubetsu, Shakubetsu and Omagari Formations. The taxonomy of *C. tokudai* was discussed in detail by Honda (1981).

Locality and Formation: YBY-2, Yubetsu Formation; SBY-1, 2, 3, 4, 5, 6, Shakubetsu Formation; OMY-2, Omagari Formation. Other localities within the Ombetsu district were given in Honda (1981).

Family Lucinidae
Subfamily Myrteinae
Genus *Lucinoma* Dall, 1901
Lucinoma hannibali (Clark, 1925)

Pl. 6, Fig. 3

Phacoides (*Lucinoma*) *hannibali* Clark, 1925, p. 89, pl. 22, figs. 2, 4; Tegland, 1933, p. 115, pl. 8, figs. 5-13 (fig. 5, reproduced from Clark, 1925).

Lucina hannibali (Clark); Weaver, 1942, p. 145, pl. 34, figs. 9, 10, 12, 18 (figs. 9, 10, reproduced from Clark, 1925).

Lucinoma hannibali (Clark); Hirayama, 1954, p. 109, pl. 11, figs. 1-4, 6-8 (fig. 6, reproduced from Tegland, 1933); Kanno, 1960, p. 248, pl. 35, figs. 3-5.

Lucina (*Phacoides*) cf. *hannibali* Clark; Watanabe, Arai and Hayashi, 1950, pl. 3, fig. 4.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	Valve
95115	D-35	29.2	32.8	89.0	Both

Remarks: A total of 18 specimens were collected from siltstone at seven localities of the Charo Formation, and one from fine-grained sandstone of the Omagari Formation. The present species was originally described by Clark (1925) from the Oligocene of Northwest America. It is characterized by its subcircular to subtrapezoidal shell with numerous concentric lamellae on its surface, and by its elongate and lanceolate lunule. Watanabe, Arai and Hayashi (1950, pl. 3, fig. 4) illustrated *Lucina* (*Phacoides*) cf. *hannibali* from the Akahira Formation of the Chichibu Basin, but it is assigned here to *Lucinoma hannibali*, as was done by Oyama, Mizuno and Sakamoto (1960).

The present species resembles *Lucinoma nagaoi* Oyama and Mizuno (1958, p. 601, pl. 4, figs. 7-9) from the Yamaga Formation (late Oligocene) of the Ashiya Group, Kyushu, but it differs from the latter in having a more inequilateral shell and more anteriorly situated beaks. It also resembles *Lucinoma acutilineata* (Conrad, 1849, p. 725, pl. 18, figs. 2, 2a-b; *fide* Dall, 1909), originally described from the Astoria Formation (Miocene) of Northwest America, but it differs in having more anteriorly situated beaks.

The present species also resembles *Lucinoma columbiana* (Clark and Arnold, 1923, p. 144, pl. 25, figs. 2a-b), originally described from the Sooke Formation (late Oligocene or early Miocene) of British Columbia, Canada. But, it differs from the latter by having a more inequilateral shell. *Lucinoma hannibali* has also been recorded from: Blakeley Formation of Northwest America (Tegland, 1933); and the Akahira (Hirayama, 1954) and Ushikubitoge Formations (Kanno, 1960) of the Chichibu Basin.

Associated fauna: The present species is associated with *Portlandia watasei* (s.s.), *Cyclocardia tokudai*, and *Turritella* sp. in the Charo Formation; and with *Clinocardium* sp., *Dentalium* sp., *Turritella tokunagai*, and *Balanus* sp. in the Omagari Formation.

Locality and Formation: OMH-3, Omagari Formation; D-03, 24, 31, 35, 36, 37, 40, Charo Formation.

Family Thyasiridae
Genus *Conchocele* Gabb, 1866
Conchocele bisecta (Conrad, 1849)

Pl. 4, Fig. 24, Pl. 5, Figs. 11a-b,
Pl. 6, Figs. 7a-b

Venus bisecta Conrad, 1849, p. 724, pl. 17, figs. 10, 10a (*fide* Dall, 1895).

Non Cryptodon bisectus (Conrad); Dall, 1895, p. 713, pl. 26, figs. 2, 5.

Thyasira bisecta Conrad; Reagan, 1909, p. 180, pl. 1, fig. 7 on page 176; Yabe and Nomura, 1925, p. 84, pl. 23, figs. 2, 7-10; Yokoyama, 1927a, p. 457, pl. 52, fig. 11; Yabe, 1927a, fig. 2; Lark, 1932, p. 810, pl. 14, fig. 2; Khomenko, 1933, pl. 1, fig. 10; Niino, 1934, pl. 5, figs. 1-7; Tan, 1938, fig. 6; Abbott, 1954, p. 384, fig. 77a; Shikama, 1954, pl. 4, fig. 11; Abbott, 1974, p. 463, fig. 5336.

Non Thyasira bisecta Conrad; Arnold, 1903, p. 135, pl. 15, fig. 4; Oldroyd, 1924, p. 120, pl. 10, fig. 1.

Conchocele disjuncta Gabb; Takahashi, 1922, p. 80, pl. 9, fig. 4 (in part); Habe, 1958, p. 26, pl. 2, fig. 5; Habe, 1961, p. 124, pl. 56, fig. 15; Okutani, 1962, p. 23, pl. 2, fig. 9; Habe, 1964a, p. 181, pl. 56, fig. 15 (reproduced from Habe, 1961).

Thyasira bisecta (Conrad); Yokoyama, 1925c, p. 122, pl. 15, figs. 1, 2; Yokoyama, 1926c, p. 294, pl. 35, figs. 2, 3; Yokoyama, 1929, p. 391, pl. 72, fig. 9; Grant and Gale, 1931, p. 281; Makiyama, 1934, p. 147-151; Nomura, 1935a, p. 108, pl. 7, fig. 8; Kuroda, 1938, p. 417-419; Slodkewitsch, 1938b, p. 147, pl. 66, fig. 10, pl. 67, figs. 1, 1a; Tagami, 1941, p. 1005, pl. 50, figs. 1d-e; Simonova, 1941, p. 85, pl. 12, fig. 3, pl. 13, fig. 2 ? (*fide* Krishtofovich, 1969); Weaver, 1942, p. 142, pl. 34, figs. 5, 6 (reproduced from Conrad, 1849); Takayasu, 1961, pl. 2, figs. 5, 6; Moore, 1963, p. 72, pl. 23, figs. 8, 14, 15; Krishtofovich, 1969, p. 190, pl. 5, figs. 8, 9; Bernard, 1972, p. 368, figs. 3, 4, 9, 13D; Yoon, 1976, p. 10, pl. 3, figs. 10, 11, 14.

Non Thyasira bisecta (Conrad); Yokoyama, 1924, p. 18, pl. 3, fig. 2; Yokoyama, 1925a, p. 24, pl. 6, fig. 5.

Thyasira bisecta Conrad var. *nipponica* Yabe and Nomura; Yabe, 1927b, fig. 2 (reproduced from *Thyasira bisecta* of Yabe, 1927a).

Thyasira nipponica Yabe and Nomura; Watanabe, Arai and Hayashi, 1950, pl. 3, fig. 5.

Conchocele disjuncta; Nakazima, 1958, p. 186-196, figs. 1-3, pls. 8-11.

Conchocele bisecta (Conrad); Kamada, 1962, p. 92, pl. 8, figs. 7-9, pl. 9, fig. 1; Golikov and Scarlato, 1967, p. 103, fig. 88; Hayashi, 1973, pl. 3, fig. 6; Habe, 1977, p. 129, pl. 24, fig. 19; Shibata and Ina, 1983, p. 46, pl. 5, fig. 10; Ueda and Sugiyama, 1984, p. 149-151, figs. 1-6; Honda, 1986b, pl. 1, fig. 9.

Non Conchocele bisecta (Conrad); Aoki, 1954, p. 33, pl. 1, figs. 1-3, 5-8; Omori, 1977, pl. 3, figs. 6a-b.

Thyasira (*Conchocele*) *disjuncta* (Gabb); Shikama, 1964, p. 68, pl. 42, fig. 10.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
95443	OM-14	54.1	42.6	127.0	14.4	33.8	Right
95163	OM-17	69.5	60.3	115.3	38.1/2	32.5	Both
95697-1	OM-17	56.7	—	—	28.7/2	—	Both
95697-2	OM-17	55.3	45.7	121.0	28.6/2	31.3	Both
95697-3	OM-17	38.9	33.2	117.2	19.9/2	30.1	Both
95855	OM-32*	75.0	68.0	110.3	42.0/2	30.9	Both
97112-1	OMH-1	46.9	ca. 46.2	101.5	27.7/2	30.1	Both
97112-2	OMH-1	35.5	31.3	113.4	14.9/2	24.0	Both

Remarks: About 80, rather well preserved specimens having closed, chalky valves were examined. These were collected from black coarse-, gray fine- and very fine-grained sandstone, and siltstone at 12 localities of the Shitakara, Omagari and Charo Formations. The present species was originally described by Conrad (1849) from the Miocene of Astoria of Oregon, Northwest America.

It closely resembles *Conchocele disjuncta* Gabb (1869, p. 28, 29, pl. 7, figs. 48, 48a-b, p. 99; *fide* Yabe and Nomura, 1925), originally described from the Pliocene (*vide* Arnold, 1903, p. 135) of Deadman Island of southern California, America (These beds are now considered to be lower Pleistocene San Pedro Formation; L, Marincovich, Jr., 1987, *written commun.*). Many paleontologists have discussed the specific relationship between *C. bisecta* and *C. disjuncta*. However, the taxonomy is chaotic, because of their considerable intraspecific variations. Some authors regarded them as a single species (Dall, 1895; Arnold, 1903; Reagan, 1909; Yokoyama, 1924; Yabe and Nomura, 1925; Grant and Gale, 1931; Makiyama, 1934; Abbott, 1974; Habe, 1977), but others as two distinct species (Tegland, 1928; Stewart, 1930; Clark,

1932; Abbott, 1954; Kamada, 1962; Bernard, 1972; Yoon, 1976).

Fossil material described as *C. bisecta* from Japan was regarded as *C. disjuncta* or *C. nipponica* (Yabe and Nomura) by Hatai and Nisiyama (1952), and as *C. disjuncta* by Oyama (1950b) and Kanno (1960). The author regards here *C. bisecta* and *C. disjuncta* as two distinct species, because their morphological differences are sufficient to distinguish the former from the latter, as were described by several authors. For instance, Bernard (1972) distinguished *C. bisecta* from *C. disjuncta* by the concave outline of its anterior margin, more prominent umbones, and several anatomical features.

Yabe and Nomura (1925, p. 84, pl. 23, fig. 3; pl. 24, figs. 2-4) proposed *Conchocele nipponica* under the name *Thyasira bisecta* Conrad var. *nipponica*, based on specimens from Japan and Sakhalin, which had previously been assigned to *C. bisecta* (or *C. disjuncta*). *Conchocele bisecta* differs from *C. nipponica* by its more obliquely elongated shell, smaller apical angle, narrower posterior depressed area with a more distinct sulcus, and an anterior margin that projects farther forward. *Conchocele bisecta* resembles *C. bisecta omarui* (Oyama and Mizuno, 1958) from the Akahira Formation of the Ishikari Group, but *C. bisecta omarui* has a smaller and more rounded shell.

The following specimens from Northwest America were assigned to *C. disjuncta* by Tegland (1928): *Cryptodon bisectus* of Dall (1895, p. 713, pl. 26, figs. 2, 5), *Thyasira bisecta* of Arnold (1903, p. 135, pl. 15, fig. 4), and that of Oldroyd (1924, p. 120, pl. 10, fig. 1). Living *C. disjuncta*, which was described by the following authors from seas off Japan, was also assigned to *C. bisecta* by Bernard (1972): Habe (1958, p. 26, pl. 2, fig. 5), Nakazima (1958, p. 185-196, text-figs. 1-3, pls. 8-11), Habe (1961, p. 124, pl. 56, fig. 15), Okutani (1962, p. 23, pl. 2, fig. 9), and Habe (1964a, p. 181, pl. 56, fig. 15).

Conchocele disjuncta of Takahashi (1922, p. 80, pl. 9, fig. 4, in part) from the Koguchi Formation (Miocene, *vide* Hatai and Nisiyama, 1952, p. 47) of Niigata Prefecture, Central Japan, is also assigned here to *C. bisecta*, as was done by Yabe and Nomura (1925). *Thyasira bisecta* of Yokoyama (1924, p. 18, pl. 3, fig. 2) from the Asagai Formation of the Joban coal field, is assigned here to *C. nipponica*, as was also done by Yabe and Nomura (1925).

Thyasira bisecta Conrad var. *nipponica* of Yabe (1927b, fig. 2; reproduced from *T. bisecta* of Yabe, 1927a) from (Division IV" (Oligocene, *vide* Hatai and Nisiyama, 1952, p. 146)) of the Chichibu Basin of Saitama Prefecture, Central Japan, is assigned here to *C. bisecta*, as was done by Oyama, Mizuno and Sakamoto (1960). *Thyasira nipponica* of Watanabe, Arai and Hayashi (1950, pl. 3, fig. 5) from the Akahira Formation of the Chichibu Basin, is also assigned here to *C. bisecta*, as was done by Kanno (1960), and Oyama, Mizuno and Sakamoto (1960).

Conchocele bisecta of Aoki (1954) from the Kabeya Formation (Miocene) of the Joban coal field, is assigned here to *C. nipponica*, as was done by Kamada (1962) and Matsumoto and Terashima (1976). Omori (1977) illustrated *C. bisecta* from the Sawane Formation (Plio-Pleistocene) of Sado Island of Niigata Prefecture, but it is assigned here to *C disjuncta* because of its shell outline.

Thyasira (*Conchocele*) *disjuncta* of Shikama (1964) from the Japan Sea, is assigned here to *C. bisecta* because of its more prominent umbo and its projecting anterior margin. *Conchocele bisecta* has been widely recorded from Cenozoic strata of Japan, Sakhalin, Korea, Kamchatka, and Northwest America, and still lives today in the northern Pacific. The

earliest form is represented by *C. bisecta omarui*. *Conchocele bisecta* (s.l.) is one of the earliest representatives of the genus which appeared in the northern Pacific during Oligocene time, and still lives now in cool waters there. It is essentially a northern group of clams, and is an ancestral form of *C. nipponica*, as was mentioned by Yabe and Nomura (1925).

Associated fauna: The present species is associated with *Clinocardium omagariense*, *Portlandia watasei* (s.s.), *Yoldia laudabilis*, *Periploma besshoense*, *Neverita asagaiensis*, *Neptunea modestoidea*, *Mya grewingki kusiroensis*, and *Cyclocardia* sp. No other molluscan species are associated with *C. bisecta* at Locs. OMH-1 and OMK-12 of the Omagari Formation, where abundant specimens of *C. bisecta* occur closely packed in groups in gray, tuffaceous, very fine-grained sandstone.

Locality and Formation: SK2-13, 14, 15, Shitakara Formation; OM-09, 14, 17, 23, 32*, OMH-1, OMK-12, Omagari Formation; CHY-12, 34, Charo Formation.

Conchocele nipponica (Yabe and Nomura, 1925)

Pl. 8, Figs. 6a-b

Conchocele disjuncta Gabb; Kochibe, 1882, pl. 5, fig. 1; Jimbo, 1898, p. 227, fig. 1; Hachiya, 1904, p. 12, pl. 18, fig. 3; Takahashi, 1922, p. 80, pl. 9, fig. 3 (in part).

Thyasira bisecta (Conrad); Yokoyama, 1924, p. 18, pl. 3, fig. 2; Yokoyama, 1925a, p. 24, pl. 6, fig. 5.

Thyasira bisecta Conrad var. *nipponica* Yabe and Nomura, 1925, p. 84, pl. 23, fig. 3, pl. 24, figs. 2-4; Yokoyama, 1926b, p. 243, pl. 31, fig. 12; Grant and Gale, 1931, pl. 13, fig. 15; *non* Yabe, 1927b, fig. 2 (reproduced from *Thyasira bisecta* of Yabe, 1927a).

Thyasira (*Conchocele*) *nipponica* Yabe and Nomura; Kuroda, 1931, p. 48, pl. 5, fig. 28.

Thyasira (*Conchocele*) *bisectoides* Kuroda, 1931, p. 50, pl. 12, figs. 95, 96.

Thyasira nipponica Yabe and Nomura; Nomura, 1933, p. 75, pl. 3, fig. 1; Nomura and Zinbô, 1935, p. 9; Nomura, 1935b, p. 53, pl. 5, figs. 1, 2; Otuka, 1935, p. 891, pl. 57, fig. 194; Hatai, 1940, p. 125, pl. 1, fig. 8; *non* Watanabe, Arai and Hayashi, 1950, pl. 3, fig. 5.

Thyasira bisecta (Conrad) var. *nipponica* Yabe and Nomura; Slodkewitsch, 1938b, p. 148, pl. 68, figs. 1, 2, 2a.

Thyasira bisecta nipponica Yabe and Nomura; Tan, 1938, p. 4-9, figs. 1-5.

Conchocele nipponica (Yabe and Nomura); Tanaka, 1959a, p. 120, pl. 2, fig. 10, pl. 3, fig. 35; Kamada, 1962, p. 93, pl. 9, figs. 2-6; Matsumoto and Hirata, 1972, p. 757, pl. 1, figs. 4-7; Noda, Amano, Majima, Ito, and Kanno, 1983, p. 6, pl. 1, fig. 9.

Remarks: A total of 11 well preserved specimens with closed valves were collected from siltstone at 2 localities of the Omagari Formation. *Conchocele nipponica* has been variously synonymized with *C. bisecta*, together with *C. disjuncta* and *C. bisectoides* (Kuroda) by Makiyama (1934), with *C. bisecta* as well as *C. bisectoides* by Aoki (1954), or with *C. disjuncta* as well as *C. bisectoides* by Kanno (1971).

Conchocele disjuncta of the following authors was assigned to *C. nipponica* by Yabe and Nomura (1925): Kochibe (1882, pl. 5, fig. 1), Jimbo (1898, p. 227, fig. 1), Hachiya (1904, p. 12, pl. 18, fig. 3), and Takahashi (1922, p. 80, pl. 9, fig. 3, in part) from the Miocene (*vide* Hatai and Nisiyama, 1952, p. 47) of Japan. Yokoyama (1924) described *T. bisecta* from the Asagai Formation of the Joban coal field, but it is assigned here to *C. nipponica* owing to the general features of its shell, as was done by Yabe and Nomura (1925). Yokoyama (1925a) described *T. bisecta* from the Misawa Formation (Miocene, *vide* Hatai and Nisiyama, 1952, p. 145) of the Joban coal field, but it is also assigned here to *C. nipponica*, as was done by Kamada (1962).

Kuroda (1931) proposed *T.* (*Conchocele*) *bisectoides* from the Uchimura Formation (Miocene, *vide* Honma, 1931, p. 114) of Nagano Prefecture, Central Japan. But it seems to be a junior syno-

nym of *C. nipponica* in its outline, as was done by Kamada (1962). Watanabe, Arai and Hayashi (1950, pl. 3, fig. 5) illustrated *T. nipponica* from the Akahira Formation of the Chichibu Basin, but it is assigned here to *C. bisecta* in its outline, as was done by Oyama, Mizuno and Sakamoto (1960). *Conchocele nipponica* is indigeneous to Cenozoic strata of Sakhalin, Japan and Taiwan, and the occurrence from the Omagari Formation is one of the earliest records of it.

Associated fauna: The present species is associated with *Clinocardium omagariense*, *Yoldia laudabilis*, and *Portlandia watasei* (s.s.) at Loc. OM-21; and with *C. bisecta* and *Periploma besshoense* at Loc. OM-23.

Locality and Formation: OM-21, 23, Omagari Formation.

Family Cardiidae
Subfamily Protocardiinae
Genus *Nemocardium* Meek, 1876
Subgenus *Arctopratulum* Keen, 1954
Nemocardium (*Arctopratulum*) *ezoense* Takeda, 1953

Pl. 6, Figs. 1, 4

Nemocardium ezoense Takeda, 1953, p. 82, pl. 9, figs. 1-6, 8, 9, pl. 10, figs. 1, 2, pl. 11, fig. 1; Scheremetjeva, 1977, p. 68, pl. 21, figs. 4-6, pl. 22, figs. 1-14.

Nemocardium (*Arctopratulum*) *ezoense* Takeda; Keen, 1954, p. 318, pl. 1, figs. 10, 13 (reproduced from Takeda, 1953); Honda, 1980a, pl. 30, figs. 3a-c.

Arctopratulum ezoense Takeda; Habe, 1977, p. 170.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
	SK-22	39.6	31.8+	124.5	18.6/2	29.2	Both
96250	SK-40*	25.1	23.8	105.5	11.6/2	24.4	Both
	SK2-7	39.7	40.0	99.3	27.6/2	34.5	Both
97147	SKK-30	44.5	39.8	111.8	19.3	48.5	Right
95154	OM-32	47.9	46.4	103.2	32.0/2	34.5	Both

* figured specimen in Honda (1980a, pl. 30, figs. 3a-c)

Remarks: Several hundred specimens were collected in groups from gray, poorly-sorted, fine-grained sandstone often bearing pebbles and granules at 69 localities of the Shitakara Formation, and about 30 specimens from gray, very fine- and fine-grained sandstone, and siltstone at 5 localities of the Omagari Formation. The present species was originally described by Takeda (1953) from the Nisisakutan bed of the Maoka Group, and the Shitakara and the Omagari Formation.

It is characterized by its trigonal to subquadrate shell with fine radial ribs and concentric lines of growth on the surface. The surface of the shell is sculptured with more than 50, flat-topped radial ribs, with incised interspaces on the anterior and central slopes, and shows cancellate sculpture. It is also sculptured with about 20 rounded ribs on the posterior slope that are wider than the interspaces, and shows threaded sculpture. *Nemocardium ezoense* has a fairly variable outline, for instance the height/length ratio varies from 99.3 to 124.5 percent and the width/length ratio varies from 24.4 to 48.5 percent.

Nemocardium ezoense resembles *N.* (*Arctopratulum*) *yokoyamai* Takeda, 1953, and has the same ornamentation as the latter. But it differs by having a smaller shell, and by the weaker, pointed posterior cardinal on the right valve (Takeda, 1953).

Nemocardium ezoense and *Ostrea eorivularis* commonly occur together in poorly sorted fine-grained sandstone bearing pebbles and granules of the Shitakara Formation. The former occurs in large numbers in sandstone, and the latter occurs where pebbles are closely packed in sandstone. *Nemocardium ezoense* has also been recorded from the Takaradai Bed (Oligocene) of southern Sakhalin (Scheremetjeva, 1977).

Associated fauna: The present species is associated with *O. eorivularis*, *Chlamys shitakaraensis*, *Mya grewingki kusiroensis*, *Corbicula sitakaraensis*, *Thracia shitakaraensis*, n. sp., *Macoma*

sejugata, *Periploma besshoense*, and *Nemocardium yokoyamai* in the Shitakara Formation. It is also associated with *Clinocardium omagariense*, *Yoldia laudabilis*, *Portlandia watasei* (s.s.), *Neverita asagaiensis*, *Cyclocardia* spp., *Neptunea ezoana* Takeda, and *N. modestoidea* in the Omagari Formation.

Locality and Formation: SK-01, 02, 03, 07, 08, 10, 11, 12, 13, 14, 15, 16, 17, 18, 22, 27, 29, 32, 33, 35*, 37*, 38, 39, 40, 40*, 41, 42, 45, 46, 49, 50, 51, 52, 53, 54, A, B, C, D, E, B-01, 02, 03, 05, 06, SK1-3, SK2-4, 7, 8, 16, 17, SK3-3, SKK-2, 5, 6, 8, 10, 11, 13, 17, 21, 22, 23, 24, 26, 27, 29, 30, 31, Shitakara Formation ;
OMH-B, 6830R, OM-06, 25, 32, Omagari Formation.

Nemocardium (*Arctopratulum*) *yokoyamai* Takeda, 1953

Pl. 4, Fig. 5

Cardium (*Laevicardium*) *tristiculum* ; Yokoyama, 1930, p. 415, pl. 78, figs. 3-6 (*non Cardium* (*Laevicardium*) *tristiculum* Yokoyama, 1924).
Nemocardium yokoyamai Takeda, 1953, p. 84, pl. 9, figs. 10-12, pl. 11, fig. 4 [new name for *Cardium* (*Laevicardium*) *tristiculum* of Yokoyama, 1930] ; Scheremetjeva, 1977, p. 69, pl. 21, figs. 2, 3, 7-9, 13-16 ; *non* Kanno and Matsuno, 1960, pl. 4, fig. 9.
Nemocardium (*Arctopratulum*) *yokoyamai* Takeda ; Keen, 1954, p. 318.
Arctopratulum yokoyamai Takeda ; Habe, 1977, p. 170.

Dimension (in mm) :

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
97120	SK-52	20.0	20.9	95.7	ca. 3.4	16.3	Left
95135	B-05	24	33	72.7	—	—	Right*

* incomplete specimen

Remarks: Several specimens were collected from iron-stained, very fine- and fine-grained sandstone, and siltstone at five localities of the Shitakara and Omagari Formations. Takeda (1953) proposed *Nemocardium yokoyamai* for *Cardium* (*Laevicardium*) *tristiculum* of Yokoyama (1930) from the Maoka Group of southern Sakhalin (*vide* Oyama, Mizuno and Sakamoto, 1960, p. 175).

Kanno and Matsuno (1960, pl. 4, fig. 9) illustrated *N. yokoyamai* from the Sankebetsu Formation (Miocene) of Hokkaido. But it is probably a different species of the genus, as it was doubtfully treated as *N.* (*Keenaea*) *samarangae* (Makiyama, 1934) by Masuda and Noda (1976). The present species has also been recorded from the Tenneru and the Charo Formations (Matsui, 1962) ; the Shimokine Formation of the Tappu Group (Oligocene ; Ohara, 1966b) ; and the Takaragai bed (Oligocene) of southern Sakhalin (Scheremetjeva, 1977).

Associated fauna: The present species is associated with *Nemocardium ezoense* and *Mya grewingki* (s.l.) in the Shitakara Formation ; and with *Cyclocardia tokudai*, *Periploma besshoense*, *Clinocardium omagariense*, *Portlandia watasei* (s.s.), and *Turritella poronaiensis* in the Omagari Formation.

Locality and Formation: SK-17, 52, B-05, SKK-30, Shitakara Formation ; OM-26, Omagari Formation.

Subgenus *Keenaea* Habe, 1951 *Nemocardium* (*Keenaea*) *iwakiense* (Makiyama, 1934)

Pl. 4, Figs. 9a-b

Cardium (*Nemocardium*) *iwakiense* Makiyama, 1934, p. 144, pl. 5, figs. 25-29.
Nemocardium iwakiense (Makiyama) ; Hirayama, 1955, p. 99, pl. 4, fig. 16 ; Nemoto and O'Hara, 1979, pl. 1, fig. 10.
Nemocardium (*Keenaea*) *iwakiense* (Makiyama) ; Kamada, 1962, p. 100, pl. 10, figs. 5-7.
Nemocardium iwakiense Makiyama ; Devyatilova and Volobueva, 1981, p. 74, pl. 27, fig. 2.

Remarks: A total of five, well-preserved specimens were collected from siltstone at one locality of the Omagari Formation. This species is characterized by its rounded shell and radial ribs intersecting concentric threads : more than 40 ribs on the anterior and central slopes, and 18 to 20 ribs on the posterior

slope (Makiyama, 1934). It resembles *N.* (*Keenaea*) *samarangae* (Makiyama, 1934), which is known in Miocene to Recent faunas of Japan, but it differs from the latter by having a larger shell, a relatively smaller posterior area, and in other ways (Makiyama, 1934).

Nemocardium iwakiense has also been recorded from the Shitakara Formation (Imanishi, 1953) and the Oligocene of the Koryak Upland (Devyatilova and Volobueva, 1981).

Associated fauna: The present species is associated with *Cyclocardia tokudai*, *Periploma besshoense* and *Clinocardium omagariense*.

Locality and Formation: OM-25, Omagari Formation.

Subfamily Trachycardiinae
Genus *Trachycardium* Mörch, 1853
Trachycardium kinsimarae (Makiyama, 1934)

Pl. 5, Figs. 16a-b

Cardium (*Trachycardium ?*) *kinsimarae* Makiyama, 1934, p. 141, pl. 6, fig. 35.

Laevicardium (*Trachycardium ?*) *kinsimarae* (Makiyama); Slodkewitsch, 1938b, p. 154, pl. 75, figs. 1-3.

Trachycardium kinsimarae (Makiyama); Oyama, Mizuno and Sakamoto, 1960, p. 179, pl. 55, fig. 1 (reproduced from Makiyama, 1934).

Description: Shell ovate, inequilateral and moderately compressed. Height of shell greater than length. Anterodorsal margin widely rounded, posterodorsal margin narrowly arched, and ventral margin narrowly rounded. Beaks inconspicuous, and almost situated centrally. A weak ridge runs from the umbo to the posteroventral corner. Posterodorsal area well inflated. Surface sculptured with about 35 round-topped radial ribs that are wider than the interspaces. Inner surface unknown.

Dimensions (in mm):

Specimen no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
1	OMH-11	23.5	ca. 20	117.5	3.4	17.0	Right*
1	OMH-11	23.4	19.0	123.2	3.7	19.5	Left*
2	OMH-11	23.2	20.5	113.2	4.7	22.9	Right*
2	OMH-11	25.2	22.9	110.0	5.9	25.8	Left*

* matching valves

Remarks: Only three specimens, with closed valves, were collected from fine-grained sandstone at two localities of the Omagari Formation. The present species was originally described by Makiyama (1934) on the basis of a right valve from the Marie Formation (Oligocene, *vide* Oyama, Mizuno and Sakamoto, 1960, p. 179) of northern Sakhalin. Although the specimens at hand are much smaller than the type specimen, they are referable to the present species owing to the general features of their shells.

Associated fauna: The present species is associated with *Clinocardium* sp., and Myophiuridae gen. et. sp., indet.

Locality and Formation: OMH-11, 12, Omagari Formation.

Subfamily Laevicardiinae
Genus *Profulvia* Kafanov, 1976
Profulvia harrimani (Dall, 1904)

Pl. 6, Fig. 6

Papyridea harrimani Dall, 1904, p. 114, pl. 10, fig. 5; Khomenko, 1933, p. 16, pl. 2, fig. 8; Slodkewitsch, 1938b, p. 156, pl. 81, figs. 5-7; Krishtofovich *in* Krishtofovich and Ilyina, 1954, p. 96, pl. 18, fig. 5; Hirayama, 1955, p. 100, pl. 2, fig. 24; Oyama, Mizuno and Sakamoto, 1960, p. 180, pl. 52, figs. 4a-c (fig. 4a, reproduced from Makiyama, 1934; 4b-c, from Yokoyama, 1924); Kamada, 1962, p. 107, pl. 11, figs. 3-5; Uozumi, Fujie and Matsui, 1966, p. 177, pl. 15, figs. 1, 7; Narita and Omi, 1975, pl. 2, figs. 1a-b, pl. 3, fig. 2; Devyatilova and Volobueva, 1981, p. 72, pl. 27, fig. 1.

Papyridea (*Fulvia*) *nipponica* Yokoyama, 1924, p. 17, pl. 3, figs. 3, 4.

Cardium (*Papyridea*) *harrimani* (Dall); Makiyama, 1934, p. 141, pl. 6. figs. 32-34.

Papyridea harrimani nipponica Yokoyama; Kamada, 1962, p. 108, pl. 11, figs. 6-8.

Fulvia hariimani [sic] (Dall); Keen, 1973, p. 4.

Profulvia harrimani (Dall); Kafanov, 1976, p. 111.
Papyrider [sic] *harrimani* Dall; Nemoto and O'Hara, 1979, pl. 1, fig. 9.
Laevicardium (*Profulvia*) *harrimani* (Dall); Keen, 1980, pl. 13, fig. 6 (reproduced from Dall, 1904).

Remarks: Only one imperfect external mold of a right valve having about thirty-nine, radial ribs, was collected from siltstone of the Charo Formation. On the basis of an internal cast of a left valve, Dall (1904) described *Papyridea harrimani* from a "Miocene" bed on Popof Island of southwestern Alaska (this bed is now assigned to the Eocene or Oligocene Stepovak Formation; L. Marincovich, Jr., 1985, *pers. commun.*), and noted more than 35 radial ribs on the central part of the surface. Many authors have placed this species in the genus (or subgenus) *Papyridea* Swainson, 1840, but Kafanov (1976, p. 111) placed it in his newly proposed genus *Profulvia*. Subsequently, Keen (1980) placed this species in the genus *Laevicardium* Swainson, 1840, and lowered *Profulvia* to subgenus rank.

Yokoyama (1924) proposed *Papyridea* (*Fulvia*) *nipponica*, which has about 35 radials, from the Asagai Formation. Kamada (1962) examined specimens of *P. harrimani* and *P. nipponica* from the Asagai Formation, and regarded the latter as a subspecies of *P. harrimani*, on the basis of the number of radial ribs: 30 to 35 (with a mean of 33) in *P. harrimani* and 45 to 56 (with a mean of 48) in *P. nipponica*.

But the ribs count does not sufficiently differentiate these two species, because *P. harrimani* has more than 35 radials on the middle part of the shell surface (Dall, 1904), and also because there are more than about 47 ribs on the whole surface in Dall's figure (pl. 10, fig. 5). Therefore, the author here regards *P. nipponica* as being synonymous with *P. harrimani*, as was done by Makiyama (1934); Hatai and Nisiyama (1952); and Oyama, Mizuno and Sakamoto (1960).

The present species resembles *Profulvia kurodai* (Sawada, 1962), but it differs from the latter in having a more rounded shell. *Profulvia harrimani* has also been recorded from the Shitakara and the Omagari Formations (Mizuno, 1964b), the Shimokine Formation of the Tappu Group (Ohara, 1966b), the Ainonai Formation (Miocene) of Hokkaido (Uozumi, Fujie and Matsui, 1966); the Ainonai and the Tokoro Formations (Narita and Omi, 1975); the Oligocene of the Koryak Upland (Volobueva, 1980; Devyatilova and Volobueva, 1981); the Miocene of Kamchatka (Khomenko, 1933; Slodkewitsch, 1938a, b); and the Machigar Formation (Oligocene) of northern and southern Sakhalin (Krishtofovich *in* Krishtofovich and Ilyina, 1954).

Associated fauna: The present species is associated with *Lucinoma hannibali*, *Cyclocardia* sp., and *Trominina japonica*.

Locality and Formation: D-24, Charo Formation.

Family Vesicomyidae
Genus *Hubertschenckia* Takeda, 1953
Hubertschenckia ezoensis (Yokoyama, 1890)

Pl. 5, Figs. 13, 14

Tapes ezoënsis Yokoyama, 1890, p. 197, pl. 25, figs. 6–8.
Non Meretrix (*Macrocallista*) *ezoensis*, (Yokoyama); Yokoyama, 1928, p. 77, pl. 8, fig. 1.
Tapes (new gen. ?) *ezoensis* Yokoyama; Minato and Uozumi, 1951b, p. 150, pl. 13, figs. 108a-b.
Hubertschenckia ezoensis (Yokoyama); Takeda, 1953, p. 85, pl. 13, fig. 5.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
99281	SK-49	30.0	43.0	69.8	18.0/2	20.9	Both

Remarks: Only two specimens, with closed valves, were collected from fine-grained sandstone bearing pebbles and

granules at one locality of the Shitakara Formation. The present species was originally described by Yokoyama (1890) under the name *Tapes ezoënsis*, from the Poronai Formation (*vide* Minato and Uozumi, 1951b, p. 150). Takeda (1953) placed it in his newly proposed genus *Hubertschenckia*, and Boss and Turner (1980) doubtfully synonymized the genus with *Calyptogena* Dall, 1891.

Yokoyama (1928) described this species under the name *Meretrix* (*Macrocallista*) *ezoensis*, from the Upper Byoritz Beds (Pliocene) of Taiwan. But the latter is a different venerid species owing to its more roundly inflated shell, as was done by Takeda (1953). The present species has also been recorded from the Tappu Formation of the Tappu Group (Ohara, 1966b ; Ôhara and Kanno, 1973) ; the Omagari Formation (Takeda, 1953) ; and the Charo and the Nuibetsu Formation (Matsui, 1962).

Associated fauna : The present species is associated with *Nemocardium ezoense* and *Ostrea* sp. It is also associated with *Conchocele bisecta* in the Poronai and the Omagari Formation (Takeda, 1953), and in the Nuibetsu Formation (Tanai, 1961 ; Oda, Nemoto and Uemura, 1959) ; and, with *C. bisecta* (or *C. disjuncta*), and *Orectospira wadana* in the Tappu Formation (Ohara, 1966b ; Ôhara and Kanno, 1973).

Locality and Formation : SK-49, Shitakara Formation.

Family Veneridae
Subfamily Pitarinae
Genus *Callista* Poli, 1971
Callista sp.

Remarks : Only two specimens, having open valves, were collected from fine-grained sandstone bearing pebbles at one locality of the Shitakara Formation.

Associated fauna : The present species is associated with *Nemocardium ezoense* and *Corbicula sitakaraensis*.

Locality and Formation : B-02, Shitakara Formation.

Subfamily Tapetinae
Genus *Liocyma* Dall, 1870
Liocyma terrena (Yokoyama, 1924)

Pl. 5, Fig. 1

Venus terrena Yokoyama, 1924, p. 15, pl. 2, fig. 19.
Liocyma terrena (Yokoyama) ; Kamada, 1962, p. 117, pl. 13, figs. 8, 9 ; Nemoto and O'Hara, 1979, pl. 1, fig. 11.
Liocyma terrena [sic] (Yokoyama) ; Makiyama, 1934, p. 153, pl. 6, fig. 44 ; Hirayama, 1955, p. 103, pl. 3, figs. 15–17.

Remarks : Only two specimens were collected from siltstone at one locality of the Charo Formation. The present species was originally described by Yokoyama (1924) from the Asagai Formation.

Associated fauna : The present species is associated with *Yoldia sobrina*, and *Acila* (s.s.) sp.

Locality and Formation : D-42, Charo Formation.

Liocyma furtiva (Yokoyama, 1924)

Pl. 5, Figs. 2, 3

Venus furtiva Yokoyama, 1924, p. 15, pl. 2, fig. 6.
Liocyma furtiva (Yokoyama) ; Makiyama, 1934, p. 152, pl. 6, figs. 41–43, 45–48 ; Watanabe, Arai and Hayashi, 1950, pl. 4, fig. 2 ; Krishtofovich *in* Krishtofovich and Ilyina, 1954, p. 98, pl. 19, figs. 2, 3 ; Hirayama, 1955, p. 102, pl. 3, figs. 18–20 ; Kamada, 1962, p. 116, pl. 13, figs. 5–7 ; Matsumoto, 1964, p. 105, pl. 2, figs. 11, 12 ; Matsumoto and Terashima, 1976, p. 45, pl. 9, figs. 1–3 ; Nemoto and O'Hara, 1979, pl. 1, fig. 12 : O'Hara and Nemoto, 1982, pl. 2, figs. 4–6.
Liocyma furtiva [sic] (Yokoyama) ; Devyatilova and Volobueva, 1981, p. 94, pl. 29, figs. 3–9, pl. 38, fig. 6.

Remarks : Only four specimens were collected from siltstone at two localities of the Nuibetsu Formation. The present species was originally described by Yokoyama (1924) from the Asagai Formation. It has also been recorded from horizon 4 at Machigar in northern Sak-

halin (Makiyama, 1934); the Machigar Formation (Oligocene) of southern Sakhalin (Krishtofovich *in* Krishtofovich and Ilyina, 1954); the Oligocene to Miocene of Kamchatka (Volobueva, 1980; Devyatilova and Volobueva, 1981); the Akahira Formation of the Chichibu Basin (Watanabe, Arai and Hayashi, 1950); the Ôga Formation of Shizuoka Prefecture, Central Japan (Matsumoto, 1964); and the Muroto Formation of Shikoku, Southwest Japan (Matsumoto and Terashima, 1976).

Associated fauna: The present species is associated with *Cyclocardia* sp., *Turritella* sp. and *Dentalium* sp.

Locality and Formation: NB-31, NBK-71, Nuibetsu Formation.

Subfamily Clementinae
Genus *Clementia* Gray, 1842
Clementia sp.

Remarks: Only one specimen was collected from siltstone of the Nuibetsu Formation.

Associated fauna: The present species is associated with *Cyclocardia tokudai*, *Turritella nuibetsuensis*, n. sp., and *Trominina ishikariensis* (Hayasaka and Matsui).

Locality and Formation: D-11, Nuibetsu Formation.

Family Mactridae
Subfamily Mactrinae
Genus *Mactra* Linné, 1767
Mactra sp.

Pl. 5, Fig. 8

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
97125	SK-56	ca. 27.2	ca. 35.6	76.4	5.4	15.2	Left

Remarks: Only one imperfect left valve was collected from fine-grained sandstone of the Shitakara Formation. Shell small, trigonally ovate, moderately inflated, and inequilateral. Beak small, moderately elevated and opisthogyrous. Surface sculptured with feeble concentric lines of growth. The present species resembles *Pseudocardium sachalinensis* (Schrenck, 1862), living on fine sand bottoms of the Okhotsk Sea, Sakhalin, Kurile Islands, Hokkaido, northern Honshu, northern Korea, and Sikhote-Alin, eastern USSR (Habe and Ito, 1965). But it differs from the latter by having a more weakly inflated umbonal area.

Associated fauna: The present species is associated with *Corbicula sitakaraensis* and *Turritella* sp.

Locality and Formation: SK-56, Shitakara Formation.

Genus *Spisula* Gray, 1837
Subgenus *Mactromeris* Conrad, 1868
Spisula (*Mactromeris*) *sorachiensis* Uozumi, 1955

Pl. 5, Fig. 15, Pl. 8, Fig. 2

Spisula sorachiensis Otatume (MS); Uozumi, 1955b, p. 78, pl. 12, figs. 3, 5.
Spisula sorachiensis Uozumi; Hirayama, 1956, p. 116, pl. 6, fig. 16.
Spisula (*Mactromeris*) *sorachiensis* Uozumi; Oyama, Mizuno and Sakamoto, 1960, p. 202, pl. 62, figs. 1a-c (figs. 1a-b, reproduced from Uozumi, 1955b; fig. 1c, from Hirayama, 1956).

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	Valve
97151	YBK-2	32.0	46.1	69.4	Left
99282-1	SK-25	37.7	51.0	73.9	Left

Remarks: A total of seven specimens were collected from gray, poorly sorted, fine-grained sandstone at three localities of the Yubetsu and Shitakara Formations. This species resembles *Spisula* (*Mactromeris*) *nagakoensis* Hatai and Nisiyama (1949) from the Asagai Formation, but it differs from the latter by having a more compressed and more trigonal shell.

The present species is allied also to

Pseudocardium sachalinensis, but differs in having a more compressed and more elongated shell. *Spisula sorachiensis* has also been recorded from an unnamed stratum on Hikoshima Island in Yamaguchi Prefecture, western Honshu, which is a correlative of the Ashiya Group of Kyushu (Hirayama, 1956).

Associated fauna: The present species is associated with *Solen shitakaraensis*, n. sp. and *Phaxas* sp.

Locality and Formation: YBK-2, Yubetsu Formation; SK-25, B-08, Shitakara Formation.

Spisula sp.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	Valve
95134	B-04	35.9	54.3	66.1	Right

Remarks: A total of three specimens were collected from fine-grained sandstone bearing granules at two localities of the Shitakara Formation. The present species is characterized by its moderate, trigonally subelliptical shell with numerous fine concentric growth lines on the surface. It resembles *Spisula sorachiensis*, but differs in having a more elongated shell.

Associated fauna: The present species is associated with *Nemocardium ezoense*, *Thracia shitakaraensis*, n. sp., and *Chlamys shitakaraensis*.

Locality and Formation: SK-51, B-04, Shitakara Formation.

Family Tellinidae
Subfamily Macominae
Genus *Macoma* Leach, 1819
Subgenus *Macoma* s.s.
Macoma (*Macoma*) *sejugata*
(Yokoyama, 1924)

Pl. 5, Fig. 4

Tellina sejugata Yokoyama, 1924, p. 14, pl. 2, figs. 9–11.

Macoma sejugata (Yokoyama); Makiyama, 1934, p. 155, pl. 4, fig. 18; Kanno, 1960, p. 301, pl. 43, figs. 7, 8; Kamada, 1962, p. 130, pl. 16, figs. 1–5; Nemoto and O'Hara, 1979, pl. 2, fig. 1; O'Hara and Nemoto, 1982, pl. 2, fig. 1.

Macoma asagaiensis Makiyama, 1934, p. 155, pl. 4, figs. 15, 16, 19; Hirayama, 1955, p. 104, pl. 3, figs. 4–11; Kanno, 1960, p. 300, pl. 43, figs. 9a-b.

Macoma (s.s.) *asagaiensis* Makiyama; Watanabe, Arai and Hayashi, 1950, pl. 4, fig. 6.

Macoma (s.s.) *sejugata* (Yokoyama); Watanabe, Arai and Hayashi, 1950, pl. 4, figs. 7, 8.

Dimensions (in mm):

Specimen no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
1	SK-42	30.0	40.2	74.6	9.2/2	11.4	Both

Remarks: Several tens of specimens were collected from fine-grained sandstone bearing pebbles, and granular or pebbly conglomerate at three localities of the Shitakara Formation; fine-grained sandstone at four localities of the Omagari Formation; and siltstone at three localities of the Charo Formation.

The present species was originally described by Yokoyama (1924) from the Asagai Formation. It is characterized by its moderate and elongate elliptical shell with a subtruncated posterior end. Makiyama (1934) proposed *Macoma asagaiensis* from the Asagai Formation, but it is synonymized with *M. sejugata*, because intermediate forms between the two occur together in the Asagai Formation (Kamada, 1962).

The present species has also been recorded from horizon 6 at Machigar (Oligocene) in northern Sakhalin (Makiyama, 1934); the Maoka Series (Oli-

gocene) in southern Sakhalin (Takeda, 1953); the Shimokine Formation of the Tappu Group (Oligocene), Central Hokkaido (Ohara, 1966b); and the Akahira, the Matsuida (early to middle Miocene; Watanabe, Arai and Hayashi, 1950); the Ushikubitoge Formation, and the Nenokami Sandstone (early Miocene; Kanno, 1960) of the Chichibu Basin.

Associated fauna: The present species is associated with *Nemocardium ezoense*, and *Chlamys shitakaraensis* in the Shitakara Formation; with *Yoldia laudabilis* in the Omagari Formation; and with *Portlandia* spp. in the Charo Formation.

Locality and Formation: SK-10, 11, 42, Shitakara Formation; OMH-A, C, D, H, Omagari Formation; D-18, 22, 27, Charo Formation.

Macoma (*Macoma*) *optiva* (Yokoyama, 1923)

Pl. 7, Figs. 4a-b

Tellina optiva Yokoyama, 1923, p. 6, pl. 2, figs. 3, 4; Yokoyama, 1925c, p. 118, pl. 15, figs. 4, 5; Yokoyama, 1926b, p. 242, pl. 30, fig. 2.

Macoma dissimilis, (Martens); Yokoyama, 1925a, p. 20, pl. 5, fig. 9; Yokoyama, 1929, p. 388, pl. 74, fig. 2.

Non Tellina dissimilis Martens, 1865, p. 430 (*vide* Zhidkova *et al.*, 1972, p. 132).

Tellina izurensis Yokoyama; Yokoyama, 1927b, p. 200, pl. 52, figs. 1, 2.

Non Tellina izurensis Yokoyama, 1925a, p. 19, pl. 2, fig. 12.

Macoma optiva (Yokoyama); Otuka, 1934, p 619, pl. 48, fig. 51; Nomura, 1935c, p. 36, pl. 4, figs. 4, 12; Slodkewitsch, 1938b, p. 472, pl. 94, figs. 4-9; Otuka, 1940, p. 97, text-fig. C on page 97; Uozumi, 1953b, p. 358, pl. 22, figs. 176a-b; Kanno, 1960, p. 299, pl. 43, figs. 10a-c, pl. 44, figs. 1, 2; Araki, 1960, p. 98, pl. 7, figs. 8a-b; Iwai, 1961, pl. 1, fig. 21; Kamada, 1962, p. 128, pl. 15, figs. 1-6; Ilyina, 1963, p. 81, pl. 27, figs. 6, 7 (*fide* Marincovich, 1983, p. 98); Iwai, 1965, p. 44, pl. 13, figs. 13, 14 (fig. 13, reproduced from Iwai, 1961); Kanno, 1967, pl. 1, fig. 13; Zhidkova *et al.*, 1968, p. 121, pl. 13, fig. 2 (reproduced from Lautenschleger, 1953, pl. 18, fig. 10), pl. 16, figs. 1, 1a (fig. 1, from Zhidkova, 1954, pl. 17, fig. 2; fig. 1a, from Ilyina *in* Krishtofovich and Ilyina, 1954, pl. 20, fig. 2); Kishu Shimanto Research Group, 1970, pl. 6, figs. 16-18; Hayashi, 1973, pl. 4, fig. 12; Hayashi and Miura, 1973, pl. 1, fig. 25; Itoigawa *in* Itoigawa, Shibata and Nishimoto, 1974, p. 99, pl. 29, figs. 21, 22; Shibata and Kato, 1975, pl. 16, fig. 17; Katto, Masuda and Sako, 1976, pl. 4, fig. 11; Suehiro, 1979, p. 82, pl. 13, figs. 8a-c, pl. 14, figs. 1, 2; Ogasawara and Nomura, 1980, p. 89, pl. 11, figs. 1-4; Bito, Hayakawa, Kaseno, Ogasawara, and Takayama, 1980, pl. 3, figs. 12a-b; Ogasawara and Yashima, 1981, pl. 3, figs. 4, 8; Devyatilova and Volobueva, 1981, p. 84, pl. 38, figs. 1a-b; Tsuru, 1983, p. 66, pl. 14, figs. 8, 9; Shibata and Ina, 1983, pl. 6, figs. 4, 5; Akamatsu, 1984, pl. 1, fig. 15; Ogasawara and Sato, 1986, pl. 3, fig. 1; *non* Mizuno, Sumi and Yamaguchi, 1969, pl. 27, fig. 5.

Macoma optiva Yokoyama; Shikama, 1954, pl. 5, figs. 6, 7, 9, 10; Ilyina *in* Krishtofovich and Ilyina, 1954, p. 231, pl. 20, figs. 1, 2.

Macoma n. sp. ?; Moore, 1963, p. 81, pl. 29, figs. 10, 11; Addicott, 1976, p. 33, pl. 8, fig. 4.

Macoma (s.s.) *optiva* (Yokoyama); Itoigawa, Shibata, Nishimoto, and Okumura, 1981 (1982, p. 99), pl. 19, fig. 20; *non* Kim and Yoon, 1978, p. 7, pl. 1, fig. 4.

Macoma (*Macoma*) *optiva* (Yokoyama); Masuda, Amano, Katsura, and Ito, 1981, pl. 4, fig. 13; Marincovich, 1983, p. 98, pl. 19, figs. 1-10.

Remarks: Only one specimen was collected from fine-grained sandstone of the Omagari Formation. The present species was originally described by Yokoyama (1923) from the Fujina Formation (Miocene) of Shimane Prefecture, Southwest Japan.

Yokoyama (1925a) described *Macoma dissimilis* (Martens, 1865, *non* Deshayes, 1855) from the Kokozura Formation (Miocene, *vide* Hatai and Nisiyama, 1952, p. 81) of the Joban coal field, Northeast Honshu. Yokoyama (1929) also described *M. dissimilis* from Beds II (originally assigned to a Pliocene age, but now thought to probably be of Miocene age) of northern Sakhalin. But these specimens are assigned to *M. optiva*, as was done by Kamada (1962).

Yokoyama (1927b) described *Tellina izurensis* Yokoyama, 1925, from the Chikubetsu Formation (Miocene) of Hokkaido, but it is assigned here to *M. optiva*, as was done by Hatai and Nisi-

yama (1952), and Ogasawara and Nomura (1980). Moore (1963) described *Macoma* n. sp. ? from the Astoria Formation (Miocene) of Northwest America. Addicott (1976) also described *Macoma* n. sp. ? from the Callam Formation (Miocene) of Northwest America. But these are also assigned to *M. optiva* (Marincovich, 1983).

Mizuno, Sumi and Yamaguchi (1969, pl. 27, fig. 5) illustrated *M. optiva* from the Tokomuro Formation (Miocene) of the Atsunai Group, but it is assigned here to *Macoma* (*Macoma*) new species. Kim and Yoon (1978, p. 7, pl. 1, fig. 4) described an external mold of a left valve of *M. optiva* from the Duho Formation (Miocene) of Korea, but it is probably another species of *Macoma*, owing to its more posteriorly situated beak and more inequilateral shell than *M. optiva*, as was noted by Ogasawara and Nomura (1980). *Macoma optiva* ontogenetically changes the placement of its beaks : they are situated more posteriorly in juveniles, and tend to be at a more central location in later stages of growth (Suehiro, 1979).

The present species resembles *Macoma*) *izurensis* (Yokoyama, 1925), but differs in having a larger, more rounded, and more equilateral shell. However, in juvenile specimens of *M. optiva* are hardly distinguishable from *M. izurensis* in outline (Itoigawa *in* Itoigawa, Shibata and Nishimoto, 1974 ; Suehiro, 1979). Both *M. optiva* and *M. izurensis* commonly occur together, and are the representatives of the "*Macoma-Lucinoma*" assemblage in the First Setouchi Supergroup (lower to middle Miocene) of Southwest Japan (Shibata, 1978).

Macoma optiva has also been recorded from Miocene of the Kurile Islands and Kamchatka, and the Tachilni Formation (upper Miocene) of Alaska (Marincovich, 1983) ; and the Narrow Cape Formation (upper Oligocene or lowermost Miocene) of Sitkinak Island, Alaska (as cf., Allison and Marincovich, 1981).

Associated fauna : The present species is associated with *Yoldia laudabilis*, *Portlandia watasei* (s.s.), *Clinocardium omagariense*, and *Conchocele bisecta*.

Locality and Formation : OM-17, Omagari Formation.

Family Solenidae
Genus *Solen* Linné, 1758
Solen shitakaraensis Honda, n. sp.

Pl. 8, Figs. 7–10

Description : Shell size moderate (about 7 cm in length and 1.5 cm in height), straight, elongated, cylindrical, and gently convex. Both anterior and posterior ends truncated and gaping. Both dorsal and ventral margins nearly straight, and the former almost parallel with the latter. Anterior end widely rounded and weakly produced beyond beaks. Posterior end vertical and nearly straight. Beaks small and situated at extreme anterior end. Surface smooth except for feeble growth lines. Hinge area and inner surface sculpture unknown.

Dimensions (in mm) :

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	Valve
95129-1 (Holotype)	B-08	12.0	66.0	18.2	Left

Repository : Holotype (IGPS coll. cat. no. 95129-1) and one paratype (IGPS coll. cat. no. 95129-2) in the Institute of Geology and Paleontology, Tohoku University, Sendai, Japan.

Comparison : The present new species resembles *Solen connectens* Oyama, 1951, originally described from the Yamaga Formation of Kyushu, and *S. saitamensis* Kanno (1958, p. 193, pl. 4, fig. 15) from the Ushikubitoge Formation of the Chichibu Basin. But it differs from these species by having a relatively shorter shell. It also resembles *S.* (*En-*

sisolen) *krusensterni* Schrenck, 1867, living in Japan and Sakhalin (Habe, 1977), but differs in having the anterior end more weakly produced beyond the beaks.

Remarks: A total of 11 specimens of internal molds were examined. They were collected from poorly sorted fine-grained sandstone bearing pebbles at three localities of the Shitakara Formation.

Associated fauna: The new species is associated with *Spisula sorachiensis*, and *Thracia shitakaraensis*, n. sp.

Locality and Formation: SK-B, B-08 (type locality), B-Y, Shitakara Formation.

Family Myidae
Genus *Mya* Linné, 1758
Subgenus *Arenomya* Winckworth, 1930
Mya (*?Arenomya*) *grewingki grewingki* Makiyama, 1934

Pl. 8, Figs. 1, 3, 5

Mya crassa Grewingk, [sic]; Jimbo, 1898, p. 227, pl. 1, fig. 3.

Mya crassa Grew.; Yokoyama, 1924, p. 12, pl. 1, figs. 11-16.

Mya grewingki Makiyama, 1934, p. 156, pl. 7, figs. 50-52; Nagao and Inoue, 1941, p. 147, pl. 32, figs. 1, 7-10, pl. 33, figs. 7, 8; Minato, Matsui and Uozumi, 1950, p. 107, pl. 10, fig. 83; Watanabe, Arai and Hayashi, 1950, pl. 4, fig. 11; Fujie, 1957, p. 386, pl. 5, figs. 5, 7, pl. 6, figs. 2, 4a-b; Nemoto and O'Hara, 1979, pl. 2, fig. 2; O'Hara and Nemoto, 1982, pl. 2, figs. 7, 8.

Mya (*Arenomya*) *grewingki* Makiyama; Hirayama, 1955, p. 109, pl. 3, figs. 21-24; Kanno, 1960, p. 317, pl. 45, figs. 4-7; Kamada, 1962, p. 140, pl. 17, figs. 1a-b; Devyatilova and Volobueva, 1981, p. 97, pl. 30, figs. 4, 5.

Mya grewingki Makiyama forma α, Fujie, 1957, p. 388, pl. 6, figs. 3a-b.

Mya grewingki Makiyama forma β, Fujie, 1957, p. 388, pl. 5, figs. 6, pl. 7, figs. 5a-b (in part).

Mya grewingki Makiyama forma γ, Fujie, 1957, p. 388, pl. 6, figs. 5a-b.

Mya (*?Arenomya*) *grewingki* Makiyama; Allison and Marincovich, 1981, pl. 1, fig. 33; Allison and Marincovich, 1982, pl. 4, fig. 8 (reproduced from Allison and Marincovich, 1981).

Dimensions(in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
95465	OM-31	29.4	42.5	69.2	20.0/2	23.5	Both

Remarks: Several specimens were collected from poorly sorted fine-grained sandstone bearing pebbles at 4 localities of the Shitakara Formation, and 30 specimens from medium-grained sandstone at 1 locality of the Omagari Formation. Makiyama (1934) proposed *Mya grewingki*, based on *M. crassa* Grewingk, 1850 of Yokoyama (1924) from the Asagai Formation, and synonymized *M. crassa* of Jimbo (1898) from the Charo Formation (*vide* Hatai and Nisiyama, 1952, p. 90) with *M. grewingki*. *Mya grewingki* is characterized by its large, inequilateral, and subquadrate suboval shell.

The present species resembles *Mya* (*? Arenomya*) *grewingki kusiroensis* Nagao and Inoue, 1941, but differs in having a larger and more inflated shell. It also resembles *M. grewingki nagaoi* Oyama and Mizuno, 1958, originally described from the Nisisakutan Beds (Maoka Group; *vide* Oyama, Mizuno and Sakamoto, 1960, p. 211) of southern Sakhalin, but it differs from the latter by having a more inequilateral shell. *Mya grewingki nagaoi* is synonymous with *M.* (*M.*) *salmonensis* Clark, 1932, from the Poul Creek Formation of Alaska (MacNeil, 1965; Kanno, 1971). The present species is allied also to *M.* (*?Arenomya*) *ezoensis* Nagao and Inoue, 1941, but differs in having a larger and more rounded shell.

The present species has also been recorded from the Oligocene of Sakhalin and Kamchatka: horizons 1, 2 and 3 at Machigar in northern Sakhalin (Makiyama, 1934); the Nisisakutan and the Aragai Beds of southern Sakhalin (Takeda, 1953); the Mallenian Stage of the Koryak Upland, eastern USSR (Volobueva, 1980); and the Vayampolka Group of Kamchatka (Devyatilova and

Volobueva, 1981). It has also been recorded from lower Miocene of Japan: the Akahira Formation (Watanabe, Arai and Hayashi, 1950) and the Nenokami Sandstone (Kanno, 1960) of the Chichibu Basin; and the "Goyasu Formation" of the Joban coal field (O'Hara and Nemoto, 1982).

In Alaska, *M.* cf. *grewingki* has been recorded from the Poul Creek Formation (MacNeil, 1965). Allison and Marincovich (1981) recorded *M. grewingki* from the Narrow Cape Formation (upper Oligocene or lowermost Miocene) of Sitkinak Island, Alaska. *Mya grewingki grewingki* is directly descended from *M. grewingki kusiroensis* (MacNeil, 1965).

Associated fauna: The present species is associated with *Nemocardium ezoense*, *Ostrea eorivularis*, *Thracia shitakaraensis*, n. sp., and *Periploma besshoense* in the Shitakara Formation. It is not associated with other molluscan species in the Omagari Formation. In general, both *M. grewingki* (s.s.) and *M. grewingki kusiroensis* are associated with *Macoma sejugata*, as a *Macoma-Mya* association (Amano, 1981).

Locality and Formation: SK-40*, 50, 53, SKK-30, Shitakara Formation; OM-31, Omagari Formation.

Mya (*?Arenomya*) *grewingki kusiroensis* Nagao and Inoue, 1941

Pl. 5, Figs. 5, 9

Mya grewingki var. *kusiroensis* Nagao and Inoue, 1941, p. 150, pl. 32, figs. 2-8; Minato, Matsui and Uozumi, 1950, p. 150, pl. 10, figs. 84-86 (reproduced from Nagao and Inoue, 1941).

Mya grewingki Makiyama forma β, Fujie, 1957, p. 388, pl. 7, fig. 9 (in part).

Mya grewingki var. *elongata* Fujie, 1957, p. 389, pl. 7, figs. 3, 4, 8 (in part).

Mya grewingki kusiroensis Nagao and Inoue; Oyama, Mizuno and Sakamoto, 1960, p. 211, pl. 65, figs. 1a-e (reproduced from Nagao and Inoue, 1941); *non* Kanno and Ogawa, 1964, pl. 3, fig. 18.

Mya (*?Arenomya*) *kusiroensis* Nagao and Inoue; MacNeil, 1965, p. G27, pl. 1, figs. 5, 6, 8-10.

Mya (*?Arenomya*) *kusiroensis* (Nagao and Inoue); Hickman, 1969, p. 64, pl. 8, figs. 1-3.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
	SK-42	28.2	38.7	72.9	12.7/2	16.5	Both
95707	B-05	21.1	40.1	52.6	3.8	9.5	Left
95435	B-06	17.2	39.1	44.0	4.0	10.2	Left

Remarks: A total of 70 specimens were collected from fine-grained sandstone at 14 localities of the Shitakara Formation and 1 locality of the Omagari Formation. This species is characterized by its small, moderately inflated, and elongated elliptical shell.

Fujie (1957) synonymized *M. grewingki kusiroensis* with *M. grewingki nagaoi*, but it differs from the latter in having a more inequilateral shell and relatively shorter shell. Kanno (1971) synonymized *M. grewingki kusiroensis* and *M. grewingki nagaoi* with *M. salmonensis*. The present species resembles *M.* (*?Arenomya*) *ezoensis*, but differs by having a more rounded shell.

Kanno and Ogawa (1964, pl. 3, fig. 18) illustrated *M. grewingki kusiroensis* from the upper part of the Takinoue Formation (Miocene) of Hokkaido, but this species is probably assignable to *M.* (*M.*) *cuneiformis* (Böhm, 1915), due to its somewhat large shell and other features of the shell.

Mya grewingki kusiroensis is probably derived from *M. ezoensis*, which is the earliest known *Mya* (MacNeil, 1965). In Alaska, *M. grewingki kusiroensis* has been recorded from the upper part of the *Acila shumardi* zone (late middle Oligocene) and the basal part of the Poul Creek Formation or the underlying Kulthieth Formation, and *M. grewingki kusiroensis* is the earliest known *Mya* in the USA (MacNeil, 1965). The present species has also been recorded from the Eugene Formation (Oligocene) of Oregon, Northwest America (Hickman, 1969).

Associated fauna: The present species is associated with *Ostrea eorivularis*, *Nemocardium ezoense*, *Cyclocardia* sp., *Neptunea modestoidea*, *Conchocele bisecta*, *Yoldia laudabilis*, and *Corbicula sitakaraensis*.

Locality and Formation: SK-41, 42, 54, B, B-05, 06, SK2-3, 8, 9, 10, 14, 15, SK3-5, 9, Shitakara Formation; OMH-D, Omagari Formation.

Family Myochamidae
Genus *Myadora* Gray, 1840
Myadora sp., indet.

Pl. 5, Fig. 7

Remasks: A poorly-preserved, somewhat deformed left valve was collected from siltstone of the Charo Formation. The present species is characterized by its small and triangularly ovate shell with rather distinct and regularly spaced, coarse concentric lines of growth on the surface. It resembles *Myadora suzuensis* Masuda, 1966 from the Higashi-Innai Formation (Miocene) of the Noto Peninsula, Central Japan, but it is distinguished from the latter in having a more triangularly shell.

The present species also resembles *M. okadae* Hatai and Masuda, 1960 from the Moniwa Formation (Miocene) of Miyagi Prefecture, Northeast Honshu, but it differs from the latter by its more triangular shell and more distinct concentric sculpture on the surface. It is closely allied to a living species, *M. fluctuosa* Gould, 1861 and the Pleistocene *M. ikebei* Habe, 1950, but a precise conparison with both species is reserved until well-preserved specimens are obtained.

Associated fauna: The present species is associated with *Dentalium* sp., and *Eocylichna multistriata*.

Locality and Formation: CH-38, Charo Formation.

Family Periplomatidae
Genus *Periploma* Schumacher, 1817
Subgenus *Aelga* Slodkewitsch, 1935
Periploma (*Aelga*) *besshoense* (Yokoyama, 1924)

Pl. 4, Figs. 25a-b, Pl. 5, Figs. 12a-c

Tellina besshoensis Yokoyama, 1924, p. 14, pl. 2, figs. 1-5; *non* Yokoyama, 1929, p. 388, pl. 74, fig. 1.

Periploma besshoensis (Yokoyama); Makiyama, 1934, p. 153; Otuka, 1941, p. 153, fig. 4 on page 148; Uozumi, 1952, p. 213, pl. 16, figs. 128a-b; Takeda, 1953, pl. 13, fig. 6; Hirayama, 1955, p. 107, pl. 4, fig. 31; Hatai and Koike, 1957, pl. 4, fig. 8; *non* Kanno and Matsuno, 1960, pl. 4, fig. 4.

Laternula (*Aelga*) *besshoensis* (Yokoyama); Slodkewitsch, 1938b, p. 124, pl. 54, figs. 5-8, pl. 55, figs. 1, a, 2, a, 3, a, pl. 56, fig. 1; *non* Zhidkova *et al.*, 1968, p. 136, pl. 5, fig. 1 (reproduced from *Laternula* (*Aelga*) *borensis* Ilyina *in* Krishtofovich and Ilyina, 1954).

Periploma cf. *besshoensis* (Yokoyama); Otuka, 1943, p. 234, pl. 3, fig. 14; Katto, 1960, pl. 10, fig. 12.

Periploma (*Aelga*) *besshoense* (Yokoyama); Krishtofovich *in* Krishtofovich and Ilyina, 1954, p. 84, pl. 13, figs. 1-3; Kamada, 1962, p. 75, pl. 6, figs. 1-3 (in part); Kanno, 1971, p. 96, pl. 3, fig. 5, pl. 11, fig. 10; Shikama and Kase, 1976, p. 22, pl. 1, fig. 22, pl. 2, fig. 14; Suehiro, 1979, p. 85, pl. 15, figs. 2a-c; Marincovich, 1980, p. C10, fig. 3 on page C6; Devyatilova and Volobueva, 1981, p. 103, pl. 30, figs. 6, 7; Allison and Marincovich, 1981, pl. 2, figs. 1, 2; Allison and Marincovich, 1982, pl. 1, fig. 24, pl. 2, fig. 1 (reproduced from Allison and Marincovich, 1981).

Periploma besshoense (Yokoyama); Oyama, Mizuno and Sakamoto, 1960, p. 214, pl. 66, figs 2a-f (figs. 2a-e, reproduced from Yokoyama, 1924; fig. 2f, from Hirayama, 1955): Kanno and Ogawa, 1964, pl. 3, fig. 19; Matsumoto, 1964, p. 108, pl. 2, figs. 13a-b; Mizuno and Inoue, 1969, pl. 30, fig. 2; Matsumoto and Terashima, 1976, p. 45, pl. 9, fig. 4; Nemoto and O'Hara, 1979, pl. 2, fig. 5; Fuse and Kotaka, 1986, pl. 18, fig. 18.

Remarks: Abundant specimens were collected from fine- and very fine-grained sandstone, and siltstone at 16 localities of the Shitakara, Omagari, Charo, and Nuibetsu Formations. The present species was originally described by Yokoyama (1924) from the Asagai Formation. Makiyama (1934, p. 153) proposed *Peri-*

ploma yokoyamai for *Tellina besshoensis* of Yokoyama (1929, p. 388, pl. 74, fig. 1) from the Miocene of northern Sakhalin. *Periploma yokoyamai* differs from *P. besshoense* in having a more equilateral shell with broadly rounded posterior end (Makiyama, 1934).

The present species resembles *P.* (*Aelga*) *ezoense* Mizuno and Inoue, 1969, but it differs in having regular concentric lines of growth and rostrated posterior margin. It also resembles *P.* (*Aelga*) *mitsuganoense* Araki, 1959, originally described from the Ichishi Group (Miocene) of Mie Prefecture, Southwest Japan. But it differs from the latter in having a more equilateral and more rounded shell.

Kanno and Matsuno (1960, pl. 4, fig. 4) illustrated *P. besshoensis* from the Sankebetsu Formation (Miocene) of Hokkaido, but it seems to be *P. pulchella* Hatai and Nisiyama, 1949, owing to its more equilateral shell than *P. besshoense*, as was done by Masuda and Noda (1976). Kamada (1962, p. 75, pl. 6, figs. 1–4) described *P. besshoense* from the Asagai (figs. 1–3) and the Shirasaka (fig. 4) Formation of the Uchigo Group of the Joban coal field. But his specimen (pl. 6, fig. 4) is probably referable to *P. yokoyamai*, in its rather equilateral shell and subtruncated posterior end, as was doubtfully done by Masuda and Noda (1976).

Zhidkova *et al.* (1968, p. 136, pl. 5, fig. 1; reproduced from *Laternula* (*Aelga*) *borensis* Ilyina *in* Krishtofovich and Ilyina, 1954, p. 218, pl. 13, fig. 10) described *L.* (*A.*) *besshoensis* (Yokoyama) from the Neogene of southern Sakhalin. But it is assigned here to *P. yokoyamai*, because of its larger, broadly rounded, and more equilateral shell than *P. besshoense*.

Periploma cf. *besshoensis* of Otuka (1943) from the Kurosawa Formation (Miocene) of Akita Prefecture, Northeast Honshu, is assigned here to *P. besshoense*, as was done by Hatai and Nisiyama (1952). *Periploma* cf. *besshoensis* of Katto (1960) from the Shijujiyama Formation (Oligocene) of Kochi Prefecture of Shikoku, Southwest Japan, is also assigned here to *P. besshoense*.

In Japan, *P. besshoense* has also been recorded from the Wakkanabe, the Akahira and the Hiragishi Formation of the Ishikari Group, and the Poronai and the Momijiyama Formation (Shimokawara, 1963); the Tappu Group (Ohara, 1966b); the Hota Group of the Boso Peninsula, Central Japan (Hatai and Koike, 1957); the Fujina Formation of Shimane Prefecture, Southwest Japan (Suehiro, 1979); the Muroto Formation of Kochi Prefecture (Matsumoto and Terashima, 1976); the Hioki Group of Yamaguchi Prefecture, Southwest Japan (Fuse and Kotaka, 1986); and the Nishisonogian Stage of Kyushu (Mizuno, 1964a).

Periploma besshoense has also been recorded from the Oligocene and Miocene of the Koryak Upland, Sakhalin and Kamchatka (Devyatilova and Volobueva, 1981); the Mallenian Stage (Oligocene) of the Koryak Upland (Volobueva, 1980); and the Maoka Series (Oligocene) in southern Sakhalin (Takeda, 1953). In Alaska, *P. besshoense* has been recorded from the Yakataga and the Poul Creek Formation (Kanno, 1971), the Narrow Cape Formation of Sitkinak Island (upper Oligocene or lowermost Miocene; Allison and Marincovich, 1981), and the Topsy Formation (Miocene; Marincovich, 1980).

Associated fauna: The present species is associated with *Cyclocardia* spp., *Portlandia watasei* (s.s.), *Turritella poronaiensis*, *Yoldia laudabilis*, *Clinocardium omagariense*, *Neverita asagaiensis*, and *Conchocele bisecta*. *Periploma besshoense* occurs together with *P. ezoense* in the Shitakara, the Charo and the Nuibetsu Formation (Mizuno, 1975, *written commun.*).

Locality and Formation: SK-37*, 50

SK2-13, Shitakara Formation; OM-04, 06, 14, 15, 17, 23, 26, 27, 32, OMH-10, Omagari Formation; CH-b, CHY-12, Charo Formation; NB-07, Nuibetsu Formation.

Periploma (Aelga) ezoense
Mizuno and Inoue, 1969

Periploma ezoense Mizuno and Inoue, 1969, p. 654, pl. 30, fig. 3.

Remarks: Only one specimen was collected from fine-grained sandstone of the Shitakara Formation. The present species was originally described from the Poronai Formation.

Associated fauna: The present species is associated with *Ostrea eorivularis*. It is not usually associated with *P. besshoense* in the Poronai Formation (Mizuno and Inoue, 1969), and only *P. ezoense* usually occurs in the Shitakara Formation (Mizuno, 1975, *written commun.*).

Locality and Formation: SK2-1, Shitakara Formation.

Family Thraciidae
Genus *Thracia* Leach, 1824
Subgenus *Thracia* s.s.
Thracia (Thracia) shitakaraensis
Honda, n. sp.

Pl. 6, Figs. 2, 5, Pl. 7, Figs. 1-3, 5-7

Description: Shell size medium, thin, oblong to trapezoidal, moderately convex, and inequilateral. Height about three-quarters of length. Posterior margin obliquely truncated. Right valve slightly larger and more convex than the left. Anterodorsal margin arched, posterodorsal margin nearly straight, and ventral margin broadly rounded. Umbones inconspicuous and opisthogyrate. Beaks pointed, incurved, and situated anteriorly. Beak of right valve elevated above that of left valve, and beak of left valve indents the right valve below its beak.

A weak ridge runs from umbo to posteroventral corner, enfeebled toward the posterior margin, and sets off the almost flattened posterior surface. Surface with numerous, somewhat irregular, and weakly undulated lines of growth. Inner surface and hinge plate unknown.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	L	H/L (%)	W	W/L (%)	Valve
95428-4 (Holotpye)	B-03	35.5	48.6	73.0	11.4/2	11.7	Both
95137-1 (Paratype)	B-03	37.2	56.6	65.7	5.6	9.9	Right*
95137-1 (Paratype)	B-03	36.1	56.5	63.9	5.4	9.6	Left*
95137-2 (Paratype)	B-03	38.7	51.2	75.6	7.8	15.2	Left
95433	B-06	37.6	50.6	74.3	5.7	11.3	Left
95434-1	B-10	36.2	47.2	76.7	9.7	20.6	Right*
95434-1	B-10	35.3	46.5	75.9	7.7	16.6	Left*
99283	SK-42	29.0	39.5	73.4	9.2/2	11.6	Both
97105	SK-51	34.2	45.7	74.8	13.9/2	15.3	Both
99284	SK-A	32.1	38.5	83.4	10.2/2	13.2	Both

* matching valves

Repository: Holotype (IGPS coll. cat. no. 95428-4) and two paratypes (IGPS coll. cat. nos. 95137-1, 95137-2) in the Institute of Geology and Paleontology, Tohoku University, Sendai, Japan.

Comparison: The present new species closely resembles *Thracia kidoensis* Kamada (1955a, p. 11, pl. 1, figs. 1, 2) from the Asagai Formation, but it differs from the latter in having a more quadrate shell and a stronger ridge running from umbo to posteroventral corner. It also resembles *T. chigayensis* Kanno (1958, p. 197, pl. 5, fig. 2) from the Nenokami Sandstone of the Chichibu Basin. But it differs from the latter in having more anteriorly situated beaks and a more broadly rounded ventral margin. The present new species also resembles *Thracia itoi* Habe, 1961, which lives off of northern Japan, but the new species differs in having a less inflated umbonal region and a more smoothly rounded ventral margin.

Remarks: Several tens of specimens, most of which have closed valves and without original shell material, were examined. These occur in fine-grained sandstone and granular conglomerate at 12 localities of the Shitakara Formation.

However, most specimens have been somewhat deformed after burial, so the present new species shows a fairly variable outline; for instance, height/length ratio varies from 63.9 to 83.4 percent and width/length ratio varies from 9.6 to 20.6 percent.

Associated fauna: The new species is associated with *Nemocardium ezoense*, *Chlamys shitakaraensis*, *Ostrea eorivularis*, and *Mya grewingki* (s.l.).

Locality and Formation: B-02, 03 (type locality), 06, 10, SK-40*, 41, 42, 50, 51, 53, A, B, Shitakara Formation.

Family Cuspidariidae
Genus *Cardiomya* A. Adams, 1864
Subgenus *Cardiomya* s. s.
Cardiomya (*Cardiomya*) *kotakai*
Honda, n. sp.

Pl. 5, Fig. 6

Description: Shell small, inflated, thin, ovately elongate, and strongly rostrate. Ventral margin widely rounded. Surface sculptured with about 19 rounded radial ribs that are much narrower than the interspaces. Each interspace sculptured with one intercalary riblet. Hinge area and inner surface unknown.

Repository: Holotype (IGPS coll. cat. no. 99278)

Comparison: The present new species resembles *Cardiomya* (*Cardiomya*) *interstitialis* (Takeda, 1953) from the Aragai Bed of the Maoka Group and the Nuibetsu Formation, and *C.* (*Cardiomya*) *makiyamai* (Kanehara, 1937). But the new species is distinguished from these by having a more elongated shell and more numerous radial ribs. This new species also resembles *C. mitsuganoensis* Shibata (1970, p. 67, pl. 2, figs. 9, 10) from the Ichishi Group, but it differs from the later in having a more elongated shell.

Remarks: Only one incomplete specimen of a left valve was collected from siltstone of the Nuibetsu Formation.

Associated fauna: The new species is associated with *Turritella* sp., *Eocylichna multistriata*, and *Orectospira wadana*.

Locality and Formation: NB-17, Nuibetsu Formation.

Cardiomya (*Cardiomya*) *makiyamai*
(Kanehara, 1937)

Cuspidaria (*Cardiomya*) *makiyamai* Kanehara, 1937a, p. 783, pl. 23, figs. 3-9.

Remarks: Several specimens were collected from very fine-grained sandstone of the Omagari Formation and iron-stained, tuffaceous, fine-grained sandstone of the Nuibetsu Formation. This species was originally described from the Asagai Formation.

Associated fauna: The present species is associated with *Cyclocardia* spp., and *Turritella* spp.

Locality and Formation: OM-30, Omagari Formation; NBK-19, Nuibetsu Formation.

Class Gastropoda
Family Trochidae
Subfamily Solariellinae
Genus *Minolia* A. Adams, 1860
"Minolia" funiculata
(Yokoyama, 1890)

Margarita funiculata Yokoyama, 1890, p. 197, pl. 20, figs. 13a-b.
"Minolia" funiculata (Yokoyama); Oyama, Mizuno and Sakamoto, 1960, p. 27, pl. 1, figs. 1a-d (reproduced from Yokoyama, 1890).

Remarks: A total of six specimens are at hand. These were collected from siltstone at three localities of the Charo and Nuibetsu Formations. The present species was originally described by Yokoyama (1890) from the Poronai Formation, under the name *Margarita funiculata*.

Associated fauna: The presest species is associated with *Portlandia watasei* (s.s.), *Malletia poronaica*, and *Cyclocar-*

dia sp.

Locality and Formation: CHY-3, 30, Charo Formation; NBY-12, Nuibetsu Formation.

Genus *Machaeroplax* Friele, 1877
Machaeroplax eos (Hirayama, 1955)

Margarites eos Hirayama, 1955, p. 111, pl. 5, figs. 23–32; Kamada, 1962, p. 144, pl. 18, fig. 8.
Machaeroplax eos (Hirayama); Oyama, Mizuno and Sakamoto, 1965, p. 28, pl. 1, figs. 3a-e (reproduced from Hirayama, 1955).
Margarites (s.s.) *eos* Hirayama; Tanaka, 1961, p. 83, pl. 2, fig. 11.

Remarks: Only two specimens were collected from dark gray siltstone at two localities of the Charo Formation. This species was originally described from the Asagai Formation. It has also been recorded from the Moriya Formation (Miocene) of Nagano Prefecture, Central Japan (Tanaka, 1961).

Associated fauna: The present species is associated with *Turritella* sp.

Locality and Formation: CHK-12, 72, Charo Formation.

Subfamily Monodontinae
Genus *Turcicula* Dall, 1881
Subgenus *Ginebis* Taki and Otuka, 1943
Turcicula (*Ginebis*) *sakhalinensis* Takeda, 1953

Turcicula sakhalinensis Takeda, 1953, p. 49, pl. 2, figs. 2, 4, 5, 8, 9.
Bathybembix (*Ginebis*) *sakhalinensis* (Takeda); Oyama, Mizuno and Sakamoto, 1960, p. 29, pl. 1, figs. 7a-e (reproduced from Takeda, 1953).
Turcicula (*Ginebis*) *sakhalinensis* Takeda; Noda, 1975, p. 75, pl. 10, fig. 15 (reproduced from Takeda, 1953).

Remarks: Only one specimen was collected from siltstone of the Nuibetsu Formation. The present species was originally described by Takeda (1953) from the Aragai and the Hattyorei Beds of the Maoka Group, and the Nuibetsu Formation. It resembles *Turcicula* (*Ginebis*) *nagaoi* Noda (1975, p. 74, pl. 9, fig. 19, pl. 10, fig. 6) from the Manda Group (Eocene) of Kyushu. But it differs from the latter in having less numerous tubercles.

Associated fauna: The present species is associated with gastropods and bivalves of indeterminate identification.

Locality and Formation: NBK-45, Nuibetsu Formation.

Subfamily Margaritinae
Genus *Margarites* Gray, 1847
Margarites makiyamai Hirayama, 1955

Umbonium sp.; Yokoyama, 1924, p. 12, pl. 1, figs. 18, 19.
Margarites sp.; Makiyama, 1934, p. 159.
Margarites makiyamai Hatai and Nisiyama, 1952, p. 279 (invalid).
Margarites (*Margarites*) *makiyamai* Hatai and Nisiyama; Hirayama, 1955, p. 111, pl. 5, figs. 20–22.
"*Margarites*" *makiyamai* Hatai and Nisiyama; Oyama, Mizuno and Sakamoto, 1960, p. 29, pl. 1, figs. 2a-g (2a-d, reproduced from Yokoyama, 1924; 2e-g, from Hirayama, 1955).

Remarks: Only one imperfect specimen was collected from siltstone of the Nuibetsu Formation. Hatai and Nisiyama (1952, p. 279) proposed *Margarites makiyamai* for *Umbonium* sp. of Yokoyama (1924) from the Asagai Formation. But *M. makiyamai* Hatai and Nisiyama is invalid under the International Code of Zoological Nomenclature, because there are no statement in Hatai and Nisiyama (1952), which distinguish the former from the latter (Masuda and Noda, 1976). Subsequently, Hirayama (1955, p. 111, pl. 5, figs. 20–22) described *M.* (*Margarites*) *makiyamai* Hatai and Nisiyama from the Asagai Formation. Hirayama is regarded as the author of *M. makiyamai*, because his description is accompanied by the statement that differenciates *M. makiyamai*.

Associated fauna: The present species is associated with *Turritella nuibetsuensis*, n. sp.

Locality and Formation: NBK-63,

Nuibetsu Formation.

Family Viviparidae
Subfamily Bellamyinae
Genus *Bellamya* Jousseaume, 1886
Subgenus *Sinotaia* Haas, 1939
Bellamya (Sinotaia) mabutii
(Suzuki, 1941)

Viviparus uryuensis Yokoyama, 1932, p. 236, pl. 1, fig. 10 (in part).
Viviparus mabutii Suzuki, 1941b, p. 6, pl. 1, figs. 2-9.
Viviparus cf. *mabutii* Suzuki; Suzuki, 1941c, p. 21.
Viviparus (Idiopoma) mabutii Suzuki; Fukada, 1950, p. 9, text-fig. 8.
Bellamya (Sinotaia) mabutii (Suzuki); Oyama, Mizuno and Sakamoto, 1960, p. 32, pl. 2, figs. 2a-g (reproduced from Suzuki, 1941b).

Remarks: Only one specimen was collected from fine-grained sandstone bearing pebbles of the Shakubetsu Formation. The present species was originally described by Suzuki (1941b) from the Ashibetsu Formation of the Ishikari Group. On the other hand, Yokoyama (1932) proposed *Viviparus uryuensis* from the Upper Tachibetsu Formation of the Uryu Group, Uryu coal field, Hokkaido. Suzuki (1941c) assigned *V. uryuensis* of Yokoyama (1932) to *V.* cf. *mabutii*, but it is allocated here to *Bellamya mabutii*, as was done by Oyama, Mizuno and Sakamoto (1960).

The present species resembles *B. (Sinotaia) uryuensis* (Yokoyama, 1932, p. 236, pl. 1. figs. 8, 9, in part), but differs by having a more flattened periphery on the whorls. It has also been recorded from the "Tenneru Formation" of the Urahoro Group (Mizuno, 1964b).

Associated fauna: The present species is associated with *Corbicula sitakaraensis*. It is also associated with *Cipangopaludina isikariensis* (Suzuki) in the Ashibetsu Formation (Oligocene; Fukada, 1950).

Locality and Formation: SB-01*, Shakubetsu Formation.

Genus *Cipangopaludina*
Hannibal, 1912
Cipangopaludina isikariensis
(Suzuki, 1941)

Viviparus isikariensis Suzuki, 1941b, p. 4, pl. 1, figs. 1a-c.
Viviparus (Cipangopaludina) isikariensis Suzuki; Fukada, 1950, p. 9, text-fig. 5.
Cipangopaludina isikariensis (Suzuki); Oyama, Mizuno and Sakamoto, 1960, p. 33, pl. 2, figs. 3a-d (3a-c, reproduced from Suzuki, 1941b; 3d, from Fukada, 1950).

Remarks: Only two specimens were collected from tuffaceous, iron-stained, very fine-grained sandstone of the Shakubetsu Formation. The present species was described by Suzuki (1941b) from the Ashibetsu Formation (Oligocene) of the Ishikari Group, central Hokkaido. It has also been recorded from the Numata Formation (Oligocene) of the Uryu Group of the Uryu coal field, central Hokkaido (Fukada, 1950). The genus *Cipangopaludina* is one of the Asiatic fresh-water molluscs that also occurs in Oligocene strata of the Alaska Peninsula (MacNeil, 1965).

Associated fauna: The present species is associated with *Corbicula tokudai*, *Semisulcospira fiscina yokoyamai* Suzuki, *Anodonta subjapanensis*, and *Modiolus* sp.

Locality and Formation: SB-F, SBY-3, Shakubetsu Formation.

Family Turritellidae
Subfamily Orectospirinae
Genus *Orectospira* Dall, 1925
Orectospira wadana (Yokoyama, 1890)

Pl. 10, Figs. 1, 3

Turritella Wadana Yokoyama, 1890, p. 198, pl. 15, figs. 9-11.
Trochocerithium wadanum (Yokoyama); Kanehara, 1937c, p. 160, pl. 15, figs. 16-18; Tagami, 1941, p. 1005, pl. 50, figs. 1b-c; Uozumi, 1952, p. 213, pl. 16, figs. 119, 127a-b (in part); Takeda, 1953, p. 51, pl. 4, figs. 7, 11, 13 (in part).
Orectospira wadana (Yokoyama); Kotaka, 1959, p. 111; Urata, 1961, p. 13, pl. 4, figs. 3-6; Kanno and Ogawa, 1964, pl. 4, fig. 9; Kishu Shimanto

Research Group, 1970, pl. 6, figs. 2, 3; Honda, 1986b, pl. 1, figs. 11a-b.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	D
97130	CH-83	9.8	6.0
97117	NB-63	25.1	13.9

Remarks: Abundant specimens were collected from siltstone and fine-grained sandstone at 30 localities of the Charo and Nuibetsu Formations. The present species was originally described by Yokoyama (1890) from "gray limestone of Hokkaido" (probably the Poronai Formation; *vide* Hatai and Nisiyama, 1952, p. 271).

It resembles *Orectospira shimokawarai* Urata, 1961 from the Poronai Formation, but it differs from the latter in having: 1) a smaller pleural angle, 2) slightly inflated periphery of the whorls, 3) the ornamentation gets weaker in the adult stage, and 4) spiral tuberculous ridge running a little above the suture, and not imbricating over the succeeding whorl (Urata, 1961).

The present species also resembles *O. nenokamiensis* (Kanno, 1958, p. 209, pl. 6, figs. 11, 12) from the Nenokami Sandstone (early Miocene) of the Chichibu Basin, but it differs from the latter by having only one nodulous spiral row (Kanno, 1958). It also resembles *O. takayamai* Urata (1961, p. 12, pl. 4, figs. 1a-c) from the Sakasegawa Formation (Eocene) of Kyushu, but *O. takayamai* differs in having "larger pleural angle, flat profile of whorls, nodulous carina well developing on the adult whorl" (Urata, 1961).

Trochocerithium wadanum of Uozumi (1952, p. 213, pl. 16, fig. 120, in part), and of Takeda (1953, p. 51, pl. 4, fig. 12, in part), both from the Poronai Formation, are allocated here to *O. shimokawarai*, as was done by Urata (1961).

The present species has also been recorded from the Nisisakutan and the Aragai Beds of the Maoka Group (Oligocene) of southern Sakhalin (Takeda, 1953); the Kylanian Stage (Eocene) of eastern Kamchatka (Plonina and Berson, 1978); the Tappu Group (Oligocene; Ohara, 1966b); the Momijiyama Formation (Oligocene: Shimokawara, 1963; Kanno and Ogawa, 1964); the Oiwake Bed (Miocene: Tagami, 1941; Poronai Formation ?, Oligocene, *vide* Hatai and Nisiyama, 1952, p. 257) of Hokkaido; the Muro Group (Oligocene) of the Kii Peninsula, Southwest Honshu (Kishu Shimanto Research Group, 1975); and the Nishisonogian Stage (Oligocene) of Kyushu (Mizuno, 1964a). *Orectospira wadana* is one of the characteristic species of the Poronai, the Charo and the Nuibetsu Formation (Mizuno, 1964b); and also of the Poronai fauna (Mizuno, 1965).

Among the Poronaian molluscs characterized by many cold-water species, it is remarkable that both fossil and living species of *Orectospira* are sporadically known in low to middle latitudes of Europe, Africa, Southeast Asia, Taiwan, and Japan (Urata, 1961). In Japan, several modern species of *Orectospira* have been recorded from Sagami Bay, Honshu to Kyushu (lat. 33° to 36°N), and they live on muddy bottoms at a depth of 100 to 565 fathoms (180 to 1,017 m) (Habe, 1955; Urata, 1961). In general, *O. wadana* and *O. shimokawarai* do not occur together in the Poronai Formation, and they belong to different phylogenetic groups (Urata, 1961).

Associated fauna: The present species is associated with *Cyclocardia* sp., *C. tokudai*, *Turritella* sp., *Dentalium* spp., and *Eocylichna multistriata*.

Locality and Formation: CH-09, 18, 36, 53, 67, 75, 79, 83, 85, 86, G, D-09, 27, 32, 35, 39, CHY-1, 9, 10, CHK-17, Charo Formation; NB-01, 02, 06, 17, 42, 63, 75, D-17, NBY-16, NBK-19, Nuibetsu Formation.

Subfamily Turritellinae
Genus *Turritella* Lamarck, 1799
Subgenus *Hataiella* Kotaka, 1959
Turritella (*Hataiella*) *nuibetsuensis*
Honda, n. sp.

Pl. 9, Figs. 3-5, 11 ; Fig. 14(a)

Description : Shell medium in size, solid, heavy, slender, and conical in outline. Apical angle about 15°. Whorls about 15 in number. Whorl profile moderately convex and slightly shouldered a little adapically to suture. Interspace between C and abapical suture shallowly excavated. Protoconch unknown. Whorl sculptured with three primary C, B and a, two secondary T and s, one tertiary s_2, and other minute spirals (indicated by dots) : C, T, ., and B on its lower half ; s_2, s, a, ., and . on its upper half. Notation of spiral ornamentation by Marwick (1957) and Kotaka (1959) as (C T•B s_2 s a••). Spirals narrower than the interspaces. Whorl also feebly sculptured with deeply sinuated and asymmetrical growth-lines, and their maximums fall on B. Aperture oval.

Dimensions (in mm) :

IGPS coll. cat. no.	Loc. no.	H	D	AA	NW	Notation
96779 (Holotype)	D-Y	53.5	14.0	15°	15	(C T•B s_2 s a••)
95624	D-11	—	—	—	—	(C T•B s_2 s a••)

Repository : Holotype (IGPS coll. cat. no. 96779) in the Institute of Geology and Paleontology, Tohoku University, Sendai, Japan.

Comparison : The new species resembles *Turritella* (*Hataiella*) *poronaiensis* Takeda, 1953, but differs from *T. poronaiensis* by its more flattened whorl profile, asymmetrical growth lines (*see* Fig. 14(a)) and development C, T, B, s_2, and other minute spirals indicated by dots, because the notation of *T. poronaiensis* is shown as (C t b s a r).

The new species also resembles *T. mitagawaensis* Kanno, 1958 from the Tomita Siltstone Member of the Ushikubitoge Formation (early Miocene) of the Chichibu Basin, but it differs from the latter by having a different spiral notation, because that of the latter is shown as (u c t b s a•r). It is allied also to *T.* (*Hataiella*) *poronaiensis bathysinuata* Shuto and Ueda, 1967 from the Yamaga Formation of the Ashiya Group of Kyushu, but it is different from the latter in having the spirals narrower than the interspaces, a more flattened whorl profile, and different spiral ornamentation, because that of *T. poronaiensis bathysinuata* is shown as (u_2 u C T B S A r r_1).

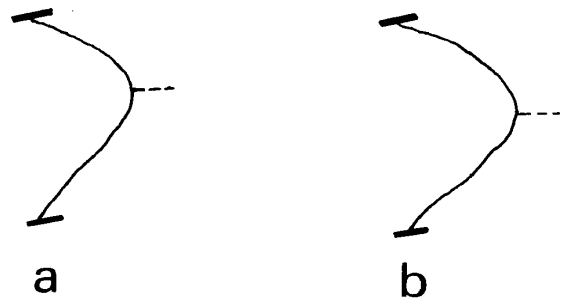


Fig. 14. Growth-line sinus of *Turritella* (*Hataiella*) *nuibetsuensis*, n. sp. and *T.* (*Hataiella*) *poronaiensis*. a, *T. nuibetsuensis*, n. sp. (IGPS coll. cat. no. 96779 (Holotype), Loc. D-Y, Charo Formation) ; b, *T. poronaiensis*, (IGPS coll. cat. no. 96781, Loc. CH-56, Charo Formation). Heavy lines denote posterior and anterior sutures, and dashed lines denote the position of the sinus apex.

The new species also resembles *T.* (*Hataiella*) *infralirata* Nagao, 1928b, originally described from the Yamaga Formation, but it is discriminated from the latter in its more flattened whorl profile and spiral notation, because that of *T. infralirata* is shown as (u C•t B s a•r•).

Remarks : Abundant but mostly incomplete specimens are at hand. These were collected from siltstone and poorly sorted, coarse- to fine-grained sandstone at 20 localities of the Charo and Nuibetsu Formations. In 1960, Professor Atsuyuki Mizuno of Ehime

University collected about 50, somewhat decorticated specimens of *Turritella* n. sp. from coarse-grained sandstone of a riverside cliff along the Makayo-gawa, probably at the basal part of the Nuibetsu Formation in the Akan district (Mizuno, 1978, *written commun.*).

Based on these specimens, Mizuno, Sato and Sumi (1963) recorded the occurrence of *Turritella nuibetsuensis* Kotaka and Mizuno (MS) from the Nuibetsu Formation, but that species had not yet been validly proposed. The specimens have been preserved in the Institute of Geology and Paleontology, Tohoku University, Sendai, Japan. Recently, several tens of rather well-preserved specimens assignable to this invalid species were collected from other localities of the Kushiro coal field (Yui, 1975MS ; Kaiho, 1977MS).

The author describes this new species herein, based on the specimens of Kotaka and Mizuno (MS), Yui (1975MS) and Kaiho (1977MS). The new species also includes *T. nuibetsuensis* Mizuno (MS) (invalid) from the Charo and the Nuibetsu Formation of the Ukotakinupuriyama district, northwestern part of the Kushiro coal field (Inoue and Suzuki, 1962).

Associated fauna : The new species is commonly associated with *Cyclocardia tokudai*, *C.* sp., *Orectospira wadana*, *Portlandia watasei* (s.s.), and *Trominina* spp., and rarely with *T. poronaiensis* at Loc. D-35. *Turritella nuibetsuensis*, n. sp. is also associated with *O. wadana*, *Trominina* spp., *Dentalium nunomae*, *Malletia poronaica*, *P. watasei*, *Cyclocardia akagii*, and *Fulgoraria antiquior* (Takeda) in the Nuibetsu Formation of the Akan district (Mizuno, Sato and Sumi, 1963).

Locality and Formation : D-Y (type locality), D-02, 26, 30, 32, 35, 40, 41, CHK-13, Charo Formation ; D-11, 17, NBK-19, 27, 31, 41, 51, 63, 71, 75, 60070217, Nuibetsu Formation.

Turritella (*Hataiella*) *poronaiensis* Takeda, 1953

Pl. 9, Figs. 6a-b ; Fig. 14(b)

Turritella poronaiensis Takeda, 1953, p. 50, pl. 4, fig. 6, pl. 5, figs. 1-3, 5, 6 ; Kanno and Ogawa, 1964, pl. 4, figs. 10, 11.

Turritella (*Hataiella*) *poronaiensis* Takeda ; Kotaka, 1959, p. 95, pl. 8, fig. 19, pl. 10, figs. 8-10, 16, 17 ; Honda, 1986b, pl. 1, figs. 12a-b

Remarks : Several tens of specimens were collected from siltstone, and very fine- and fine-grained sandstone at 29 localities of the Omagari, Charo and Nuibetsu Formations. This species was originally described from the Poronai, the Shitakara, the Charo, and the Nuibetsu Formation. It is characterized by its highly turriculate shell with 13 rounded whorls, and 7 or 6 narrowly elevated spiral lines on each whorl. The spiral notation is shown as (C t b s a r).

The present species resembles *T.* (*Hataiella*) *poronaiensis bathysinuata* Shuto and Ueda, 1967, but it differs from the subspecies in having more numerous spiral lines on the shoulder, and more symmetrical growth lines. It also resembles *T. mitagawaensis* Kanno, 1958, but the former "shows sometimes fairly rounded whorl profile" (Kotaka, 1959). The present species has also been recorded from the Momijiyama Formation (Kanno and Ogawa, 1964), and the Aluginian Stage (Oligocene) of eastern Kamchatka (Plonina and Berson, 1978).

Associated fauna : The present species is associated with *Portlandia watasei* (s.s.), *Clinocardium omagariense*, *Yoldia laudabilis*, *Cyclocardia laxata*, *Periploma besshoense*, *Neverita asagaiensis*, and *Neptunea ezoana* in the Omagari Formation. It is also associated with *Cyclocardia* spp., *Orectospira wadana*, *P. watasei* (s.s.) *Acila kusiroensis*, *Eocylichna multistriata*, and *Dentalium nunomae* in the Charo and Nuibetsu Formations. It is also associated with *T. tokunagai* at Locs. OM-02 and OM-12, and with *T.*

importuna at Loc. OM-30.

Locality and Formation: OM-02, 04, 12, 14, 15, 21, 22, 26, 30, 32, Omagari Formation; CH-52 56, 76, 79, CH-H, D-33, 35, CHY-23, 33, CHK-16, Charo Formation; NB-16, 24, 35, 41, 75, f, NBY-1, 9, 13, Nuibetsu Formation.

Turritella tokunagai Yokoyama, 1924

Turritella tokunagai Yokoyama, 1924, p. 10, pl. 1, figs. 8-10; Makiyama, 1934, p. 160; Kanehara, 1937b, p. 8, pl. 2, fig. 1, pl. 4, fig. 4; Ida, 1952, p. 56; Kishu Shimanto Research Group, 1970, pl. 6, fig. 1; Nemoto and O'Hara, 1979, pl. 2, fig. 11; Kotaka, 1980, pl. 2, figs. 8, 12, 13 (reproduced from Yokoyama, 1924); O'Hara and Nemoto, 1982, pl. 2, figs. 12, 13.

Turritella (*Haustator*) *tokunagai* Yokoyama; Otuka, 1938, p. 40, pl. 1, text-fig. 17 on page 43 (reproduced from Kanehara, 1937b): Kotaka, 1950, p. 34, pl. 5, figs. 7, 8 (reproduced from Yokoyama, 1924); Hirayama, 1955, p. 114, pl. 5, figs. 37-40.

"Turritella" tokunagai Yokoyama; Kotaka, 1959, p. 106, pl. 11, figs. 7, 8, 11, 12, 15 (figs. 7, 8, reproduced from Yokoyama, 1924); Kamada, 1962, p. 149.

Remarks: A total of nine specimens were collected from siltstone and fine-grained sandstone at eight localities of the Omagari, Charo and Nuibetsu Formations. This species was originally described from the Asagai Formation. It is characterized by its small, somewhat ventricosed conical shell with five spiral lines on the surface, and by having "a little over ten whorls" (Yokoyama, 1924).

The present species is closely related to *T. importuna* Yokoyama, 1924, but it differs by having more numerous spiral lines being narrower than the interspaces, and by having a smaller apical angle (Makiyama, 1934; Kotaka, 1980). Makiyama (1934) considered that *T. tokunagai* is synonymous with *T. importuna*, or that it is a subspecies of the latter, and suggested that they may represent sexual dimorphism, because they occur together in the Asagai Formation. Kotaka (1980) also suggested that there may be a dimorphism in *tokunagai-importuna* group.

The present species has also been recorded from horizons 2 and 3 at Machigar (Oligocene) of northern Sakhalin (Makiyama, 1934); the Mizunoya Shale of the Yunagaya Series (Miocene; Kanehara, 1937b); the "Goyasu Formation" (late Oligocene to earliest Miocene) of the Joban coal field (O'Hara and Nemoto, 1982); the Muro Group (Oligocene) of the Kii Peninsula (Kishu Shimanto Research Group, 1970); and the Nishisonogian Stage (Oligocene) of Kyushu (Mizuno, 1964a).

Associated fauna: The present species is associated with *Portlandia watasei* (s.s.), *Cyclocardia poronaiensis*, new name, *C. tokudai*, *Clinocardium omagariense*, *Turritella poronaiensis*, and *Neptunea ezoana* in the Omagari Formation; and with *P. watasei* (s.s.), *Cyclocardia* sp., *Conchocele bisecta*, *Periploma besshoense*, *Eocylichna multistriata*, and *Dentalium* sp. in the Charo and Nuibetsu Formations. It is also associated with *Portlandia yotsukurensis*, *Cyclocardia akagii*, *Macoma optiva*, *Yoldia laudabilis*, and *Chlamys* sp. in fine-grained sandstone to siltstone of the Muro Group (Kishu Shimanto Research Group, 1970); with *Clinocardium asagaiense* (Makiyama), and *Acila*(*Truncacila*) *oyamadensis* Hirayama in fine- to medium-grained sandstone of the "Goyasu Formation" (O'Hara and Nemoto, 1982).

Locality and Formation: OMH-3, OM-02, 12, 17, 27, Omagari Formation; CH-22, CHY-12, Charo Formation; NB-54, Nuibetsu Formation.

Turritella importuna Yokoyama, 1924

Turritella importuna Yokoyama, 1924, p. 10, pl. 1, figs. 6, 7; Makiyama, 1934, p. 161, p. 7, figs. 54, 55, 60; Kotaka, 1980, pl. 2, figs. 7, 9-11 (figs, 7, 9, reproduced from Yokoyama, 1924; figs. 10, 11, from Makiyama, 1934).

Turritella (*Haustator*) Yokoyama; Otuka, 1938, p. 40; Kotaka, 1950, p. 34, pl. 5, figs. 9, 10; Hirayama, 1955, p. 113, pl,. 5, figs. 33–36.
"Turritella" importuna Yokoyama; Ida, 1952, p. 61, pl. 5, figs. 2, 3; Kotaka, 1959, p. 106, pl. 11, figs. 13, 14 (reproduced from Yokoyama, 1924); Kamada, 1962, p. 149.

Remarks: A total of 11 specimens were collected from siltstone, fine- and very fine-grained sandstone, and conglomerate at six localities of the Omagari, Charo and Nuibetsu Formations. This species was originally described from the Asagai Formation. It is characterized by its small and conical shell with four rather distinct spiral lines on the surface. *Turritella importuna* has also been recorded from horizons 3 and 7 at Machigar (Oligocene) of northern Sakhalin (Makiyama, 1934).

Associated fauna: The present species is associated with *Yoldia laudabilis*, *Portlandia watasei* (s.s.), and *Cyclocardia expansa* in the Omagari Formation; and with *Cyclocardia* sp., *C. ezoense*, *Dentalium* sp., *Eocylichna multistriata*, and *"Minolia" funiculata* in the Nuibetsu Formation. It is not associated with other molluscan species in the Charo Formation.

Locality and Formation: OM-07, 20, 25, 30, Omagari Formation; CHY-4, Charo Formation; NBY-12, Nuibetsu Formation.

Turritella sp.

Pl. 9, Figs. 2, 7

Remarks: Several hundred specimens of *Turritella* sp. are at hand. These occur sporadically (or in groups) in siltstone (and fine-grained sandstone) at 74 localities of the Shitakara, Omagari, Charo, and Nuibetsu Formations. The specimens were not specifically identified, because original shell material is decorticated, and it is difficult to observe their delicate spiral ornamentations. But most of them may be assigned to *T. poronaiensis*, *T. nuibetsuensis*, n. sp., *T. tokunagai*, or *T. importuna*, based on their general shell features.

Associated fauna: The present species is commonly associated with *Cyclocardia* spp., *Dentalium* sp., *Yoldia* spp., *Orectospira wadana*, *Eocylichna multistriata*, and *Acila* spp., and rarely with *Portlandia watasei* (s.s.), *P. thraciaeformis*, and *Clinocardium* sp. in the Omagari, Charo and Nuibetsu Formations. It is also associated with *Corbicula sitakaraensis* and *Mactra* sp. in the Shitakara Formation.

Locality and Formation: SK-56, B, SKK-15, Shitakara Formation; OM-21, 22, OMH-10, 6830R, Omagari Formation; CH-11, 14, 18, 21, 25, 27, 28, 29, 36, 42, 46, 48, 50, 64, 65, 66, 70, 74, 75, 77, 87, D-03, 09, CHY-6, 7, 8, 16, 27, CHK-3, 12, Charo Formation; NB-06, 07, 14, 17, 22, 25, 27, 28, 31, 33, 39, 47, 48, 49, 52, 60, 62, 64, 65, 67, 71, 72, 76, 77, C, E, F, d, h, D-11, NBY-2, 10, 16, 17, NBK-36, 50, 75, Nuibetsu Formation.

Family Thiaridae
Subfamily Pleurocerinae
Genus *Semisulcospira* Boettger, 1886
Semisulcospira fiscina yokoyamai Suzuki, 1944

Semisulcospira fiscina (Yokoyama); Suzuki, 1941c, p. 22, pl. 1, fig. 5 (in part).
Melanoides (*Semisulcospira*) *fiscina* (Yokoyama); Ôtatume, 1942, p. 285, pl. 10, figs. 7, 8 (in part).
Semisulcospira fiscina yokoyamai Suzuki, 1944, p. 101.

Remarks: Only three specimens were collected from tuffacous, iron-stained, fine-grained sandstone at one locality of the Shakubetsu Formation. Yokoyama (1932, p. 237, pl. 1, figs. 2, 3) proposed *Semisulcospira fiscina* from the Lower Okada, the Lower and the Upper Numata, and the Tachibetsu Beds of the Uryu Group (Oligocene) of the Uryu coal field, Hokkaido. Subsequently, Suzuki (1944, p. 101) proposed *S. fiscina yokoyamai* for

S. fiscina of Suzuki (1941c) from the Upper Tachibetsu Formation, and assigned *Melanoides* (*Semisulcospira*) *fiscina* of Ôtatume (1942) from the Lower *Corbicula* Beds (Akahira Formation, Oligocene) of the Ishikari Group, to *S. fishina yokoyamai*.

The present subspecies differs from *S. fiscina* (s.s.) in having a more elongated shell and much weaker longitudinal ribs. It has also been recorded from the Soun Coal-bearing Member of the Teshibetsu Formation (Oligocene) of the Urahoro Group (Mizuno, 1964b).

Associated fauna: The present species is associated with *Corbicula tokudai*, *Cipangopaludina isikariensis*, *Anodonta subjapanensis yokoyamai*, and *Modiolus* sp.

Locality and Formation: SBY-3, Shakubetsu Formation.

Family Potamididae
Genus *Cerithidea* Swainson, 1840
Cerithidea ishikariensis
Yokoyama, 1932

Cerithidea ishikariensis Yokoyama, 1932, p. 236, pl. 1, figs. 4-7.

Remarks: Only one poorly preserved specimen was collected from tuffaceous, gray, fine-grained sandstone of the Shakubetsu Formation. This species was originally described from the Lower and the Middle Okada Beds (Oligocene) of the Uryu Group. It is characterized by its moderate, turriculate shell with 20 or more numerous longitudinal ribs, and about 10 spiral striae, on the surface.

The present species resembles *Cerithidea* (*C.*) *sugai* Mizuno and Fujii, 1958, originally described from the so-called Taki Formation of the Joban coal field, but it differs from the latter in having more numerous spiral striae. It has also been recorded from the Soun Coal-bearing Member of the Teshibetsu Formation (Mizuno, 1964b).

Associated fauna: The present species is associated with *Corbicula sitakaraensis* and *Cipangopaludina isikariensis*.

Locality and Formation: SB-F, Shakubetsu Formation.

Family Naticidae
Subfamily Polinicinae
Genus *Neverita* Risso, 1826
Subgenus *Neverita* s.s.
Neverita (*Neverita*) *asagaiensis*
(Makiyama, 1934)

Pl. 9, Figs. 12-15

Natica janthostoma Desh.; Yokoyama, 1924, p. 12, pl. 1, fig. 20

Non Natica janthostoma Deshayes, 1839, p. 361 (*fide* Marincovich, 1977, p. 405).

Ampullina ? asagaiensis Makiyama, 1934, p. 162, pl. 7, figs. 58, 59, 66, 67.

Ampullina cf. *asagaiensis* Makiyama; Watanabe, Arai and Hayashi, 1950, pl. 5, fig. 11; Kanno, 1960, p. 357, pl. 48, figs. 6, 7; Kanno and Ogawa, 1964, pl. 4, figs. 16a-b.

Ampullina asagaiensis Makiyama; Hirayama, 1955, p. 118, pl. 4, figs. 5a-b; Kamada, 1962, p. 160, pl. 19, figs. 5a-b; Katto and Masuda, 1978, p. 107, pl. 2, figs. 3a-b; Nemoto and O'Hara, 1979, pl. 2, figs. 13a-b.

Description: Shell small, conical, globose, and rather thick. Apical angle about 95 to 100°. Shell exterior colored pale brown, except for white umbilical callus. Whorls about five and smooth except for feeble growth lines. Height of body whorl about 0.7 that of shell. Suture slightly channeled. Aperture oval and inner lip with smooth umbilical callus. Umbilicus perfectly closed (or rarely, slitlike open).

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	D
95159-1	OM-28	34.9	30.0
95159-2	OM-28	38.3	31.7
95159-4	OM-28	34.4	30.5
95159-8	OM-28	34.6	30.0
95159-9	OM-28	29.3	26.4

Remarks: About 110 rather well preserved specimens, lacking only portions of the apex and whorls due to decortication, were examined. They were collected from siltstone, fine-grained sandstone and conglomerate at 27 localities of the Shitakara, Omagari, Charo, and Nuibetsu Formations. The present species was originally described by Makiyama (1934), under the name *Ampullina ? asagaiensis* from horizons 3 and 4 (Marie Formation, Oligocene; *vide* Oyama, Mizuno and Sakamoto, 1960, p. 48) at Machigar of northern Sakhalin and the Asagai Formation (Oligocene).

The present species has long been assigned to the genus *Ampullina* Bowdich, 1822 by Japanese molluscan paleontologists. But it definitely does not belong to the subfamily Ampullospirinae and should be placed in the Polinicinae (Honda and Marincovich, 1982). Based on the criteria of Marincovich (1977, p. 245), it is placed in *Neverita* (s.s.) (Honda and Marincovich, 1982). *Ampullina* Bowdich, 1822 has been confused with other ampullospirine genera, and is generally cosidered to be invalid (Sohl, 1960).

Yokoyama (1924) described *Natica janthostoma* Deshayes, 1839 from the Asagai Formation, but it is assigned here to *Neverita asagaiensis*, as was done by Oyama, Mizuno and Sakamoto (1960). *Ampullina* cf. *A. asagaiensis* from the following Oligocene or lower Miocene strata of Japan, are also assigned to *N. asagaiensis*, as was done by Katto and Masuda (1978): the Akahira Formation (early Miocene; Watanabe, Arai and Hayashi, 1950) and the Nenokami Sandstone (early Miocene; Kanno, 1960) of the Chichibu Basin; and the Momijiyama Formation (Oligocene; Kanno and Ogawa, 1964).

The present species has also been recorded from the Charo Formation (Oligocene; Matsui, 1962); the Poronai Formation (Oligocene; Shimokawara, 1963); the Shimokine Formation of the Tappu Group (Oligocene; Ohara, 1966b); and the Tanami Formation (Oligocene) of the Kii Peninsula, Southwest Honshu (Katto and Masuda, 1978). *Neverita* (*Neverita*) is essentially a northern temperate subgenus and lives in temperate and Arctic waters of the eastern Pacific and elsewhere, while all extinct ampullospirines are associated with tropical or subtropical faunas (Marincovich, 1977).

Associated fauna: The present species is associated with *Ostrea eorivularis*, *Periploma besshoense*, *Nemocardium ezoense*, and *Corbicula sitakaraensis* in the Shitakara Formation; and *Clinocardium omagariense*, *Portlandia watasei* (s.s.), *Yoldia laudabilis*, *Neptunea ezoana*, *Cyclocardia tokudai*, *C. laxata*, *P. besshoense*, and *N. modestoidea* in the Omagari Formation. It is also associated with *Cyclocardia ezoensis* and *Caryocorbula* sp. in the Nuibetsu Formation.

Locality and Formation: SK-35, 35*, 37*, B-09, SK2-9, 13, Shitakara Formation; OM-01, 03, 07, 11, 13, 14, 15, 17, 19, 20, 22, 24, 25, 28, 32, OMH-10*, 6830R, Omagari Formation; CHY-16, 28, 30, Charo Formation; NB-R, Nuibetsu Formation.

Family Calyptraeidae

Genus *Crepidula* Lamarck, 1799

Crepidula matajiroi Makiyama, 1957

Crepidula auricula Yokoyama, 1924, p. 11, pl. 1, figs. 5a-c; Kanno, 1960, p. 355, pl. 48, figs. 1, 2.
Crepidula matajiroi Makiyama, 1957, pl. 11, figs. 5a-c (reproduced from Yokoyama, 1924).

Remarks: Only one specimen was collected from very fine-grained sandstone of the Omagari Formation. Makiyama (1957) proposed the new name *Crepidula matajiroi* for *C. auricula* Yokoyama, 1924 from the Asagai Formation, because Yokoyama's *C. auricula* had been preoccupied by Blainville (1824). *Crepidula matajiroi* has also

been recorded from the Nenokami Sandtone (early Miocene) of the Chichibu Basin (Kanno, 1960).

Associated fauna: The present species is associated with *Clinocardium omagariense*, *Cyclocardia laxata*, *Yoldia laudabilis*, *Periploma besshoense*, *Neverita asagaiensis*, and *Nemocardium ezoense*.

Locality and Formation: OM-32, Omagari Formation.

Family Buccinidae
Genus *Trominina* Oyama and Mizuno, 1958
Trominina japonica (Takeda, 1953)

Pl. 10, Figs. 13a-b

Ancistrolepis japonicus Takeda, 1953, p. 56, pl. 1, figs. 1, 3, 5-7; Matsui, 1957, pl. 8, fig. 12.
Trominina japonica (Takeda); Oyama, Mizuno and Sakamoto, 1960, p. 62, pl. 9, figs. 3a-e (reproduced from Takeda, 1953).

Remarks: A total of 18 specimens were collected from siltstone (and fine-grained sandstone) at 12 localities of the Charo and Nuibetsu Formations. The present species was originally described by Takeda (1953) from the Nisisakutan and the Aragai Bed of the Maoka Group (Oligocene) of southern Sakhalin, and the Charo and the Nuibetsu Formation. It is characterized by its moderately thin, fusiform shell with more than seven whorls ornamented with six spiral ribs.

The present species resembles *T. hokkaidoensis* (Hayasaka and Uozumi, 1954) and *T. ishikariensis* (Hayasaka and Matsui, 1951), both from the Momijiyama Formation of Oligocene age. But it differs from the latter by having a relatively higher shell. It has also been recorded from the Pepeshiru Formation (Oligocene) of Hokkaido (Matsui, 1957), the Poronai Formation (Shimokawara, 1963), and the Alugian Stage (Oligocene) of eastern Kamchatka (Plonina and Berson, 1978).

Associated fauna: The present species is associated with *Dentalium* sp., *Cyclocardia* sp., *Portlandia* spp., *Orectospira wadana*, and *Callianassa* sp. It is also associated with *Trominina ishikariensis* at Loc. D-35, and with *T. umbelliformis* (Hayasaka and Uozumi) at Loc. D-19.

Locality and Formation: CH-61, 85, D-04, 06, 20, 24, 35, CHY-14, 33, Charo Formation; NB-74, D-19, NBY-14, Nuibetsu Formation.

Trominina hokkaidoensis (Hayasaka and Uozumi, 1954)

Pl. 10, Figs. 11a-b

Ancistrolepis yudaensis var. *ishikariensis* Hayasaka and Matsui, 1951, p. 334, pl. 1, fig. 3 (in part).
Ancistrolepis yudaensis var. *isikariensis* [sic] Hayasaka and Matsui; Matsui, 1951, p. 126, pl. 12, figs. 105, 106.
Ancistrolepis hokkaidoensis Hayasaka and Uozumi, 1954, p. 402, pl. 25, fig. 8, pl. 26, fig. 5.
Trominina hokkaidoensis (Hayasaka and Uozumi); Oyama, Mizuno and Sakamoto, 1960, p. 63, pl. 10, fig. 2 (reproduced from Hayasaka and Uozumi, 1954); Kanno and Ogawa, 1964, p. 291, pl. 4, figs. 3a-b.

Remarks: Several specimens were collected from siltstone at two localities of the Nuibetsu Formation. *Ancistrolepis yudaensis* var. *ishikariensis* Hayasaka and Matsui (1951, p. 334, pl. 1, fig. 3, in part) and that of Matsui (1951, p. 126, pl. 12, figs. 105, 106), both from the Momijiyama Formation, are allocated here to *Trominina hokkaidoensis*, as was done by Kanno and Ogawa (1964), and Oyama, Mizuno and Sakamoto (1960).

The present species resembles *T. ishikariensis*, but differs from it in having a relatively higher spire, a narrower apical angle, and a convex periphery of its whorls (Hayasaka and Uozumi, 1954). It has also been recorded from the Alugian Stage (Oligocene) of eastern Kamchatka (Plonina and Berson, 1978).

Associated fauna: The present species is associated with *Yoldia sobrina*, *Turritella nuibetsuensis*, *Eocylichna mul-*

tistriata, and *Liocyma furtiva*.

Locality and Formation: D-15, NBK-71, Nuibetsu Formation.

Trominina ishikariensis (Hayasaka and Matsui, 1951)

Pl. 10, Figs. 10a-b

Ancistrolepis yudaensis var. *ishikariensis* Hayasaka and Matsui, 1951, p. 334, pl. 1, figs. 4a-b (in part).

Non Ancistrolepis yudaensis var. *isikariensis* [sic] Hayasaka and Matsui; Matsui, 1951, p. 126, pl. 12, figs. 105, 106.

Ancistrolepis ishikariensis Hayasaka and Matsui; Hayasaka and Uozumi, 1954, p. 401, pl. 26, fig. 2.

Trominina ishikariensis (Hayasaka and Matsui); Oyama, Mizuno and Sakamoto, 1960, p. 63, pl. 11, figs. 1a-c (fig. 1a, reproduced from Hayasaka and Uozumi, 1954; 1b-c, from Hayasaka and Matsui, 1951).

Remarks: A total of seven specimens were collected from siltstone and fine-grained sandstone at six localities of the Charo and Nuibetsu Formations. The present species was originally described by Hayasaka and Matsui (1951) from the Momijiyama Formation. But the specimen (pl. 1, fig. 3) is assigned here to *T. hokkaidoensis*, as was done by Kanno and Ogawa (1964).

The present species resembles *Ancistrolepis yudaensis* Otuka, 1934 from the Lower Kadonosawa series (Miocene) of Northeast Honshu. But it differs from the latter in having fewer spiral lines on the surface.

Associated fauna: The present species is associated with *Cyclocardia tokudai*, and *Turritella nuibetsuensis*, n. sp.

Locality and Formation: D-23, 35, CHK-4, Charo Formation; D-11, NBY-3, 5, Nuibetsu Formation.

Trominina umbelliformis (Hayasaka and Uozumi, 1954)

Pl. 10, Figs. 12a-b

Melongena agasiana [sic] Yokoyama; Matsui, 1950, p. 6, text-fig. 4.

Melongena angasiana Yokoyama; Hayasaka and Matsui, 1951, p. 336, pl. 1, fisg. 5a-b.

Neptunea umbelliformis Hayasaka and Uozumi, 1954, p. 403, pl. 25, fig. 10, pl. 26, fig. 1; Kanno and Ogawa, 1964, pl. 4, fig. 4.

Trominina umbelliformis (Hayasaka and Uozumi); Oyama, Mizuno and Sakamoto, 1960, p. 64. 11, figs. 2a-d (figs. 2a-b, reproduced from Hayasaka and Uozumi, 1954; 2c-d, from Hayasaka and Matsui, 1951).

Remarks: Only three specimens were collected from siltstone and fine-grained sandstone at two localities of the Charo and Nuibetsu Formations. This species is characterized by its rather large shell with more than four whorls being ornamented with many spiral ribs, and by the development of the keel on the middle part of the whorl.

Melongena angasiana Yokoyama of Matsui (1950) and of Hayasaka and Matsui (1951), both from the Momijiyama Formation, are allocated here to *T. umbelliformis*, as was done by Oyama, Mizuno and Sakamoto (1960), and Hayasaka and Uozumi (1954).

Associated fauna: The present species is associated with *Portlandia yotsukurensis*, *Acila* sp., *Malletia poronaica*, *Dentalium nunomae*, and *Trominina japonica*.

Locality and Formation: D-46, Charo Formation; D-19, Nuibetsu Formation.

Genus *Neptunea* Röding, 1798

Neptunea dispar Takaeda, 1953

Pl. 10, Figs. 8a-b

Neptunea dispar Takaeda, 1953, p. 55, pl. 1, figs. 2, 4, 8-12; Matsui, 1958, p. 209, pl. 30, figs. 7, 8.

Neptunea ? dispar Takeda; Oyama, Mizuno and Sakamoto, 1960, p. 67, pl. 12, figs. 1a-c (reproduced from Takeda, 1953).

Remarks: Only four specimens were collected from fine-grained sandstone at four localities of the Charo and Nuibetsu Formations. The present species was originally described by Takeda (1953) from the Nisisakutan bed of the Maoka

Group (Oligocene) and the Nuibetsu Formation. It is characterized by its moderate, fusiform shell with five or six whorls being ornamented with numerous spiral striae on the surface, and with tubercles on the shoulder.

Associated fauna: The present species is associated with *Cyclocardia* spp., and *Lima* sp.

Locality and Formation: CHY-5, D-35, Charo Formation; NBY-6, 8, Nuibetsu Formation.

Neptunea ezoana Takeda, 1953

Pl. 10, Figs. 9, 14, 15

Neptunea ezoana Takeda, 1953, p. 52, pl. 2, figs. 1, 3, 6.

Trominina ? ezoana (Takeda); Oyama, Mizuno and Sakamoto, 1960, p. 66, pl. 10, figs. 1a-b (reproduced from Takeda, 1953).

Remarks: About 30 specimens were collected from fine- and very fine-grained sandstone, siltstone, and conglomerate at 16 localities of the Omagari and Charo Formations. The present species was originally described by Takeda (1953) from the Nisisakutan and the Aragai Bed of the Maoka Group, the Omagari, the Charo and the Nuibetsu Formation. It is characterized by its moderate, fusiform shell with 7 whorls being ornamented with 4 spiral ribs on the forth and sixth whorls and 11 or 12 ones on the body whorl. *Neptunea ezoana* has also been recorded from the Shitakara Formation (Matsui, 1958).

Associated fauna: The present species is associated with *Clinocardium omagariense*, *Portlandia watasei* (s.s.), *Yoldia laudabilis*, *Cyclocardia tokudai*, *C. laxata*, and *Neptunea modestoidea*.

Locality and Formation: OM-01, 02, 03, 05, 06, 11, 14, 16, 17, 19, 20, 25, 30, 32, OMK-5 Omagari Formation, D-47, Charo Formation.

Neptunea modestoidea Takeda, 1953

Neptunea modestoidea Takeda, 1953, p. 53, pl. 3, figs. 1-7, pl. 5, fig. 8; Matsui, 1985, p. 206, pl. 30, figs. 1a-b.

Ancistrolepis modestoides (Takeda); Oyama, Mizuno and Sakamoto, 1960, p. 60, pl. 8, figs. 5a-d (reproduced from Takeda, 1953).

Remarks: About 30 specimens were collected from very fine- and fine-grained sandstone, and siltstone at 19 localities of the Shitakara, Omagari, Charo, and Nuibetsu Formations. This species was originally described from the Nisisakutan and the Aragai Bed of the Maoka Group, the Poronai, and the Charo Formation. It is characterized by its moderate, fusiform shell with about seven whorls being ornamented with five spiral lines. *Neptunea modestoidea* has been recorded from the Alugial Stage (Oligocene) of eastern Kamchatka (Plonina and Berson, 1978), and the Shimokine Formation of the Tappu Group, central Hokkaido (Oligocene; Ohara, 1966b).

Associated fauna: The present species is associated with *Cyclocardia* sp., *Mya grewingki kusiroensis*, *M.* sp., *Conchocele bisecta*, and *Ostrea eorivularis* in the Shitakara Formation; *Cyclocardia* spp., *Neverita asagaiensis*, *Turritella* spp., *Portlandia watasei* (s.s.), *Yoldia laudabilis*, *Periploma besshoense*, *Acila* spp., and *Neptunea ezoana* in the Omagari Formation; and *Cyclocardia tokudai*, *Eocylichna multistriata*, and *Trominina japonica* in the Charo and Nuibetsu Formations.

Locality and Formation: SK2-9, 12, 14, 15, SK3-5, SKK-13, Shitakara Formation; OM-05, 13, 14, 17, 30, 32, OMH-G, 6830R, OMK-5, Omagari Formation; CH-08, CHY-29, D-35, Charo Formation; NB-75, Nuibetsu Formation.

Neptunea ogasawarai Honda, n. sp.

Pl. 9, Figs. 16a-b

Ancistrolepis yamanei Kanehara, 1937b, p. 13, pl. 4, fig. 8 (in part).

Cymatium kaneharai Hatai and Nisiyama, 1952, p. 169 (invalid).

Description: Shell moderate in size and fusiform. Whorls are five in number, roundly shouldered, and sculptured with longitudinal and spiral costae. Apical angle about 40°. Longitudinal costae are low, roundly topped, and narrower than the interspaces. Spiral costae are three in number, equally spaced, much narrower than the interspaces, and intersect longitudinal costae forming tubercles on the surface. Body whorl ornamented with four, equally spaced spiral ribs, which are much narrower than the interspaces. Base of body whorl ornamented with 10 distinct spiral ribs. Apertural part unknown.

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	D	AA
99298 (Holotype)	CH-25	53.1+	29.4	ca. 40°

Comparison: The present new species is allied to *Neptunea modestoidea* Takeda, but differs in having a fewer spiral ribs. It is allied also to *N. shoroensis* Matsui (1958, p. 204, pl. 29, figs. 5, 6) from the Tenneru (Oligocene) and the Shitakara Formation, but it differs from the latter in having a more angular periphery of whorls.

Remarks: Only one, rather well preserved specimen was collected from siltstone of the Charo Formation. It is referable to *Ancistrolepis yamanei* Kanehara (1937b, p. 13, pl. 4, fig. 8, in part) from the Asagai Formation, which is clearly distinguishable from the other specimens (pl. 1, figs. 1, 2, paratype; pl. 3, fig. 7, holotype) from the Mizunoya Formation (Miocene) of the Joban coal field.

Hatai and Nisiyama (1952, p. 169) proposed *Cymatium kaneharai* for Kanehara's figured specimen (pl. 4, fig. 8), but it is invalid under the International Code of Zoological Nomenclature (Masuda and Noda, 1976). It is treated as *Cymatium* sp., because it is unfavorably preserved (Masuda and Noda, 1976). The author describes the new species herein based on a specimen from the Charo Formation.

Associated fauna: The new species is associated with *Turritella* sp.

Locality and Formation: CH-25, Charo Formation.

Family Nassariidae
Genus *Molopophorus* Gabb, 1868
Molopophorus kusiroensis Takeda, 1953

Pl. 9, Figs. 8a-b

Molopophorus kusiroensis Takeda, 1953, p. 57, pl. 4, figs. 5, 9, pl. 5, figs. 4, 14.

Remarks: Only two specimens were collected from siltstone at two localities of the Nuibetsu Formation. The present species has been recorded from the Shitakara (Takeda, 1953) and the Charo Formation (Matsui, 1962).

Associated fauna: The present species is associated with *Orectospira wadana*, *Turritella poronaiensis*, and *Dentalium nunomae*.

Locality and Formation: NB-63, Nuibetsu Formation.

Family Fasciolariidae
Genus *Priscofusus* Conrad, 1865
Priscofusus ishijimai Hirayama, 1955

Priscofusus ishijimai Hirayama, 1955, p. 121, pl. 5, figs. 14–19; Nemoto and O'Hara 1979, pl. 2, figs. 17a-b.

Remarks: A total of five specimens were collected from very fine- and fine-grained sandstone at three localities of the Omagari Formation. The present species was originally described from the Asagai Formation.

Associated fauna: The present species is associated with *Portlandia watasei* (s.s.), and *Clinocardium omagariense*.

Locality and Formation: OM-02, 21,

32, Omagari Formation.

Family Volutidae
Genus *Fulgoraria* Schumacher, 1817
Subgenus *Musashia* Hayashi, 1960
Fulgoraria (Musashia) antiquior
(Takeda, 1953)

Neopsephaea antiquior Takeda, 1950, p. 60, pl. 4, figs. 20, 21.
Psephaea (Neopsephaea) antiquior Takeda; Takeda, 1953, p. 59, pl. 4, figs. 1-4, 10, pl. 5, fig. 7 (pl. 4, figs. 2, 4, reproduced from Takeda, 1950).
Fulgoraria (Psephaea) antiquior (Takeda); Oyama, Mizuno and Sakamoto, 1960, p. 79, pl. 16, figs. 3a-d (reproduced from Takeda, 1953).
Musashia (Neopsephaea) antiquior (Takeda); Shikama, 1967, p. 114, pl. 13, figs. 1, 2, text-fig. 19.
Neopsephaea antiquior (Takeda); Shikama, 1968, p. 17.
Musashia antiquior (Takeda); Akamatsu, 1984, pl. 1, fig. 7.

Remarks: Only two specimens were collected from siltstone at two localities of the Charo and Nuibetsu Formations. Takeda (1950) proposed *Neopsephaea antiquior* from the Poronai and the Charo Formation, and the Nisisakutan and the Aragai Bed of the Maoka Group, probably in the sense of *Psephaea (Neopsephaea) antiquior*. But the new subgenus *Neopsephaea* Takeda (1950, p. 60) is invalid, under the International Code of Zoological Nomenclature, because he gave no indication of the type species (Masuda and Noda, 1976).

The present species has also been recorded from the Takinoue Formation (Miocene) of Hokkaido (Akamatsu, 1984), and the Ochiai Formation of the Tanzawa Group (Miocene) of Central Honshu (Shikama, 1967).

Associated fauna: The present species is associated with *Turritella* sp., *Cyclocardia* sp., and *Dentalium nunomae*.

Locality and Formation: CHY-7, Charo Formation; NBY-15, Nuibetsu Formation.

Family Olividae
Genus *Olivella* Swainson, 1931
Olivella ezoana Matsui, 1959

Pl. 9, Figs. 9a-b

Olivella ezoana Matsui, 1959, p. 295, pl. 1, figs. 9-13.

Remarks: Only one specimen was collected from siltstone of the Nuibetsu Formation. This species has been recorded from the Ombetsu Group and the Poronai Formation (Matsui, 1959).

Associated fauna: The present species is associated with *Cyclocardia ezoensis* and *Eocylichna ezoana* (Matsui).

Locality and Formation: NB-48*, Nuibetsu Formation.

Family Turridae
Subfamily Genotiinae
Genus *Riuguhdrillia* Oyama, 1951
Riuguhdrillia rugosa (Takeda, 1953)

Pl. 10, Figs. 2a-b

Spirotropis (Antiplanes) rugosa Takeda, 1953, p. 61, pl. 5, fig. 9.
Riuguhdrillia rugosa (Takeda); Oyama, Mizuno and Sakamoto, 1960, p. 81, pl. 18, fig. 4 (reproduced from Takeda, 1953).

Remarks: Only three specimens were collected from siltstone at three localities of the Charo and Nuibetsu Formations. This species has been recorded from the Charo Formation (Takeda, 1953).

Associated fauna: The present species is associated with *Portlandia watasei* (s.s.), *Cyclocardia tokudai*, and *Orectospira wadana*.

Locality and Formation: CHY-17, Charo Formation; D-17, NBY-14, Nuibetsu Formation.

Family Scaphandridae
Genus *Eocylichna* Kuroda and Habe, 1952
Eocylichna multistriata
(Takeda, 1953)

Pl. 9, Fig. 1

Cylichna multistriata Takeda, 1953, p. 61, pl. 2, figs.

7, 10, 11, 16.

Scaphander murtistriata [sic] (Takeda); Matsui, 1959, p. 301, pl. 2, figs. 14-16.

Eocylichna multistriata (Takeda); Oyama, Mizuno and Sakamoto, 1960, p. 84, pl. 18, figs. 11a-d (reproduced from Takeda, 1953).

Dimensions (in mm):

IGPS coll. cat. no.	Loc. no.	H	D
97110	CH-78	14.2	8.3

Remarks: About 30 somewhat depressed specimens were collected from siltstone and fine-grained sandstone at 26 localities of the Omagari, Charo and Nuibetsu Formations. The present species was originally described by Takeda (1953) from the Charo and the Nuibetsu Formation, and the Aragai Bed of the Maoka Group. Shell small (generally smaller than one cm in height and attains a maximum height of about 1.5 cm), thin, cylindrical, and involute. Surface colored pinkish gray, and ornamented with numerous, minute spiral lines which intersect longitudinal ones, and form the cancellate sculpture.

The present species resembles *Eocylichna ezoana* (Matsui, 1959), but *E. ezoana* differs in having a "larger, more slender outline and narrower aperture" (Matsui, 1959, p. 303). It also resembles *E. stolida* (Hirayama, 1955, p. 125, pl. 5, figs. 11-13) from the Asagai Formation, but it differs from the latter in having a smaller and more slender shell. *Eocylichna multistriata* has also been recorded from the Shitakara Formation (Matsui, 1959), and the Wakkanabe and the Poronai Formation (Shimokawara, 1963).

Associated fauna: The present species is associated with *Dentalium* sp., *Cyclocardia* sp., *Portlandia watasei* (s.s.), and *Turritella* sp.

Locality and Formation: OM-17, Omagari Formation; CH-19, 38, 78, F, CHY-12, 18, D-35, Charo Formation; NB-09, 10, 14, 17, 31, 39, 45, 51, 61, 64, 69, 75, 76, C, K, NBY-12, 16, NBK-71, Nuibetsu Formation.

Eocylichna ezoana (Matsui, 1959)

Pl. 9, Figs. 10a-b

Scaphander ezoana Matsui, 1959, p. 302, pl. 2, figs. 13, 17-19.

Remarks: Only one specimen was collected from fine-grained sandstone of the Charo Formation, and two specimens from siltstone at two localities of the Nuibetsu Formation. The present species was originally described by Matsui (1959) under the genus *Scaphander* from the Poronai (Oligocene) and the Momijiyama (Oligocene) Formation, and the Ombetsu Group.

Associated fauna: The present species is associated with *Trominina* spp., *Turritella* spp., and *Cyclocardia* spp.

Locality and Formation: D-35, Charo Formation; NB-04, 48*, Nuibetsu Formation.

Class Scaphopoda
Family Dentaliidae
Genus *Dentalium* Linné, 1758
Subgenus *Fissidentalium* Fischer, 1885
Dentalium (*Fissidentalium*) *nunomae* Takeda, 1953

Pl. 10, Figs. 4, 7

Dentalium nunomae Takeda, 1953, p. 62, pl. 4, fig. 8, pl. 5, fig. 12.

Dentalium (*Fissidentalium*) *nunomae* Takeda; Honda, 1986b, pl. 1, figs. 13, 14.

Description: Shell medium in size, cylindrical, rather thick, slightly curved ventrally, and rounded in section. Diameter gradually decreases toward the apex. Surface sculptured with about 45 longitudinal ribs that intersect numerous, fine growth lines and form a latticed pattern. Longitudinal ribs are low and narrower than the interspaces. Growth lines are narrow, low, and weaker (sometimes much weaker) than the longitudinal ribs, and are prominent on the apertural portion. The interspaces of lon-

gitudinal ribs are divided into two parts by fine riblets. Apical part unknown.

Dimensions (in mm) :

IGPS coll. cat. no.	Loc. no.	L	D
97129*	CH-15	13.3+	—
97127*	CH-87	24.4+	5.0

* incomplete specimen

Remarks : Several hundred specimens belonging to the genus *Dentalium*, were collected from siltstone (rarely from fine- or very fine-grained sandstone) at 98 localities of the Shitakara, Omagari, Charo, and Nuibetsu Formations. But only several tens of them from 19 localities were specifically identified as *D. nunomae*, because other specimens have mostly worn or eroded surface, and their delicate surface ornamentation is hardly observable. However, there are a few indeterminant species of *Dentalium* having an original smooth surface.

Based on two imperfect specimens, Takeda (1953) proposed *Dentalium nunomae* from the Hattyorei Bed of the Maoka Group. It is characterized by its rectangular, lattice pattern formed by longitudinal ribs and growth lines. *Dentalium nunomae* resembles *D.* (*Fissidentalium*) *watanabei* Kanno (1958, p. 200, pl. 5, figs. 7-9) from the Nenokami Sandstone (early Miocene) of the Chichibu Basin, but it differs from the latter in having more numerous longitudinal ribs.

Kanno (1971, p. 99, pl. 12, figs. 1, 2) described *Dentalium* (*Coccodentalium*) cf. *D.* (*C.*) *nunomae* from the Poul Creek Formation of Alaska, but the specimens differ from *D. nunomae* in having a more ventrally curved shell. Although, Kanno placed *D. nunomae* in the subgenus *Coccodentalium* Sacco, 1896, that subgenus is characterized by its longitudinal ribs fewer than 20 in number (Emerson, 1962 ; Habe, 1964b). Allison and Marincovich (1981) listed *Dentalium* (*Coccodentalium*) cf. *D.* (*C.*) *nunomae* of Kanno (1971), from the Narrow Cape Formation (late Oligocene or earliest Miocene) of Sitkinak Island, Alaska.

The present species is allied also to *D.* (*Dentalium?*) *pseudonyma* Pilsbry and Sharp, 1898, of Moore (1963, p. 50, pl. 31, fig. 2) from the Astoria Formation (Miocene) of Northwest America. But it differs from the latter in having more numerous longitudinal ribs. *Dentalium nunomae* has also been recorded from the Poronai Formation (Shimokawara, 1963), the Tappu Group (Ohara, 1966b), and the Takinoue Formation (Miocene) of Hokkaido (Ohara, 1966a).

Associated fauna : The present species is associated with *Ostrea eorivularis*, and *Nemocardium ezoense* in the Shitakara Formation ; *Clinocardium* sp., and *Turritella tokunagai*, in the Omagari Formation ; and *T.* spp., *Orectospira wadana*, *Malletia poronaica*, *Portlandia* spp., *Acila kusiroensis*, *Cyclocardia tokudai*, and *C.* sp., in the Charo and Nuibetsu Formations.

Locality and Formation : SK-41, SKK-2, Shitakara Formation ; OMH-3, Omagari Formation ; CH-15, 54, 87, D-05, 09, 27, CHY-6, 15, Charo Formation ; NB-10, 69, f, D-11, 19, NBY-15, 17, NBK-7, Nuibetsu Formation.

Dentalium sp.

Pl. 10, Figs. 5, 6

Remarks : Abundant specimens were collected from siltstone, and fine- and very fine-grained sandstone at 79 localities of the Shitakara, Omagari, Charo, and Nuibetsu Formations.

Associated fauna : The present species is associated with *Nemocardium ezoense*, and *Ostrea eorivularis* in the Shitakara Formation ; and *Turritella* sp., *Cyclocardia* sp., *C. ezoensis*, *Yoldia laudabilis*, *Portlandia watasei* (s.s.), and *Eocylichna multistriata* in the Omagari, Charo and Nuibetsu Formations.

Locality and Formation : SK-52,

SK2-7, 13, SKK-23, 24, 27, Shitakara Formation; OM-02, 14, 21, OMH-5, 6, D, G, Omagari Formation; CH-01, 03, 07, 08, 12, 13, 14, 15, 29, 36, 38, 42, 44, 57, 67, 68, 70, 80, 82, 86, 87, E, F, G, D-09, 20, CHY-16, 27, CHK-13, Charo Formation; NB-07, 08, 09, 15, 17, 19, 20, 21, 26, 27, 29, 31, 32, 45, 46, 49, 50, 64, 66, 67, 74, 79, B, C, D, E, F, G, K, L, N, P, Q, b, e, NBY-12, D-16, Nuibetsu Formation.

LIST OF LOCALITIES

The prefixes for locality numbers, given below, correspond to particular study areas, and districts in the Kushiro coal field:

RN-, YB-, SK-, SB-, OMH-, CH-, NB-: Ombetsu district
B-, OM-, D-: Tokomuro district (Yui, 1975MS)
YBY-, SK1-, SK2-, SK3-, SBY-, OMY-, CHY-, NBY-: Akan district (Yanagisawa, 1979MS)
YBK-, SKK-, SBK-, OMK-, CHK-, NBK-: Kamicharo district (Kaiho, 1977MS, but these are omitted from the following list)
OSH: Ombetsu-machi, Shiranuka-gun, Hokkaido
UTH: Urahoro-machi, Tokachi-gun, Hokkaido
SSH: Shiranuka-machi, Shiranuka-gun, Hokkaido

A locality number with an asterisk refers to a locality that is several tens of centimeters to a few meters above (or below) a given horizon, as noted.

Rushin Formation

RN-01: road cut along a national forest road, north of the Rubeshube-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°53′2″N, Long. 143°46′40″E).
RN-02: ditto (about 150 m SW of RN-01) (Lat. 42°52′59″N, Long. 143°46′38″E).

Yubetsu Formation

YB-01: riverside cliff along the Tankono-sawa, a tributary of the Koikata-muri-gawa, OSH (Lat. 42°59′52″N, Long. 143°45′58″E).
YB-02: ditto (about 4 m above horizon of YB-01) (Lat. 42°59′52″N, Long. 143°46′0″E).
YB-03: ditto (about 1 m above horizon of YB-02) (Ditto).
YB-04: ditto (about 20 cm above horizon of YB-03) (Ditto).
YB-05: ditto (about 120 cm above horizon of YB-04) (Ditto).
YB-06: riverside cliff along a south-southeastern tributary of the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°55′36″N, Long. 143°47′38″E).
YB-07: riverside cliff along the upper stream of the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°55′24″N, Long. 143°47′21″E).
YB-08: riverside cliff along the upper stream of the Unnai-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°53′23″N, Long. 143°46′6″E).
YB-09: riverside cliff along the Chokubetsu-gawa, UTH (Lat. 42°53′10″N, Long. 143°47′32″E).
YB-10: riverside cliff along the Rubeshube-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′45″N, Long. 143°47′1″E).
YB-11: ditto (Lat. 42°52′47″N, Long. 143°47′13″E).
YB-12: road cut along a logging road, north of the Rubeshube-zawa, UTH (Lat. 42°52′51″N, Long. 143°47′15″E).
YB-13: ditto (about 5 m above horizon of YB-12) (Ditto).
YB-14: ditto (Lat. 42°52′51″N, Long. 143°47′20″E).
YB-A: boulder in river bed of the upper stream of the Shibetsu-zawa, a tribu-

tary of the Muri-gawa, OSH (Lat. 42° 55′15″N, Long. 143°47′19″E).

YB-B : riverside cliff along the upper stream of the Shakubetsu-gawa, OSH (Lat. 42°54′29″N, Long. 143°47′26″E).

YB-C : boulder below a roadside cut along a logging road, north of the Rubeshube-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′ 55″N, Long. 143°47′5″E).

YB-D : riverside cliff along the Rubeshube-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′ 47″N, Long. 143°47′17″E).

B-13 : uppermost stream of the Yukirubeshubeno-zawa, a tributary of the Tokomuro-gawa, UTH (Lat. 42°55′ 15″N, Long. 143°42′16″E).

YBY-1 : riverside cliff along a tributary of the Charo-gawa, SSH (Lat. 43°0′4″ N, Long. 144°2′40″E).

YBY-2 : riverside cliff along the Irumokunnai-zawa, western tributary of the Shoro-gawa, SSH (Lat. 43°0′39″ N, Long. 144°4′42″E).

YBY-3 : riverside cliff along a tributary of the lowerstream of the Shoro-gawa, SSH (Lat. 42°59′33″N, Long. 144°6′2″ E).

YBY-4 : ditto (Lat. 42°59′13″N, Long. 144°6′16″E).

Shitakara Formation

SK-01 : riverside cliff along the Ponrinoi-zawa a tributary of the Chambetsu-gawa, OSH (Lat. 43°0′50″ N, Long. 143°46′18″E).

SK-02 : roadside cliff along the Chambetsu-gawa, OSH (Lat. 43°0′26″ N, Long. 143°49′44″E).

SK-03 : river bed of the Chambetsu-gawa, OSH (Lat. 43°0′21″N, Long. 143° 49′53″E).

SK-04 : riverside cliff along the Chambetsu-gawa, OSH (Lat. 43°0′15″ N, Long. 143°50′11″E).

SK-05 : river bed of the Tankono-sawa, a tributary of the Koikata-muri-gawa, OSH (Lat. 42°59′54″E, Long. 143°46′2″ E).

SK-06 : riverside cliff along the Tankono-sawa, a tributary of the Koikata-muri-gawa, OSH (Lat. 42°59′ 55″N, Long. 143°46′10″E).

SK-07 : riverside cliff along the Tamono-sawa, a tributary of the Koikata-muri-gawa, OSH (Lat. 42°59′ 29″N, Long. 143°45′49″E).

SK-08 : riverside cliff along the upper stream of the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42° 55′37″N, Long. 143°47′7″E).

SK-09 : ditto (about 50 m downstream of SK-08) (Lat. 42°55′37″N, Long. 143°47′ 10″E).

SK-10 : river bed of the upper stream of the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°55′28″N, Long. 143°47′18″E).

SK-11 : riverside cliff along the middle course of the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42° 55′45″N, Long. 143°47′27″E).

SK-12 : ditto (about 75 m downstream of SK-11) (Lat. 42°55′50″N, Long. 143°47′ 27″E).

SK-13 : river bed of the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°55′45″N, Long. 143°47′33″E).

SK-14 : ditto (about 15 m downstream of SK-13) (Lat. 42°55′45″N, Long. 143°47′ 33″E).

SK-15 : ditto (Lat. 42°55′45″N, Long. 143°47′31″E).

SK-16 : ditto (Lat. 42°55′47″N, Long. 143°47′33″E).

SK-17 : riverside cliff along the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°55′48″N, Long. 143°47′38″E).

SK-18 : ditto (Lat. 42°56′0″N, Long. 143° 47′40″E).

SK-19 : river bed of the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°56′8″N, Long. 143°47′47″E).

SK-20 : ditto (Lat. 42°56′11″N, Long. 143°47′47″E).

SK-21 : riverside cliff along the

Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°56′21″N, Long. 143°48′7″E).

SK-22 : riverside cliff along the upper stream of the Shakubetsu-gawa, OSH (Lat. 42°54′34″N, Long. 143°47′52″E).

SK-23 : ditto (about 1.4 m above horizon of SK-22) (Ditto).

SK-24 : ditto (about 35 cm above horizon of SK-23) (Ditto).

SK-25 : ditto (Lat. 42°54′36″N, Long. 143°47′53″E).

SK-26 : ditto (Lat. 42°54′36″N, Long. 143°48′0″E).

SK-27 : ditto (about 3 m below horizon of SK-26) (Ditto).

SK-28 : ditto (about 25 m downstream of SK-27) (Lat. 42°54′36″N, Long. 143°48′2″E).

SK-29 : river bed of the Shakubetsu-gawa, OSH (Lat. 42°54′45″N, Long. 143°48′2″E).

SK-30 : ditto (Lat. 42°54′43″N, Long. 143°48′1″E).

SK-31 : riverside cliff along the Shakubetsu-gawa, OSH (Lat. 42°54′34″N, Long. 143°48′9″E).

SK-32 : river bed of the Unnai-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°53′32″N, Long. 143°46′0″E).

SK-33 : riverside cliff along the Unnai-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°53′15″N, Long. 143°46′2″E).

SK-34 : riverside cliff along the Chokubetsu-gawa, OSH (Lat. 42°53′18″N, Long. 143°47′31″E).

SK-35 : ditto (Lat. 42°53′13″N, Long. 143°47′36″E).

SK-36 : ditto (Lat. 42°53′7″N, Long. 143°47′36″E).

SK-37 : ditto (Lat. 42°53′5″N, Long. 143°47′36″E).

SK-38 : riverside cliff along the Chokubetsu-gawa, UTH (Lat. 42°53′3″N, Long. 143°47′33″E).

SK-39 : ditto (about 25 m SW of SK-38) (Lat. 42°53′3″N, Long. 143°47′33″E).

SK-40 : riverside cliff along the Rubeshube-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′47″N, Long. 143°47′22″E).

SK-41 : riverside cliff along a small southern tributary of the Rubeshube-zawa, a tributary of the Chokubesu-gawa, UTH (Lat. 42°52′45″N, Long. 143°47′20″E).

SK-42 : ditto (about 120 m NE of SK-41) (Lat. 42°52′49″N, Long. 143°47′22″E).

SK-43 : riverside cliff along the upper stream of the Sango-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′10″N, Long. 143°46′0″E).

SK-44 : river bed of the upper stream of the Sango-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′12″N, Long. 143°46′7″E).

SK-45 : ditto (Lat. 42°52′12″N, Long. 143°46′11″E).

SK-46 : ditto (Lat. 42°52′10″N, Long. 143°46′13″E).

SK-47 : ditto (Lat. 42°52′11″N, Long. 143°46′16″E).

SK-48 : ditto (about 1 m lower horizon of SK-47) (Lat. 42°52′11″N, Long. 143°46′16″E).

SK-49 : riverside cliff along the upper stream of the Sango-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′11″N, Long. 143°46′16″E).

SK-50 : river bed of the upper stream of the Sango-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′13″N, Long. 143°46′18″E).

SK-51 : ditto (Lat. 42°52′13″N, Long. 143°46′18″E).

SK-52 : ditto (Lat. 42°52′11″N, Long. 143°46′20″E).

SK-53 : ditto (Lat. 42°52′11″N, Long. 143°46′22″E).

SK-54 : ditto (Lat. 42°52′11″N, Long. 143°46′24″E).

SK-55 : reverside cliff along the Sango-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′8″N, Long. 143°46′33″E).

SK-56 : ditto (Lat. 42°52′8″N, Long. 143° 46′36″E).
SK-57 : ditto (about 2.5 m above horizon of SK-56) (Ditto).
SK-58 : riverside cliff along the Sango-zawa, a tributary of the Chokubetsu-gawa, UTH (about 12 m above horizon of SK-57) (Lat. 42°52′8″N, Long. 143° 46′36″E).
SK-59 : ditto (about 40 cm above horizon of SK-58) (Ditto).
SK-60 : ditto (about 2 m above horizon of SK-59) (Ditto).
SK-61 : ditto (Ditto).
SK-62 : ditto (Lat. 42°52′7″N, Long. 143° 46′38″E).
SK-A : riverside cliff along the upper stream of the Sango-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′11″N, Long. 143°46′16″E).
SK-B : riverside cliff along the Chokubetsu-gawa, UTH (Lat. 42°53′6″ N, Long. 143°47′36″E).
SK-C : riverside cliff along the upper stream of the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42° 55′40″N, Long. 143°47′20″E).
SK-D : riverside cliff along the uppermost stream of the Shakubetsu-ichigo-zawa, a tributary of the Shakubetsu-gawa, OSH (Lat. 42°55′22″N, Long. 143°48′11″E).
SK-E : riverside cliff along the Chokubetsu-gawa, UTH (Lat. 42°53′3″ N, Long. 143°47′33″E).
5729 : floats on the lower stream of the Rubeshube-zawa, a tributary of the Chokubetsu-gawa, UTH.
B-01 : upper stream of the Terano-sawa, a tributary of the Urahoro-gawa, UTH (Lat. 42°52′36″N, Long. 143°42′4″E).
B-02 : uppermost stream of the Yukirubeshubeno-zawa, a tributary of the Tokomuro-gawa, UTH (Lat. 42°55′ 10″N, Long. 143°42°38″E).
B-03 : ditto (Ditto).
B-04 : eastern tributary of the Urahoro-gawa, UTH (Lat. 42°50′50″N, Long. 143°41′34″E).
B-05 : uppermost stream of the Yukirubeshubeno-zawa, a tributary of the Tokomuro-gawa, UTH (Lat. 42°55′ 13″N, Long. 143°42′29″E).
B-06 : small northeastern tributary of the Urahoro-gawa, about 3.8 km north of Rushin, UTH (Lat. 42°56′55″N, Long. 143°40′0″E).
B-07 : uppermost stream of the Masuno-sawa, a tributary of the Urahoro-gawa, UTH (Lat. 42°53′57″N, Long. 143°42′ 33″E).
B-08 : uppermost stream of the Yukirubeshubeno-zawa, a tributary of the Tokomuro-gawa, UTH (Lat. 42°55′ 23″N, Long. 143°42′42″E).
B-09 : eastern triburary of the Rushin-gawa, UTH (Lat. 42°56′50″N, Long. 143°42′36″E).
B-10 : upper stream of the Ponotakohoshi-zawa, a tributary of the Rushin-gawa, UTH (Lat. 42°58′34″N, Long. 143°42′27″E).
B-Y : uppermost stream of the Yukirubeshubeno-zawa, a tributary of the Tokomuro-gawa, UTH (Lat. 42°55′ 35″N, Long. 143°42′24″E).
SK1-1 : lowermost course of the Shikerebe-gawa, a tributary of the Shoro-gawa, SSH (Lat. 42°10′47″N, Long. 143°58′51″E).
SK1-2 : western tributary of the lower course of the Shoro-gawa, SSH (Lat. 42°59′38″N, Long. 144°5′56″E).
SK1-3 : ditto (Lat. 42°59′38″N, Long. 144°5′53″E).
SK2-1 : western tributary of the Onnechikappu-gawa, SSH (Lat. 42°58′ 12″N, Long. 144°6′27″E).
SK2-2 : ditto (Lat. 42°58″25″N, Long. 144°6′31″E).
SK2-3 : ditto (Lat. 42°58′27″N, Long. 144°6′27″E).
SK2-4 : western tributary of the lower course of the Shoro-gawa, SSH (Lat. 43°59′28″N, Long. 144°6′33″E).
SK2-5 : upper stream of the Karisho-gawa, a tributary of the lower course of the Charo-gawa, SSH (Lat. 43°0′21″

N, Long. 144°4′33″E).
SK2-6 : ditto (Lat. 43°0′25″N, Long. 144°4′30″E).
SK2-7 : ditto (Lat. 43°0′28″N, Long. 144°4′28″E).
SK2-8 : upper stream of a northern tributary of the Ketonchi-gawa, a tributary of the Shoro-gawa, SSH (Lat. 42°1′43″N, Long. 144°4′20″E).
SK2-9 : southwestern tributary of the Shoro-gawa, SSH (Lat. 43°2′22″N, Long. 144°4′27″E).
SK2-10 : ditto (Lat. 43°2′16″N, Long. 144°4′24″E).
SK2-11 : lower stream of the Shirikurochi-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43°3′2″N, Long. 144°4′22″E).
SK2-12 : ditto (Lat. 43°3′7″N, Long. 144°4′27″E).
SK2-13 : uppermost stream of the Shirikurochi-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43°3′30″N, Long. 144°2′56″E).
SK2-14 : south-southwestern tributary of the Shoro-gawa, SSH (Lat. 43°4′8″ N, Long. 144°3′38″E).
SK2-15 : the Tannenai-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43° 3′30″N, Long. 144°2′56″E).
SK2-16 : uppermost stream of the Kuomanai-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43°9′7″N, Long. 143°57′38″E).
SK2-17 : riverside cliff along the Shoro-gawa, SSH (Lat. 43°10′54″N, Long. 143°58′51″E).
SK3-1 : upper stream of the Shiranuka-gawa, SSH (Lat. 42°58′20″N, Long. 144°5′50″E).
SK3-2 : ditto (Lat. 42°58′22″N, Long. 144°5′49″E).
SK3-3 : tributary of the lower stream of the Shoro-gawa, SSH (Lat. 42°59′18″N, Long. 144°6′16″E).
SK3-4 : lower stream of the Shirikurochi-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43°2′58″N, Long. 144°4′20″E).
SK3-5 : ditto (Lat. 43°3′6″N, Long. 144° 4′18″E).
SK3-6 : uppermost stream of the Oniyoppu-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43°6′51″N, Long. 144°4′24″E).
SK3-7 : ditto (Lat. 43°6′57″N, Long. 144°4′20″E).
SK3-8 : ditto (Lat. 43°6′58″N, Long. 144°4′18″E).
SK3-9 : a northeastern tributary of the Shoro-gawa, SSH (Lat. 43°9′54″N, Long. 144°1′3″E).

Shakubetsu Formation

SB-01 : riverside cliff along the Chambetsu-gawa, OSH (Lat. 43°0′41″ N, Long. 143°48′51″E).
SB-02 : ditto (Lat. 43°0′37″N, Long. 143° 49′26″E).
SB-03 : riverside cliff along the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°56′14″N, Long. 143°48′23″E).
SB-04 : ditto (about 50 m ESE of SB-03) (Lat. 42°56′13″N, Long. 143°48′24″E).
SB-05 : riverside cliff along the Chokubetsu-gawa, OSH (Lat. 42°53′3″ N, Long. 143°47′58″E).
SB-06 : ditto (about 10 m below horizon of SB-05) (Ditto).
SB-07 : ditto (about 5.5 m below horizon of SB-06) (Ditto).
SB-08 : riverside cliff along the Sango-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′5″N, Long. 143°46′49″E).
SB-A : riverside cliff along the Chambetsu-gawa, OSH (Lat. 43°0′49″ N, Long. 143°48′33″E).
SB-B : boulder in river bed of the Chambetsu-gawa, OSH (Lat. 43°0′45″ N, Long. 143°48′39″E).
SB-C : ditto (Lat. 43°0′44″N, Long. 143° 48′40″E).
SB-D : ditto (about 100 m SE of SB-C) (Lat. 43°0′42″N, Long. 143°48′43″E).
SB-E : riverside cliff along a logging road along the Chambetsu-gawa, OSH

(Lat. 43°0′44″N, Long. 143°48′50″E).
SB-F : riverside cliff along the Chambetsu-gawa, OSH (Lat. 43°0′36″ N, Long. 143°49′11″E).
SB-G : boulder in river bed of the Chambetsu-gawa, OSH (about 50 m E of SB-F) (Lat. 43°0′36″N, Long. 143° 49′13″E).
SB-H : boulder on logging road, along the Chambetsu-gawa, OSH (about 70 m NE of SB-G) (Lat. 43°0′39″N, Long. 143°49′19″E).
SB-I : boulder in river bed of a small northern tributary of the Chambetsu-gawa, OSH (Lat. 43°0′15″N, Long. 143° 50′26″E).
SB-J : ditto (about 100 m E of SB-I) (Lat. 43°0′15″N, Long. 143°50′31″E).
SB-K : ditto (about 25 m SE of SB-J, approximately the same horizon as SB-J) (Lat. 43°0′14″N, Long. 143°50′ 33″E).
SB-L : riverside cliff along the uppermost stream of the Yatatoshino-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′24″N, Long. 143°48′37″E).
SB-M : riverside cliff along the upper stream of the Yatatoshino-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′0″N, Long. 143°49′7″E).
SB-N : ditto (about 10 m downstream of SB-M) (Ditto).
SB-O : ditto (about 5 m downstream of SB-N) (Ditto).
SB-P : riverside cliff along the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°56′11″N, Long. 143°47′6″E).
SB-Q : riverside cliff along a tributary of the Shakubetsu-ichigo-zawa, a tributary of the Shakubetsu-gawa, OSH (Lat. 42°54′50″N, Long. 143°48′40″E).
SB-R : riverside cliff along a northern small valley of the Shakubetsu-gawa, OSH (Lat. 42°54′15″N, Long. 143°48′ 28″E).
SB-S : riverside cliff along the Chokubetsu-gawa, OSH (about 0.5 m lower horizon of SB-07) (Lat. 42°53′3″ N, Long. 143°47′58″E).
SB-T : ditto (about 4 m below horizon of SB-S) (Ditto).
SB-U : riverside cliff along the Otobe-gawa, UTH (Lat. 42°51′47″N, Long. 143°46′7″E).
SBY-1 : cliff along the lower stream of the Shiranuka-gawa, SSH (Lat. 42°57′ 31″N, Long. 144°5′29″E).
SBY-2 : uppermost stream of a northern tributary of the lower course of the Charo-gawa, SSH (Lat. 42°59′55″N, Long. 144°4′2″E).
SBY-3 : uppermost stream of the Kamino-sawa, a tributary of the Shoro-gawa, SSH (Lat. 43°2′5″N, Long. 144°7′4″E).
SBY-4 : uppermost stream of the Ketonchi-zawa, a tributary of the Shoro-gawa, SSH (Lat. 43°1′22″N, Long. 144°3′44″E).
SBY-5 : riverside cliff along the Shoro-gawa, SSH (Lat. 43°8′23″N, Long. 144° 1′22″E).
SBY-6 : southwestern tributary of the Kuomanai-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43°7′52″N, Long. 143°58′34″E).

Omagari Formation

OMH-1 : river bed of the Mizunashino-sawa, a tributary of the Chambetsu-gawa, OSH (Lat. 43°1′13″N, Long. 143° 50′51″E).
OMH-2 : riverside cliff along the Ponrinoi-zawa, a tributary of the Chambetsu-gawa, OSH (Lat. 43°0′55″ N, Long. 143°46′29″E).
OMH-3 : roadside cliff along the Chambetsu-gawa, OSH (Lat. 43°0′6″N, Long. 143°50′56″E).
OMH-4 : riverside cliff along the Tankono-sawa, a tributary of the Koikata-muri-gawa, OSH (Lat. 42°59′ 57″N, Long. 143°46′26″E).
OMH-5 : river bed of the Tankono-sawa, a tributary of the Koikata-muri-gawa, OSH (Lat. 42°59′57″N, Long. 143°46′ 29″E).

OMH-6 : ditto (Lat. 42°59′57″N, Long. 143°46′31″E).
OMH-7 : river bed of the uppermost stream of the Yatatoshino-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′4″N, Long. 143°48′58″E).
OMH-8 : riverside cliff along the Muri-gawa, OSH (Lat. 42°57′52″N, Long. 143°47′52″E).
OMH-9 : roadside cliff along the Muri-gawa, OSH (Lat. 42°57′52″N, Long. 143°48′0″E).
OMH-10 : riverside cliff along the Muri-gawa, OSH (Lat. 42°57′22″N, Long. 143°48′11″E).
OMH-11 : ditto (Lat. 42°57′11″N, Long. 143°48′12″E).
OMH-12 : riverside cliff along a small southern tributary of the Muri-gawa, OSH (Lat. 42°57′6″N, Long. 143°48′11″ E).
OMH-A : small northern valley of the Tankono-sawa, a tributary of the Koikata-muri-gawa, OSH (Lat. 43°0′0″ N, Long. 143°46′26″E).
OMH-B : river bed of the Gosukeno-sawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′29″N, Long. 143°46′0″ E).
OMH-C : riverside cliff along a western tributary of the Shakubetsu-ichigo-zawa, a tributary of the Shakubetsu-gawa, OSH (Lat. 42°55′7″N, Long. 143° 48′42″E).
OMH-D : riverside cliff along the Shakubetsu-gawa, OSH (Lat. 42°54′ 11″N, Long. 143°48′27″E).
OMH-E : float on the upper stream of the Chokubetsu-gawa, OSH.
OMH-F : riverside cliff along the Chambetsu-gawa, OSH (Lat. 43°0′41″ N, Long. 143°49′19″E).
OMH-G : riverside cliff along the Muri-gawa, OSH (Lat. 42°57′47″N, Long. 143°48′3″E).
OMH-H : ditto (Ditto).
6830R : float on the middle stream of the Chambetsu-gawa, OSH.
OM-01 : road cut along the middle course of the Rushin-gawa, UTH (Lat. 42°49′44″N, Long. 143°41′8″E).
OM-02 : roadside cliff along a small northwestern tributary of the Rushin-gawa, UTH (Lat. 42°58′30″N, Long. 143°40′46″E).
OM-03 : ditto (about 130 m SE of OM-02) (Lat. 42°58′28″N, Long. 143°40′49″ E).
OM-04 : riverside cliff along a northwestern tributary of the Rushin-gawa, UTH (Lat. 42°58′16″N, Long. 143°40′ 33″E).
OM-05 : roadside cliff along a northwestern tributary of the Urahoro-gawa, UTH (Lat. 42°56′57″N, Long. 143°40′ 10″E).
OM-06 : roadside cliff along the Taron-no-sawa, a tributary of the Rushin-gawa, UTH (Lat. 42°59′14″N, Long. 143°41′45″E).
OM-07 : riverside cliff along the Pon-otakohoshi-zawa, a tributary of the Rushin-gawa, UTH (Lat. 42°58′36″N, Long. 143°42′2″E).
OM-08 : ditto (about 140 m SE of OM-07) (Lat. 42°58′32″N, Long. 143°42′5″ E).
OM-09 : ditto (Lat. 42°58′26″N, Long. 143°42′0″E).
OM-10 : ditto (Lat. 42°58′8″N, Long. 143°42′6″E).
OM-11 : riverside cliff along the Otakohoshi-zawa a tributary of the Rushin-gawa, UTH (Lat. 42°57′56″N, Long. 143°42′18″E).
OM-12 : ditto (Ditto).
OM-13 : riverside cliff along a southwestern tributary of the Rushin-gawa, UTH (Lat. 42°57′19″N, Long. 143°41′ 29″E).
OM-14 : riverside cliff along the Sango-zawa, a tributary of the Rushin-gawa, UTH (Lat. 42°56′56″N, Long. 143°41′ 32″E).
OM-15 : riverside cliff along the uppermost stream of the Sango-zawa, a tributary of the Rushin-gawa, UTH (about 600 m SW of OM-14) (Lat. 42°

56′47″N, Long. 143°41′10″E).
OM-16 : riverside cliff along the Rushin-gawa, UTH (Lat. 42°57′16″N, Long. 143°42′20″E).
OM-17 : riverside cliff along an eastern tributary of the Rushin-gawa, UTH (Lat. 42°56′51″N, Long. 143°43′8″E).
OM-18 : riverside cliff along the uppermost stream of the Yukirubeshubenozawa, a tributary of the Tokomuro-gawa, UTH (Lat. 42°55′39″N, Long. 143°42′49″E).
OM-19 : ditto (Ditto).
OM-20 : ditto (Lat. 42°55′3″N, Long. 143°42′48″E).
OM-21 : ditto (Lat. 42°55′3″N, Long. 143°42′50″E).
OM-22 : ditto (about 130 m E of OM-21) (Lat. 42°53′2″N, Long. 143°42′54″E).
OM-23 : riverside cliff along the uppermost stream of the Kenamichippu-zawa, a tributary of the Tokomuro-gawa, UTH (Lat. 42°54′30″N, Long. 143°42′51″E).
OM-24 : ditto (Lat. 42°54′33″N, Long. 143°42′58″E).
OM-25 : riverside cliff along the Fukuyama-gawa, UTH (Lat. 42°52′54″ N, Long. 143°42′41″E).
OM-26 : ditto (about 70 m SE of OM-25) (Lat. 42°52′53″N, Long. 143°42′44″E).
OM-28 : riverside cliff along the Fukuyama-gawa, UTH (about 250 m S of OM-25) (Lat. 42°52′48″N, Long. 143° 42′45″E).
OM-28 : ditto (about 170 m S of OM-26) (Lat. 42°52′47″N, Long. 143°42′44″E).
OM-29 : riverside cliff along a southern tributary of the lower stream of the Tokomuro-gawa, UTH (Lat. 42°50′53″ N, Long. 143°42′10″E).
OM-30 : riverside cliff along an eastern tributary of the Urahoro-gawa, UTH (Lat. 42°50′45″N, Long. 143°41′48″E).
OM-31 : southwestern tributary of the Urahoro-gawa, UTH (Lat. 42°55′8″N, Long. 143°38′56″E).
OM-32 : riverside cliff along the Urahoro-gawa, about 1,250 m NNE from the junction between the Urahoro-gawa and the Tokomuro-gawa, UTH (Lat. 42°52′24″N, Long. 143°40′32″E).
OM-36 : riverside cliff along the Fukuyama-gawa, UTH (Lat. 42°53′13″ N, Long. 143°42′4″E).
OMY-1 : northern tributary of the Nuibetsu-gawa, SSH (Lat. 43°6′48″N, Long. 143°58′33″E).
OMY-2 : southwestern tributary of the Kuomanai-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43°7′52″N, Long. 143°58′34″E).
OMY-3 : riverside cliff along the Shoro-gawa, SSH (Lat. 43°8′20″N, Long. 144° 1′24″E).

Charo Formation

CH-01 : river bed of the Nupukibetsu-gawa, OSH (Lat. 43°1′24″N, Long. 143° 49′13″E).
CH-02 : riverside cliff along the uppermost stream of the Ban-no-sawa, a tributary of the Chambetsu-gawa, OSH (Lat. 42°59′43″N, Long. 143°48′ 26″E).
CH-03 : river bed of the uppermost stream of the Ban-no-sawa, a tributary of Chambetsu-gawa, OSH (Lat. 42°59′ 42″N, Long. 143°48′23″E).
CH-04 : riverside cliff along the upperstream of the Koikata-muri-gawa, OSH (Lat. 43°0′6″N, Long. 143°46′36″ E).
CH-05 : ditto (about 25 m SSW of CH-04) (Lat. 43°0′3″N, Long. 143°46′36″ E).
CH-06 : ditto (about 5 m SSW of CH-05) (Lat. 43°0′3″N, Long. 143°46′36″ E).
CH-07 : ditto (Lat. 43°0′5″N, Long. 143° 46′36″E).
CH-08 : ditto (about 5 m SSW of CH-05) (Lat. 43°0′0″N, Long. 143°46′36″E).
CH-09 : ditto (about 40 m S of CH-07) (Lat. 43°0′0″N, Long. 143°46′36″E).
CH-10 : ditto (Ditto).
CH-11 : riverside cliff along the

Koikata-muri-gawa, OSH (Lat. 42°59′48″N, Long. 143°46′41″E).

CH-12 : riverside cliff along the Koikata-muri-gawa, OSH (about 50 m SSW of CH-11) (Lat. 42°59′48″N, Long. 143°46′41″E).

CH-13 : ditto (about 5 m S of CH-12) (Ditto).

CH-14 : ditto (about 40 m SE of CH-13) (Lat. 42°59′46″N, Long. 143°46′42″E).

CH-15 : ditto (Ditto).

CH-18 : ditto (Lat. 42°59′32″N, Long. 143°46′49″E).

CH-19 : river bed of the Tamono-sawa, a tributary of the Koikata-muri-gawa, OSH (Lat. 42°59′29″N, Long. 143°46′16″E).

CH-20 : ditto (Lat. 42°59′31″N, Long. 143°46′20″E).

CH-21 : ditto (Lat. 42°59′31″N, Long. 143°46′27″E).

CH-22 : ditto (Lat. 42°59′29″N, Long. 143°46′36″E).

CH-25 : riverside cliff along the Koikata-muri-gawa, OSH (Lat. 42°59′26″N, Long. 143°46′49″E).

CH-26 : ditto (Lat. 42°59′0″E), 143°46′56″E).

CH-27 : roadside cut along the Koikata-muri-gawa, OSH (Lat. 42°58′49″N, Long. 143°47′3″E).

CH-28 : riverside cliff along the Koikata-muri-gawa, OSH (Ditto).

CH-29 : ditto (Lat. 42°58′47″N, Long. 143°47′4″E).

CH-30 : ditto (Lat. 42°58′45″N, Long. 143°47′4″E).

CH-32 : ditto (Lat. 42°58′36″N, Long. 143°47′10″E).

CH-33 : ditto (Ditto).

CH-34 : ditto (Lat. 42°58′33″N, Long. 143°47′18″E).

CH-35 : ditto (Ditto).

CH-36 : riverside cliff along the Koikata-muri-gawa, OSH (Lat. 42°58′30″N, Long. 143°47′18″E).

CH-38 : riverside cliff along the Muri-gawa, OSH (Lat. 42°58′25″N, Long. 143°47″33″E).

CH-39 : ditto (Lat. 42°58″52″N, Long. 143°46′6″E).

CH-40 : river bed of the lower stream of a northern tribatary of the Muri-gawa, OSH (Lat. 42°58′54″N, Long 143°46′6″E).

CH-41 : riverside cliff along the Muri-gawa, OSH (Lat. 42°58′52″N, Long. 143°46′44″E).

CH-42 : ditto (Ditto).

CH-43 : ditto (Lat. 42°58′20″N, Long. 143°47′38″E).

CH-44 : riverside cliff along the Tashiponai-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′45″N, Long. 143°48′2″E).

CH-45 : river bed of the Tashiponai-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′43″N, Long. 143°48′3″E).

CH-46 : river bed of the Tashiponai-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′34″N), Long. 143°48′4″E).

CH-47 : river bed of the Manpukuno-sawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′2″N, Long. 143°47′33″E).

CH-48 : riverside cliff along the Muri-gawa, OSH (Lat. 42°58′8″N, Long. 143°47′51″E).

CH-49 : ditto (Lat. 42°57′44″N, Long. 198°48′7″E).

CH-50 : ditto (Lat. 42°57′41″N, Long. 143°48′9″E).

CH-51 : ditto (Lat. 42°57′27″N, Long. 143°48′2″E).

CH-52 : riverside cliff along the upper stream of the Pon-muri-gawa, OSH (Lat. 42°58′16″N, Long. 143°46′10″E).

CH-53 - river bed of the uppermost stream of the Pon-muri-gawa, OSH (Lat. 42°57′54″N, Long. 143°45′56″E).

CH-54 : river bed of the upper stream of the Pon-muri-gawa, OSH (Lat. 42°58′3″N, Long. 143°46°26″E).

CH-55 : river bed of the Pon-muri-gawa, OSH (Lat. 42°57′47″N, Long. 143°46′40″E).

CH-56 : ditto (Lat. 42°57′41″N, Long. 143°46′43″E).
CH-57 : riverside cliff along the Pon-muri-gawa, OSH (Lat. 42°57′28″N, Long. 143°47′7″E).
CH-58 : river bed of the Pon-muri-gawa, OSH (Lat. 42°57′26″N, Long. 143°47′17″E).
CH-59 : ditto (Lat. 42°57′25″N, Long. 143°47′40″E).
CH-60 : riverside cliff along a small southern tributary of the Muri-gawa, OSH (Lat. 42°57′4″N, Long. 143°48′8″E).
CH-61 : riverside cliff along the uppermost stream of the Yatatoshino-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′44″N, Long. 143°48′34″E).
CH-62 : riverside cliff along the upper stream of the Yatatoshino-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′31″N, Long. 143°49′21″E).
CH-63 : ditto (Lat. 42°58′32″N, Long. 143°49′15″E).
CH-64 : river bed of the upper stream of the Yatatoshino-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′24″N, Long. 143°48′52″E).
CH-65 : ditto (Lat. 42°58′24″N, Long. 143°48′57″E).
CH-66 : ditto (Lat. 42°58′24″N, Long. 143°49′0″E).
CH-67 : ditto (Lat. 42°58′25″N, Long. 143°49′2″E).
CH-68 : ditto (Lat. 42°58′28″N, Long. 143°49′6″E).
CH-69 : river bed of the Pon-shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lot. 42°56′47″N, Long. 144°47′38″E).
CH-70 : riverside cliff along the lower stream of the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°56′50″N, Long. 143°48′30″E).
CH-71 : ditto (Lat. 42°56′41″N, Long. 143°48′30″E).
CH-72 : river bed of the upper stream of the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°56′18″N, Long. 143°46′40″E).
CH-73 : river bed of the upper stream of the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°56′18″N, Long. 143°46′53″E).
CH-49 : river bed of the uppermost stream of the Shakubetsu-ichigo-zawa, a tributary of the Shakubetsu-gawa, OSH (Lat. 42°55′48″N, Long. 143°48′42″E).
CH-75 : boulder on the uppermost stream of the Shakubetsu-ichigo-zawa, a tributary of the Shakubestz-gawa, OSH (Ditto).
CH-76 : river bed of the uppermost stream of the Kinashibetsu-gawa, OSH (Lat. 42°53′36″N, Long. 143°48′20″EE.
CH-77 : ditto (Lat. 42°53′36″N, Long. 143°48′22″E).
CH-78 : ditto (Lat. 42°53′35″N, Long. 143°48′28″E).
CH-79 : ditto (Lat. 42°53′34″N, Long. 143°48′31″E).
CH-80 : ditto (Lat. 42°53′32″N, Long. 143°48′33″E).
CH-81 : riverside cliff along the upper stream of the Chokubessu-gawa, UTH (Lat. 42°54′52″N, Long. 143°46′26″E.
CH-82 : boulder in river bed of the upper stream of the Yongo-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′13″N, Long. 143°47′38″E).
CH-83 : riverside cliff along the upper stream of the Yongo-zawa, a tributary of the Chokubestu-gawa, UTH (Lat. 42°52′13″N, Long. 143°47′40″EE).
CH-84 : river bed of the upper stream of the Yongo-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′9″N, Long. 143°47′43″E).
CH-85 : riverside cliff along the Sango-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°51′44″N, Long. 143°47′47″E).
CH-86 : riverside cliff along the upper-mont stream of the Nigo-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°51′34″N, Long. 143°46′54″N).

CH-87 : riverside cliff along the Muri-gawa, OSH (Lat. 42°57′4″N, Long. 143° 48′27″E).

CH-88 : river bed of the Manpukuno-sawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′2″N, Long. 143°47′27″ E).

CH-A : riverside cliff along the Nupukibetsu-gawa, OSH (Lat. 43°1′ 24″N, Long. 143°49′38″E).

CH-B : riverbed of the uppermonst stream of the Sakudano-sawa, a tributary of the Chambestu-gawa, OSH (Lat. 42°58′55″N, Long. 143°49′36″E).

CH-C : riverside cliff along the Koikata-muri-gawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′48″N, Long. 143°47′2″E).

CH-D : river bed of the Koikata-muri-gawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′36″N, Long. 143°47′ 10″E).

CH-E : river bed of the upper stream of the Pon-muri-gawa, OSH (Lat. 42°58′ 2″N, Long. 143°46′17″E).

CH-F : river bed of the Pon-shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°56′47″N, Long. 143°47′ 42″E).

CH-G : river bed of the upper stream of the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°56′14″N, Long. 143°46′21″E).

CH-H : riverside cliff along the upper stream of the Chokubetsu-gawa, UTH (Lat. 42°55′21″N, Long. 143°46′21″E).

CH-a : riverside cliff along the Koikata-muri-gawa, a tributary of the Muri-gawa, OSH (Lat. 42°59′2″N, Long. 143° 46′56″E).

CH-b : riverside cliff along the upper stream of the Shiomino-sawa, a tributary of the Muri-gawa, OSH (Lat. 42° 58′30″N, Long. 143°45′58″E).

CH-c : northwestern part of the Ombetsu district (precise locality unknown).

CH-d : riverside cliff along the upper stream of the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42° 56′20″N, Long. 143°46′32″EE).

CH-e : riverside cliff along the Yongo-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′6″N, Long. 143°47′48″E).

D-01 : riverside cliff along the lower stream of the Taron-no-sawa, a tributary of the Rushin-gawa, UTH (Lat. 42°59′7″N, Long. 143°41′23″E).

D-02 : riverside cliff along a small eastern tributary of the upper stream of the Rushin-gawa, UTH (Lat. 42°58′38″ N, Long. 143°41′10″E).

D-03 : riverside cliff along a north-northwestern tributary of the Pon-otakohoshi-zawa, a tributary of the Rushin-gawa, UTH (Lat, 42°58′27″N, Long. 143°41′36″E).

D-03 : riveride cliff along the Pon-otakohoshi-zawa, a tributary of the Rushin-gawa, UTH (Lat. 42°58′7″N, Long. 143°41′49″E).

D-03 : riverside cliff along the Tokomuro-gawa, UTH (Lat. 42°56′2″ N, Long. 143°44′27″E).

D-06 : ditto (Lat. 42°55′59″N, Long. 143° 44′36″E).

D-09 : ditto (Lat. 42°55′48″N, Long. 143° 44′14″E).

D-10 : ditto (Lat. 42°55′35″N, Long. 143° 44′12″E).

D-20 : riverside cliff along the upper stream of the Yukirubeshubeno-zawa, a tributary of the Tokomuro-gawa, UTH (Lat. 42°55′19″N, Long. 143°43′ 0″E).

D-21 : ditto (Lat. 42°55′30″N, Long. 143° 43′1″E).

D-22 : riverside cliff along the Kanamichippu-zawa, a tributary of the Tokomuro-gawa, UTH (Lat. 42°54′ 12″N, Long. 143°43′48″E).

D-23 : riverside cliff along a southern tributary of the Kenamichippu-zawa, a tributary of the Tokomuro-gawa, UTH (Lat. 42°54′3″N, Long. 143°43′ 28″E).

D-24 : riverside cliff along the uppermost

stream of a southern tributary of the Kenamichippu-zawa, a tributary of the Tokomuro-gawa, UTH (Lat. 42°53′48″N, Long. 143°43′33″E).

D-25 : riverside cliff along the Kenamichippu-zawa, a tributary of the Tokomuro-gawa, UTH (Lat. 42°54′31″N, Long. 143° 43′24″E).

D-26 : ditto (Lat. 42°54′31″N, Long. 143° 43′23″E).

D-27 : ditto (Lat. 42°54′29″N, Long. 143° 43′19″E).

D-30 ; riverside cliff along a southwestern tributary of the Fukuyama-gawa, UTH (Lat. 42°52′27″N, Long. 143°42′48″E).

D-31 : riverside cliff along the Fukuyama-gawa, UTH (Lat. 42°52′37″ N, Long. 143°43′7″E).

D-32 : ditto (Lat. 42°52′34″N, Long. 143° 43′0″E).

D-33 : riverside cliff along the Fukuyama-gawa, UTH (Lat. 42°52′36″ N, Long. 143°43′0″E).

D-34 : ditto (Lat. 42°52′41″N, Long. 143° 42′58″E).

D-35 : ditto (Lat. 42°53′2″N, Long. 143° 42′57″E).

D-36 : riverside cliff along a small south-southwestern tributary of the Fukuyama-gawa, UTH (Lat. 42°53′2″ N, Long. 143°43′7″E).

D-37 : riverside cliff along the Fukuyama-gawa, UTH (Lat. 42°53′33″ N, Long. 143°43′12″E).

D-38 : riverside cliff along a small west-northwestern tributary of the Fukuyama-gawa, UTH (Lat. 42°53′29″ N, Long. 143°43′3″E).

D-39 : riverside cliff along the Fukuyama-gawa, UTH (Lat. 42°53′31″ N, Long. 143°43′14″E).

D-40 : ditto (Lat. 42°53′34″N, Long. 143° 43′16″E).

D-41 : riverside cliff along a small western tributary of the upper stream of the Fukuyama-gawa, UTH (Lat. 42° 53′45″N, Long. 143°43′9″E).

D-42 : riverside cliff along the upper stream of the Fukuyama-gawa, UTH (Lat. 42°53′50″N, Long. 143°43′13″E).

D-46 : riverside cliff along a southwestern tributary of the Fukuyama-gawa, UTH (Lat. 42°53′29″N, Long. 143°42′55″E).

D-47 : riverside cliff along the Bakemono-zawa, a tributary of the upper stream of the Rushin-gawa, UTH (Lat. 42°59′50″N, Long. 143°41′58″E).

D-54 : riverside cliff along the Fukuyama-gawa, UTH (precise locality unknown).

D-Y : riverside cliff along a southern tributary of the Kenamichippu-zawa, a tributary of the Tokomuro-gawa, UTH (5 m upperstream of D-23) (Lat. 42°54′3″N, Long. 143°43′28″E).

CHY-1 : riverside cliff along the Karisho-gawa, a tributary of the Charo-gawa, SSH (Lat. 42°54′44″N, Long. 144°4′56″E).

CHY-2 : ditto (Lat. 42°54′52″N, Long. 144°4′50″E).

CHY-3 : northern tributary of the lower stream of the Charo-gawa, SSH (Lat. 42°59′44″N, Long. 144°4′13″E).

CHY-4 : riverside cliff along the Osappe-zawa, a thibutary of the Charo-gawa, SSH (Lat. 42°0′58″N, Long. 144°3′9″E).

CHY-5 : riverside cliff along the upper stream of a north-northeastrern tributary of the Charo-gawa, SSH (Lat. 43° 1′19″N, Long. 144°2′27″E).

CHY-6 - riverside cliff along the Tannenai-zawa, a tributary of the Shoro-gawa, SSH (Lat. 43°4′16″N, Long. 144°2′58″E).

CHY-7 : riverside cliff along the Oniyoppu-zawa, a tributary of the Shoro-gawa, SSH (Lat. 43°5′47″N, Long. 199°4′20″E).

CHY-8 : riverside cliff alosg the Oniyoppu-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43°5′50″N, Long. 144°4′22″E).

CHY-9 : ditto (Lat. 43°5′55″N, Long.

144°4′22″E).

CHY-10: riverside cliff along a western tributary of the Oniyoppu-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43°6′8″N, Long. 144°4′0″E).

CHY-11: riverside cliff along a southwestern tributary of the Shoro-gawa, SSH (Lat. 43°5′34″N, Long. 144°1′44″E).

CHY-12: riverside cliff along the Shoro-gawa, SSH (Lat. 43°6′12″N, Long. 144°2′58″E).

CHY-13: north-northeastern tributary of the Shoro-gawa, SSH (Lat. 43°6′27″N, Long. 144°3′0″E).

CHY-14: ditto (Lat. 43°6″30″N, Long. 144°3′13″E).

CHY-15: ditto (Lat. 43°6′28″N, Long. 144°3′20″E).

CHY-16: ditto (Lat. 43°6′26″N, Long. 144°3′29″E).

CHY-17: ditto (Lat. 43°6′25″N, Long. 144°3′31″E).

CHY-18: riverside cliff along the Shoro-gawa, SSH (Lat 42°7′36″N, Long. 144°1′52″E).

CHY-19: ditto (Lat. 43°7′41″N, Long. 144°1′52″E).

CHY-20: ditto (Lat. 43°7′41″N, Long. 144°1′36″E).

CHY-21: ditto (Lat. 43°7′41″N, Long. 144°1′33″E).

CHY-22: ditto (Lat. 43°7′43″N, Long. 144°1′29″E).

CHY-23: ditto (Lat. 43°7′48″N, Long. 144°1′16″E).

CHY-24: diitto (Lat. 43°7′48″N, Long. 144°1′13″E).

CHY-25: riverside cliff along the Kuomanai-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43°8′10″N, Long. 143°59′24″E).

CHY-26: riverside cliff along a northwestern tributary of the Kuomanai-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43°8′18″N, Long. 143°59′40″E).

CHY-27: riverside cliff along the uppermost stream of a southern tributary of the Kuomanai-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43°7′43″N, Long. 143°59′13″E).

CHY-28: riverside cliff along a small western tributary of the Shoro-gawa, SSH (Lat. 43°8°24″N, Long. 144°0′37″E).

CHY-29: riverside cliff along the Shoro-gawa, SSH (Lat. 43°8′28″N, Long. 144°1′9″E).

CHY-30: ditto (Lat. 43°8′32″N, Long. 144°1′4″E).

CHY-31: riverside cliff along the Pahahanpo-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43°8°52″N, Long. 144°0′53′E).

CHY-32: ditto (Lat. 43°8′50″N, Long. 144°0′31″E).

CHY-33: riverside cliff along the Shoro-gawa, SSH (Lat. 48°8′59″N, Long. 144°1′26″E).

CHY-34: ditto (Lat. 43°9′6″N, Long. 144°1′9″E).

Nuibetsu Formation

NB-01: riverside cliff along the Nupukibetsu-gawa, OSH (Lat. 43°1′25″N, Long. 143°49′38″E).

NB-02: riverside cliff along the Muri-gawa, OSH (Lat. 42°58′48″N, Long. 143°46′47″E).

NB-03: ditto (Lat. 42°58′44″N, Long. 143°46′44″E).

NB-03: ditto (Lat. 42°58′38″N, Long. 143°46′49″E).

NB-05: riverside cliff along the Koikata-muri-gawa, OSH (Lat. 42°58′39″N, Long. 143°47′4″E).

NB-06: ditto (Ditto).

NB-07: ditto (Lat. 42°58′36″N, Long. 143°47′7″E).

NB-08: riverside cliff along the Muri-gawa, OSH (Lat. 42°58′32″N, Long. 143°46′47″EE.

NB-09: ditto (Lat. 42°58′24″N, Long. 143°46′48″E).

NB-10: ditto (Lat. 42°58′22″N, Long. 143°46′49″E).

NB-11: ditto (Lat. 42°58′21″N, Long.

143°46′50″E).
NB-12: ditto (Lat. 42°58′21″N, Long. 143°46′51″E).
NB-13: ditto (Lat. 42°58′21″N, Long 143°46′56″E).
NB-14: ditto (Lat. 42°58′20″N, Long. 143°46°58″E).
NB-15: ditto (Lat. 42°58′20″N, Long. 143°46′58″E).
NB-16: ditto (Lat. 42°58′18″N, Long. 143°47′27″E).
NB-17: riverside cliff along the lower-stream of the Sakudano-sawa, a tributary of the Chambetsu-gawa, OSH (Lat. 42°59′18″N, Long. 143°51′49″E).
NB-19: riverside cliff along the Muri-gawa, OSH (Lat. 42°57′54″N, Long. 143°51′31″E).
NB-20: riverside cliff along the upper stream of the Kashimano-sawa, a tributary of the Muri-gawa, OSH (Lat. 42° 57′15″N, Long. 143°51′27″E).
NB-21: riverside cliff along the Yatatoshino-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′35″N, Long. 148°49′30″E).
NB-22: river bed of the Yatatoshino-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′18″N, Long. 143°50′ 12″E).
NB-23: river bed of a western tributary of the lower stream of the Yatatoshino-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°57′41″N, Long. 143°49′41″E).
NB-24: ditto (about 35 m lower stream of NB-23) (Ditto).
NB-25: riverside cliff along the Muri-gawa, OSH (Lat. 42°57′41″N, Long. 143°50′36″E).
NB-26: ditto (Lat. 42°57′26″N, Long. 143°50′28″E).
NB-27: ditto (Lat. 42°57′36″N, Long. 143°50′11″E).
NB-28: ditto (Ditto).
NB-29: river bed of a northern tributary of the Muri-gawa, OSH (Lat. 42°57′24″ N, Long. 143°49′8″E).
NB-30: ditto (about 30 m lower stream of NB-29) (Ditto).
NB-31: riverside cliff along the Muri-gawa, OSH (Lat. 42°56′57″N, Long. 143°48′51″E).
NB-32: ditto (Lat. 42°56′47″N, Long. 143°48′56″E).
NB-33: riverside cliff along the Muri-gawa, OSH (Lat. 42°56′47″N, Long 143°49′4″E).
NB-34: river bed of the uppermonst stream of the Shibetsu-zawa, a tributary of the Muri-gawa, OSH (Lat. 42° 56′30″N, Long. 143°46′12″E).
NB-35: river bed of the Onneabeaki-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°56′36″N, Long. 143°49′ 36″E).
NB-36: ditto (Lat. 42°56′26″N, Long. 143°49′27″E).
NB-37: ditto (Lat. 42°56′27″N, Long. 143°49′49″E).
NB-38: ditto (Lat. 42°56′24″N, Long. 143°49′46″E).
NB-39: ditto (Lat. 42°56′13″N, Long. 143°49′41″E).
NB-40: river bed of the upper stream of the Shakubetsu-sango-gawa, a tributary of the Shakubetsu-gawa, OSH (Lat. 42°56′23″N, Long. 143°51′7″E).
NB-41: riverside cliff along the upper stream of the Shakubetsu-ichigo-zawa, a tributary of the Shakubestu-gawa, OSH (Lat. 42°56′19″N, Long. 143°51′9″ E).
NB-42: river bed of the uppermosst stream of the Shakubetsu-nigo-zawa, a tributary of the Shakubetsu-gawa, OSH (Lat. 42°56″6″N, Long. 143°50′ 13″E).
NB-43: ditto (Ditto).
NB-44: ditto (Lat. 42°56′5″N, Long. 143°50′13″E).
NB-45: riverside cliff along the upper stream of the Shakubetsu-nigo-zawa, a tributary of the Shakubetsu-gawa, OSH (Lat. 42°55′32″N, Long. 143°49′ 32″E).
NB-46: riveride cliff along the Shakubetsu-ichigo-zawa, a tributary

of the Shakubetsu-gawa, OSH (Lat. 42°55′32″N, Long. 143°48′56″E).

NB-47: riverside cliff along a western tributary of the Shakubetsu-ichigo-zawa, a tributary of the Shakubetsu-gawa, OSH (Lat. 42°54′55″N, Long. 143°49′8″E).

NB-48: riverside cliff along the Shakubetsu-gawa, ONH (Lat. 42°54′5″ N, Long. 143°49′7″E).

NB-49: road cut along the Shakubetsu-gawa, OSH (Lat. 42°54′2″N, Long. 143° 49′22″E).

NB-50: ditto (about 60 m SE of NB-49) (Lat. 42°54′0″N, Long. 143°49″24″E).

NB-51: river bed of the Kinashibetsu-gawa, OSH (Lat. 42°53′15″N, Long. 143°48′43″E).

NB-52: ditto (Lat. 42°53′4″N, Long. 143°48′49″E).

NB-54: riverside cliff along the Yongo-zawa, a tributary of the Chokubestu-gawa, UTH (Lat. 42°52′2″N, Long. 143°47′54″E).

NB-55: river bed of the Yonogo-zawa, a tributary of the Chokubetsu-gawa, UTH (about 23 m lower stream of NG-54) (Ditto).

NB-60: riverside cliff along the Sango-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°51′43″N, Nong. 143°74′58″E).

NB-61: ditto (Lat. 42°51′42″N, Long. 143°47′58″E).

NB-62: ditto (Lat. 42°51′45″N, Long. 143°48′2″E).

NB-63: ditto (Lat. 42°51′45″N, Long. 143°48′7″E).

NB-64: ditto (Lat. 42°51′44″N, Long. 143°48′9″E).

NB-65: ditto (Lat. 42°51′42″N, Long. 143°48′14″E).

NB-66: riverside cliff along the Nigo-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°51′24″N, Long. 143°47′16″E).

NB-67: ditto (Lat. 42°51′26″N, Long. 143°47′27″E).

NB-68: ditto (Lat. 42°51′31″N, Long. 143°47′24″E).

NB-69: ditto (Lat. 42°51′22″N, Long. 143°47′31″E).

NB-70: ditto (Lat. 42°51′18″N, Long. 143°47′38″E).

NB-71: riverside cliff along the Otobe-gawa, UTH (Lat. 42°50′54″N, Long. 143°46′38″E).

NB-72: river bed of the Otobe-gawa, UTH (a few meters lowerstream of NB-71) (Ditto).

NB-73: ditto (Ditto).

NB-74: ditto (Lat. 42°50′51″N, Long. 143°46′35″E).

NB-75: riverside cliff along the Otobe-gawa, UTH (Lat. 42°50′39′N, Long. 143°47′10″E).

NB-76: river bed of the Otobe-gawa, UTH (Lat. 42°51′4″N, Long. 143°47′4″ E).

NB-77: riverside cliff along the Otobe-gawa, UTH (Lat. 42°51′0″N, Long. 143°47′8″E).

NB-78: river bed of the Kinashibetsu-gawa, OSH (Lat. 42°53′23″N, Long. 143°48′38″E).

NB-79: riverside cliff along the Otobe-gawa, UTH (Lat. 42°50′58″N, Long. 143°47′9″E).

NB-A: riverside cliff ablong the Muri-gawa, OSH (Lat. 42°58′52″N, Long. 143°46′42″E).

NB-B: road cut along a logging road leading to the Koikata-muri-gawa, a tributary of the Mari-gawa, OSH (Lat. 42°58′40″N, Long. 143°46′56″E).

NB-C: riverside cliff along the Muri-gawa, OSH (Lat. 42°58′34″N, Long. 143°46′48″E).

NB-D: ditto (Lat. 42°58′26″N, Long. 143°46′51″E).

NB-E: ditto (Lat. 42°58′18″N, Long. 143°47′3″E).

NB-F: ditto (Lat. 42°58′19″N, Long. 143°47′4″E).

NB-G: river bed of a western tributary of the lower stream of the Yatatoshino-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°57′47″N,

Long. 143°49′53″E).

NB-H : ditto (Lat. 42°57′47″N, Long. 143°50′0″E).

NB-I : river bed of a northern tributary of the Muri-gawa, OSH (Lat. 42°57′24″ N, Long. 143°49′7″E).

NB-J : river bed of a western tributary of the lower stream of the Yatatoshino-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°57′44″N, Long. 143°50′6″E).

NB-K : river bed of a south-southeastern tributary of the Muri-gawa, OSH (Lat. 42°57′15″N, Long. 143°50′29″E).

NB-L : river bed of the Onneabeaki-zawa, a tributary of the Muri-gawa, OSH (about 25 m lower stream of NB-35) (Lat. 42°56′36″N, Long. 143° 49′36″E).

NB-M : ditto (Lat. 24°56′13″N, Long. 143°49′37″E).

NB-N : riverside cliff along a western tributary of the Shakubetsu-ichigo-zawa, a tributary of the Shakubetsu-gawa, OSH (Lat. 42°54′56″N, Lodg. 143°49′1″E).

NB-O : river bed of the Kinashibetsu-gawa, OSH (about 20 m lower stream of NB-78) (Lat. 42°53′23″N, Long. 143° 48′38″E).

NB-P : ditto (Lat. 42°53′30″N, Long. 143°48′37″E).

NB-Q : ditto (Lat. 42°58′0″N, Long. 143° 48′52″E).

NB-R : riverside cliff along the Yongo-zawa, a tributary of the Chokubetsu-gawa, UTH (Lat. 42°52′2″N, Long. 143°48′2″E).

NB-a : riverside cliff along the Nupukibetsu-gawa, OSH (Lat. 43°1′ 38″N, Long. 143°48′38″E).

NB-b : riverside cliff along the Yatatoshino-zawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′2″N, Long. 143°49′17″E).

NB-c : river bed of a western tributary of the lower stream of the Yatatoshino-zawa, a tributary of the Mari-gawa, OSH (about 35 m lower stream of NB-24) (Lat. 42°57′41″N, Long. 143°49′41″E).

NB-d : riverside cliff along the uppermost stream of a south-southeastern tributary of the Muri-gawa, OSH (Lat. 42°56′43″N, Long. 143°50′51″E).

NB-e : riverside cliff along the Shakubetsu-nigo-zawa, a tributary of the Shakubetsu-gawa, OSH (Lat. 42° 55′18″N, Long. 143°49′56″E).

NB-f : riverside cliff along the Shakubetsu-gawa, OSH (Lat. 42°54′9″ N, Long. 143°48′50″E).

NB-g : ditto (Lat. 42°54′0″N, Loog. 143° 49′24″E).

NB-h : riverside cliff along the Koikata-muri-gawa, a tributary of the Muri-gawa, OSH (Lat. 42°58′36″N, Long. 143°47′8″E).

D-11 : riverside cliff along a small eastern tributary of the Tokomuro-gawa, UTH (Lat. 42°55′8″N, Long. 143°44′ 47″E).

D-15 : road cut along the Tokomuro-gawa, UTH (Lat. 42°54′35″N, Long. 143°44′16″E).

D-16 : riverside cliff along the Yukirubeshubeno-zawa, a tributary of the Tokomuro-gawa, UTH (Lat. 42°54′ 36″N, Long. 143°44′0″E).

D-17 : ditto (Lat. 42°54′36″N, Long. 143° 43′56″E).

D-18 : ditto (Lat. 42°54′3″)N, Long. 143° 43′47″E).

D-19 : riverside cliff along the Yukirubeshubeno-zawa, tributary of the Tokomuro-gawa, UTH (Lat. 42°55′ 0″N, Long. 143°43′29″E).

D-44 : riverside cliff along as southern tributary of the Tokomuro-gawa, UTH (Lat. 42°51′21″N, Long. 143°42′44″E).

D-55 : riverside cliff along a small northeastern tributary of the Fakuyama-gawa, UTH (Lat. 42°52′45″N, Long. 143°43′4″E).

NBY-1 : riverside cliff along a north-northeastern tributary of the Charo-gawa, SSH (Lat. 43°1′6″N, Long. 144° 2′18″E).

NBY-2: northwestern tributary of the Setara-zawa, a tributary of the Charo-gawa, SSH (Lat. 43°3′36″N, Long. 144° 1′17″E).

NBY-3: uppermost stream of a northwestern tributary of the Tantaka-zawa, a tributary of the Charo-gawa, SSH (Lat. 43°4′13″N, Long. 143°59′50″ E).

NBY-4: riverside cliff along the Tannenai-zawa, a tributary of the Shoro-gawa, SSH (Lat. 43°4′46″N, Long. 144°3′16″E).

NBY-5: riverside cliff along the lower stream of a southwestern tributary of the Shoro-gawa, SSH (Lat. 43°5′19″N, Long. 144°2′49″E).

NBY-6: ditto (Lat. 43°5′26″N, Long. 144°2′40″E).

NBY-7: riverside cliff along the lower stream of a southwestern tributary of the Shoro-gawa, SSH (Lat. 42°5′16″N, Long. 144°2′27″E).

NBY-8: ditto (Lat. 43°5′6″N, Long. 144° 2′22″E).

NBY-9: riverside cliff along the upper stream of a southwestern tributary of the Shoro-gawa, SSH (Lat. 43°4′28″N, Long. 144°1′50″E).

NBY-10: ditto (Lat. 43°4′25″N, Long. 144°1′43″E).

NBY-11: ditto (Lat. 43°4′19″N, Long. 144°1′40″E).

NBY-12: riverside cliff along a southwestern tributary of the Shoro-gawa, SSH (Lat. 43°6′20″N, Long. 144°1′54″ E).

NBY-13: ditto (Lat. 43°6′17″N, Long. 144°1′48″E).

NBY-14: ditto (Lat. 43°6′8″N, Long. 144°1′27″E).

NBY-15: ditto (Lat. 43°5′57″N, Long. 144°1′16″E).

NBY-16: ditto (Lat. 43°5′45″N, Long. 144°1′2″E).

NBY-17: riverside cliff along the Shoro-gawa, SSH (Lat. 43°7′19″N, Long. 144° 1′36″E).

NBY-18: riverside cliff along a south-southwestern tributary of the Kuomanai-gawa, a tributary of the Shoro-gawa, SSH (Lat. 43°7′45″N, Long. 144°0′33″E).

60070217: riverside cliff along the Makayo-gawa, a tributary of the Charo-gawa, SSH (basal part of the Nuibetsu Formation, precise locality unknown; Mizuno, 1978, *written commun.*). Collected by A. Mizuno, 1960.

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Plate 1

(All figures in natural size, unless otherwise stated)

Figs. 1, 2, 3, 6. *Malletia poronaica* (Yokoyama). 1, IGPS coll. cat. no. 99259, Loc. NB-76, ×1.5 ; 2, IGPS coll cat. no. 99260, Loc. NB-70 ; 3, IGPS coll. cat. no. 97100, Loc. NB-79 ; 6, IGPS coll. cat. no. 95193, Loc. D-19.

Figs. 4, 10, 13, 14, 16–18, 24. *Portlandia* (*Portlandella*) *watasei watasei* (Kanehara). 4, IGPS coll. cat. no. 97123, Loc. NB-76 ; 10a-c, IGPS coll. cat. no. 99262, Loc. CH-a ; 13a-b, IGPS coll. cat no. 97139, Loc. NBK-32 ; 14a-c, IGPS coll. cat. no. 99263, Loc. NB-a ; 16a-c, IGPS coll. cat. no. 95152, Loc. OM-17 ; 17, IGPS coll. cat. no. 97118, Loc. CH-78 ; 18, IGPS coll. cat. no. 95519, Loc. D-10 ; 24a-b, IGPS coll. cat. no. 97135, Loc. NBK-72.

Figs. 5, 7–9, 11, 12. *Nucula* (*Ennucula*) *omagariensis*, n. sp. 5, IGPS coll. cat no. 95531, Loc. D-26 ; 7, IGPS coll. cat. no. 95564-1, Loc. OM-10 ; 8, IGPS coll. cat. no. 95576-1 (Holotype), Loc. OM-06 ; 9, IGPS coll. cat. no. 95173, Loc. OM-13 ; 11a-b, IGPS coll. cat. no. 95714, Loc. OM-13 ; 12, IGPS coll. cat. no. 95160-1 (Paratype), Loc. OM-06.

Fig. 15. *Yoldia* (*Yoldia*) *laudabilis* Yokoyama. IGPS coll. cat. no. 99265, Loc. OMH-10*.

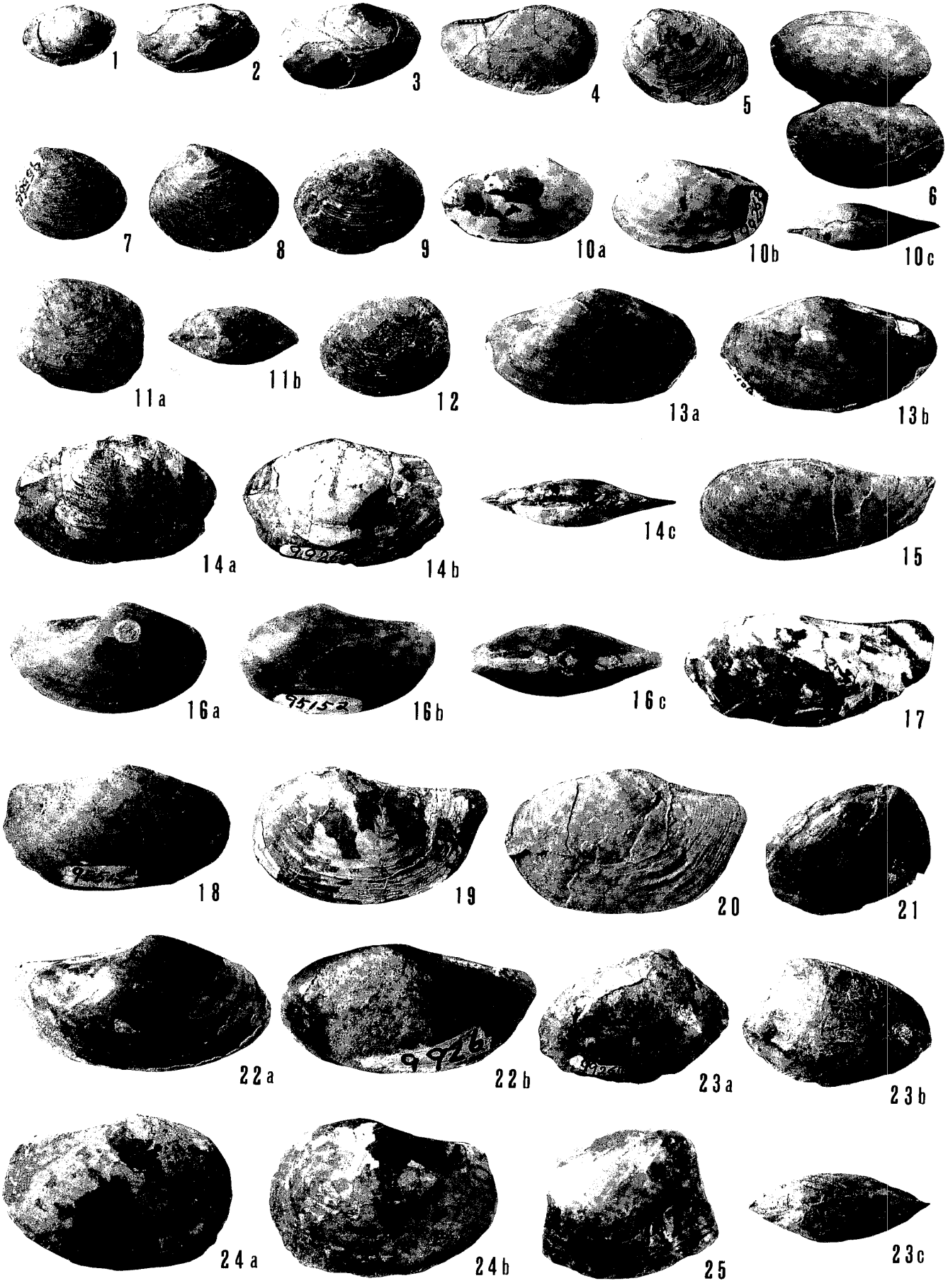
Fig. 19. *Portlandia* (*Megayoldia*) *thraciaeformis* (Storer). IGPS coll. cat. no. 99261, Loc. NB-d.

Fig. 20. *Portlandia* (*Megayoldia*) *yotsukurensis* Uozumi. IGPS coll. cat. no. 95174, Loc. D-19 (rubber cast of left valve).

Figs. 21, 23. *Acila* (*Acila*) *kusiroensis* Nagao and Huzioka. 21, IGPS coll. cat. no. 99266, Loc. CH-d ; 23a-c, IGPS coll. cat. no. 99267, Loc. NB-19.

Figs. 22a-b. *Portlandia* (*Portlandella*) sp. IGPS coll. cat. no. 99264, Loc. CH-08, ×2.

Fig. 25 *Acila* (*Acila*) *brevis* Nagao and Huzioka. IGPS coll. cat. no. 97102, Loc. NB-19.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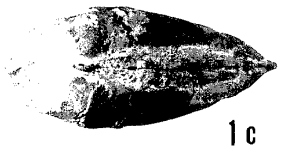
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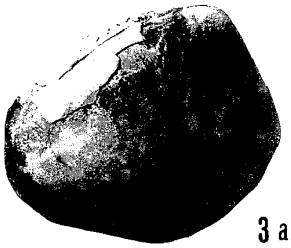
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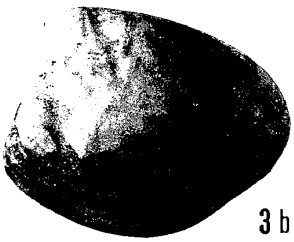
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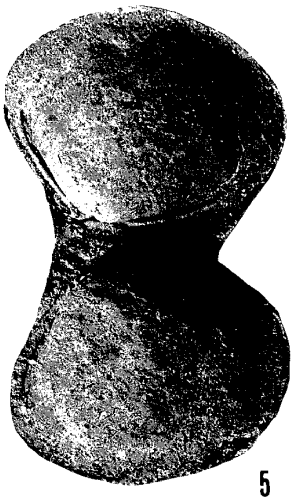
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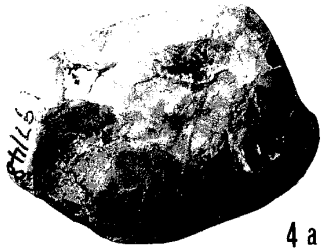

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Plate 2

(All figures in natural size, unless otherwise stated)

Figs. 1a-c. *Acila* (*Acila*) *kusiroensis* Nagao and Huzioka. IGPS coll. cat. no. 96796, Loc. NB-78.

Figs. 2-4. *Acila* (*Acila*) *elongata* Nagao and Huzioka. 2, IGPS coll. cat. no. 99268, Loc. CHK-22 ; 3a-c, IGPS coll. cat. no. 99897, Loc. NBK-39 ; 4a-c, IGPS coll. cat no. 97148, Loc. NBK-35.

Fig. 5. *Corbicula* (*Corbicula*) *tokudai* (Yokoyama). IGPS coll. cat. no. 96773, Loc. SB-Q, ×2.

Fig. 6. *Mytilus* cf. *M. luciferus* Yokoyama. IGPS coll. cat. no. 99269, Loc. SB-A.

Fig. 7. *Corbicula* (*Batissa*) *sitakaraensis* Suzuki. IGPS coll. cat. no. 96762-2, Loc. RN-02 (reproduced from Honda, 1981).

Fig. 8(A-C). A, B, *Corbicula* (*Batissa*) *sitakaraensis* Suzuki ; C, *Mytilus mabuchii* Oyama and Mizuno. IGPS coll. cat. no. 96777, Loc. SB-P.

Plate 3

(All figures in natural size)

Figs. 1, 3–6. *Ostrea eorivularis* Oyama and Mizuno. 1, IGPS coll. cat. no. 97108, Loc. SK-62 ; 3, IGPS coll. cat. no. 99271, Loc. YB-09 ; 4a-b, IGPS coll. cat no. 99704, Loc. SK-60 ; 5, IGPS coll. cat no. 99272, Loc. SK-37* ; 6, IGPS coll. cat. no. 99273, Loc. 5729.

Figs. 2a-b. *Mytilus mabuchii* Oyama and Mizuno. IGPS coll. cat. no. 97128, Loc. SK-22.

1

2 a

2 b

3

4 a

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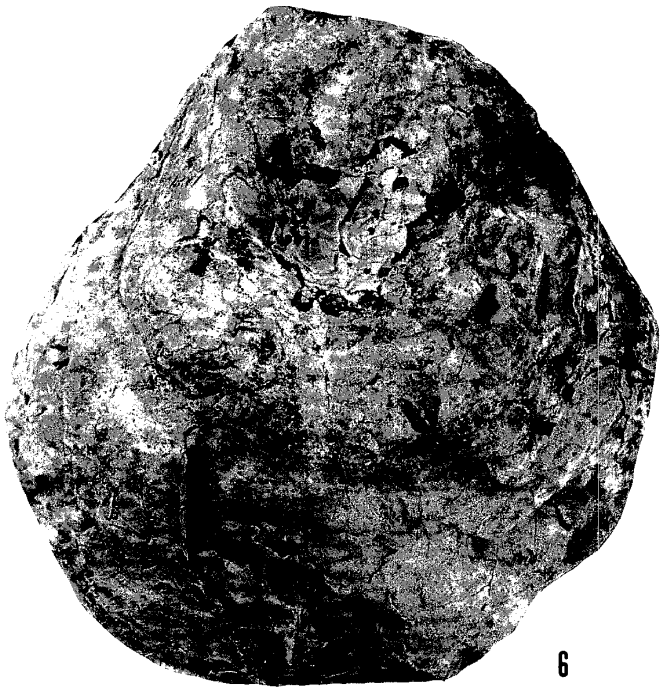

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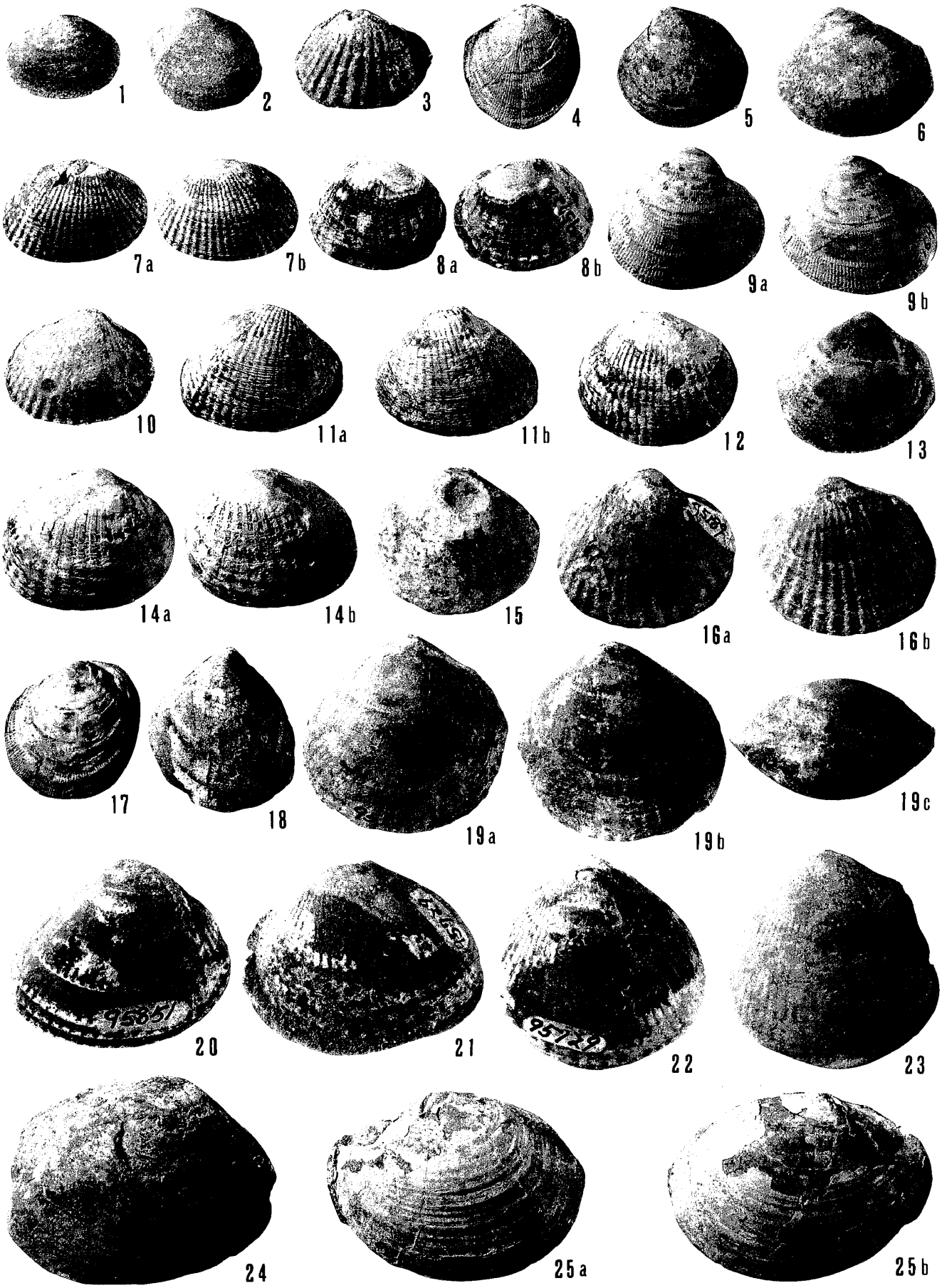
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Plate 4

(All figures in natural size, unless otherwise stated)

Figs. 1, 2, 6. *Clinocardium* sp. 1, IGPS coll. cat no. 97098, Loc. OMH-12 ×1.5 ; 2, IGPS coll. cat. no. 97119-2, Loc. OMH-8 ; 6, IGPS coll. cat. no. 97119-1, Loc. OMH-8.

Figs. 3, 14. *Cyclocardia poronaiensis*, new name. 3, IGPS coll. cat. no. 95739, Loc. OM-20 ; 14a-b, IGPS coll. cat. no. 95150, Loc. OM-36.

Figs. 4, 17. *Crenella* (*Megacrenella*) *nuibetsuensis*, n. sp. 4, IGPS coll. cat no. 99274, Loc. NB-e, ×1.5 ; 17, IGPS coll. cat. no. 97096 (Holotype), Loc. NB-08, ×2.

Fig. 5. *Nemocardium* (*Arctopratulum*) *yokoyamai* Takeda, IGPS coll. cat. no. 97120, Loc. SK-52.

Figs. 7, 11, 12. *Cyclocardia laxata* (Yokoyama), 7a-b, IGPS coll. cat. no. 95720, Loc. OM-04 ; 11a-b, IGPS coll. cat. no. 95169, Loc. OM-32 ; 12, IGPS coll. cat no. 95726, Loc. OM-32.

Figs. 8a-b. *Cyclocardia expansa* (Takeda). IGPS coll. cat. no. 95728, Loc. OM-32.

Figs. 9a-b. *Nemocardium* (*Keenaea*) *iwakiense* (Makiyama). IGPS coll. cat. no. 95164, Loc. OM-25.

Figs. 10, 16. *Cyclocardia tokudai* (Takeda). 10, IGPS coll. cat. no. 95599, Loc. D-35 ; 16a-b, IGPS coll. cat no. 95189, Loc. D-37.

Figs. 13, 19-23. *Clinocardium omagariense* Honda. 13, IGPS coll. cat. no. 95740-7, Loc. OM-32 ; 19a-c, IGPS coll. cat. no. 95729C, Loc. OM-17 ; 20, IGPS coll. cat. no. 95851, Loc. OM-21 ; 21, IGPS coll. cat no. 95729D, Loc. OM-17 ; 22, IGPS coll. cat no. 95729E, Loc. OM-17 ; 23, IGPS coll. cat. no. 95729B, Loc. OM-17.

Fig. 15. *Cyclocardia akagii* (Kanehara). IGPS coll. cat. no. 95200, Loc. OM-19, ×1.4.

Fig. 18. *Crenella* (*Megacrenella*) *shitakaraensis*, n. sp. IGPS coll. cat. no. 97111 (Holotype), Loc. SK-46.

Fig. 24. *Conchocele bisecta* (Conrad). IGPS coll. cat. no. 97112-3, Loc. OMH-1.

Figs. 25a-b. *Periploma* (*Aelga*) *besshoense* (Yokoyama). IGPS coll. cat. no. 95183, Loc. OM-32.

Plate 5

(All figures in natural size, unless otherwise stated)

Fig. 1. *Liocyma terrena* (Yokoyama). IGPS coll. cat. no. 95258, Loc. D-42.

Figs. 2, 3. *Liocyma furtiva* (Yokoyama). 2, IGPS coll. cat. no. 99276, Loc. NB-31 ; 3a-b, IGPS coll. cat. no. 99277, Loc. NB-31, ×1.4.

Fig. 4. *Macoma* (*Macoma*) *sejugata* (Yokoyama). IGPS coll. cat. no. 95139, Loc. D-18.

Figs. 5, 9. *Mya* (*?Arenomya*) *grewingki kusiroensis* Nagao and Inoue. 5, IGPS coll. cat. no. 95435, Loc. B-06, (rubber cast of left valve) ; 9a-b, IGPS coll. cat. no. 95707, Loc. B-05.

Fig. 6. *Cardiomya* (*Cardiomya*) *kotakai*, n. sp. IGPS coll. cat. no. 99278 (Holotype), Loc. NB-17, ×2.

Fig. 7. *Myadora* sp. IGPS coll. cat. no. 99279, Loc. CH-38, ×2.

Fig. 8. *Mactra* sp. IGPS coll. cat. no. 97125, Loc. SK-56.

Fig. 10. *Geloina* cf. *G. takaoi* (Nagao and Ôtatume). IGPS coll. cat. no. 95440, Loc. B-02.

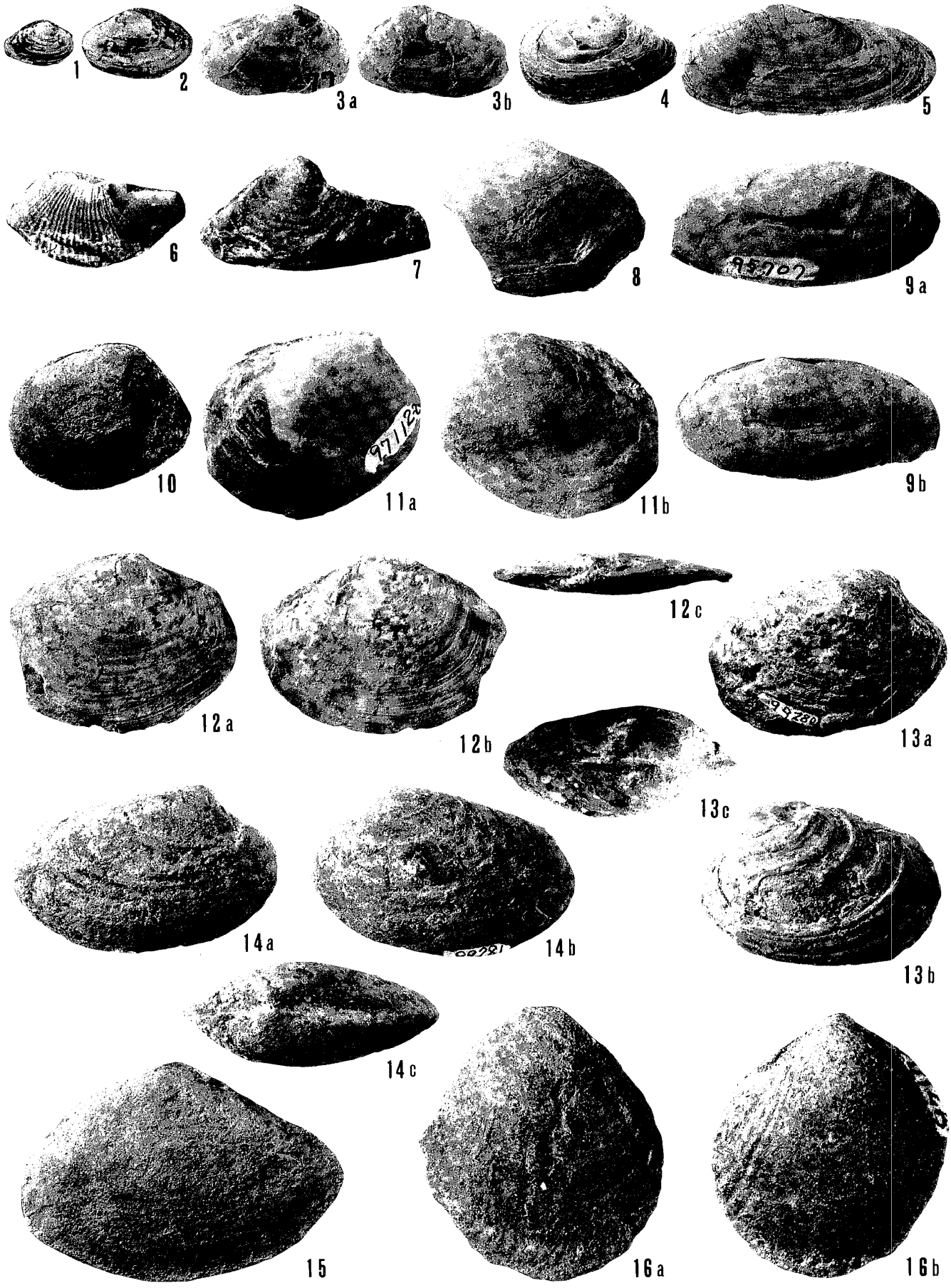
Figs. 11a-b. *Conchocele bisecta* (Conrad). IGPS coll. cat. no. 97112-2, Loc. OMH-1.

Figs. 12a-c. *Periploma* (*Aelga*) *besshoense* (Yokoyama). IGPS coll. cat. no. 97114, Loc. OMH-10.

Figs. 13, 14. *Hubertschenckia ezoensis* (Yokoyama). 13a-c, IGPS coll. cat. no. 99280, Loc. SK-49 ; 14a-c, IGPS coll. cat. no. 99281, Loc. SK-49.

Fig. 15. *Spisula* (*Mactromeris*) *sorachiensis* Uozumi. IGPS coll. cat. no. 99282-1, Loc. SK-25.

Figs. 16a-b. *Trachycardium kinsimarae* (Makiyama). IGPS coll. cat. no. 97101, Loc. OMH-12, ×2.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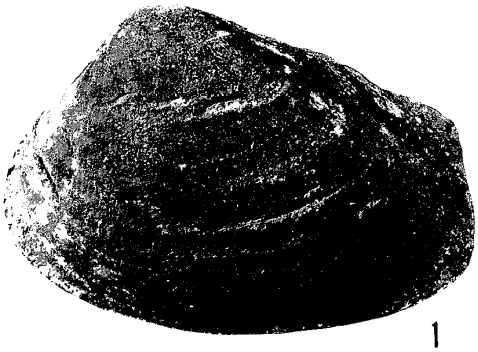
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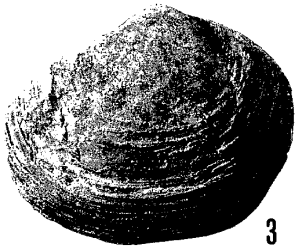
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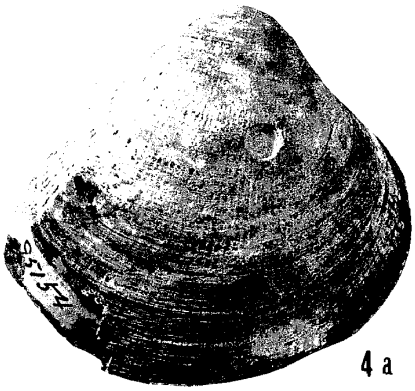
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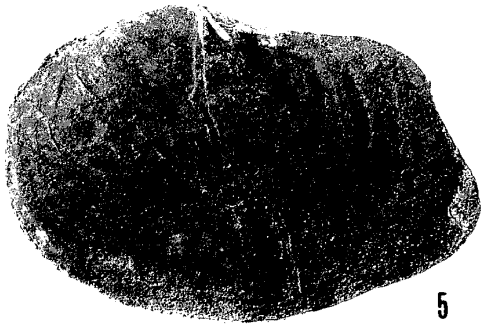
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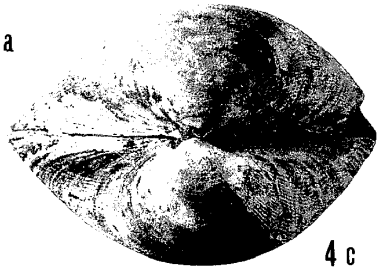
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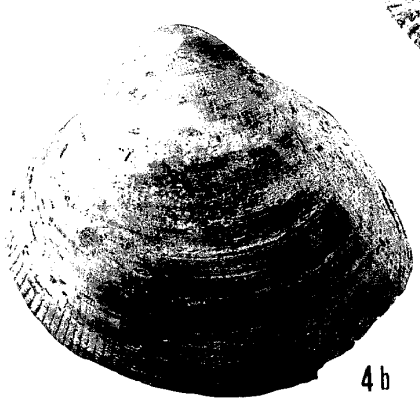
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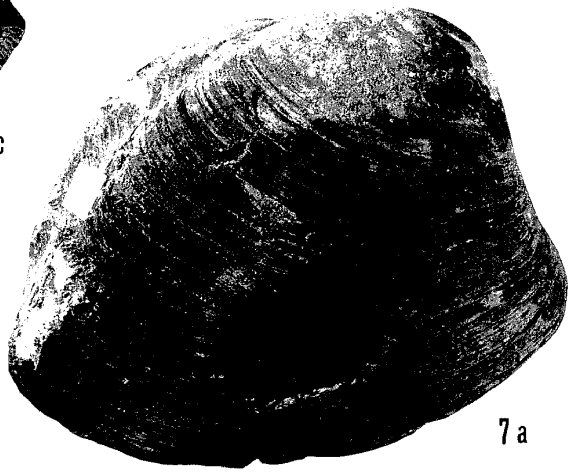
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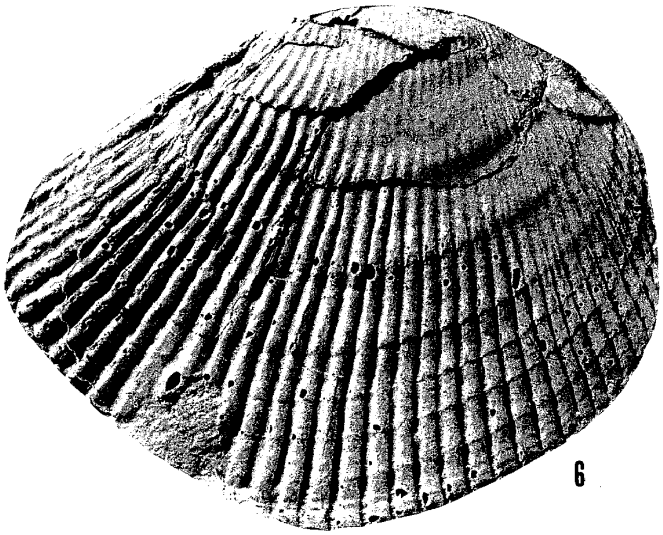
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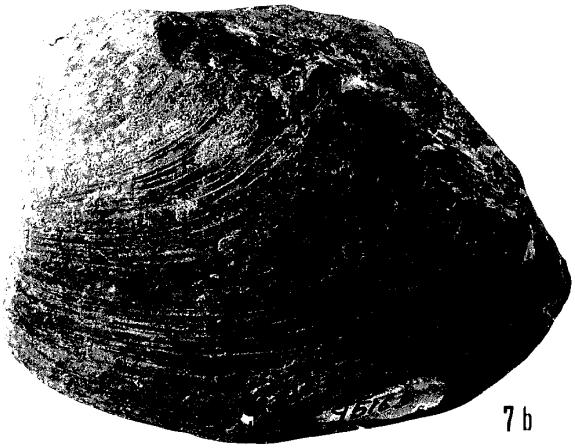
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Plate 6

(All figures in natural size)

Figs. 1, 4. *Nemocardium* (*Arctopratulum*) *ezoense* Takeda. 1, IGPS coll. cat. no. 95712, Loc. B-05 ; 4a-c, IGPS coll. cat. no. 95154, Loc. OM-32.

Figs. 2, 5. *Thracia* (*Thracia*) *shitakaraensis*, n. sp. 2, IGPS coll. cat. no. 95428-7, Loc. B-03 ; 5, IGPS coll. cat no. 95137-2 (Paratype), Loc. B-03.

Fig. 3. *Lucinoma hannibali* (Clark). IGPS coll. cat. no. 95115, Loc. D-35.

Fig. 6. *Profulvia harrimani* (Dall). IGPS coll. cat. no. 95655, Loc. D-24 (rubber cast of right valve).

Figs. 7a-b. *Conchocele bisecta* (Conrad). IGPS coll. cat. no. 95163, Loc. OM-17.

Plate 7

(All figures in natural size, unless otherwise stated)

Figs. 1–3, 5–7. *Thracia* (*Thracia*) *shitakaraensis*, n. sp. 1a-b. IGPS coll. cat. no. 99284, Loc. SK-A, ×1.2; 2, IGPS coll. cat. no. 99285, Loc. SK-B; 3a-b, IGPS coll. cat. no. 95428–4 (Holotype), Loc. B-03; 5a-b, IGPS coll. cat. no. 95434–1, Loc. B-10; 6a-c, IGPS coll. cat. no. 95137–1 (Paratype), Loc. B-03; 7a-b, IGPS coll. cat. no. 99283, Loc. SK-42, ×1.5.

Figs. 4a-b. *Macoma* (*Macoma*) *optiva* (Yokoyama). IGPS coll. cat. no. 95693, Loc. OM-17.

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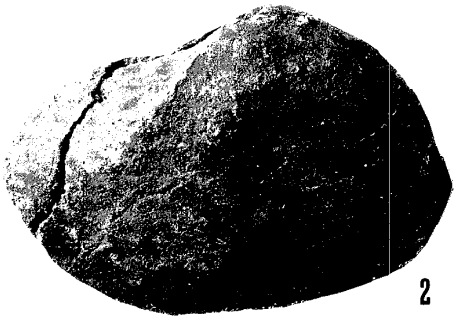
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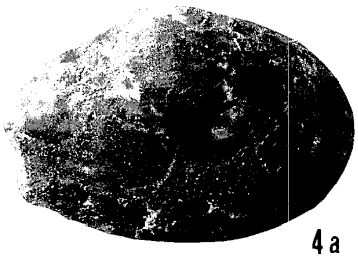
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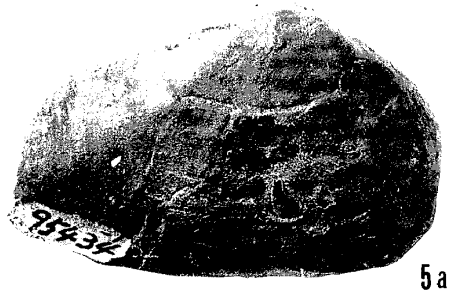

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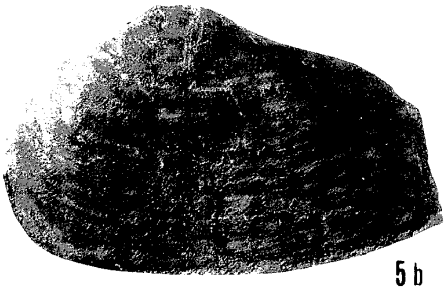
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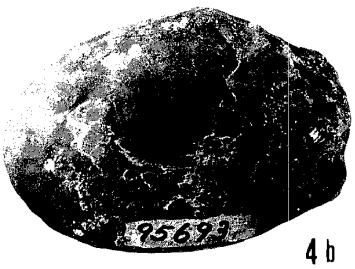

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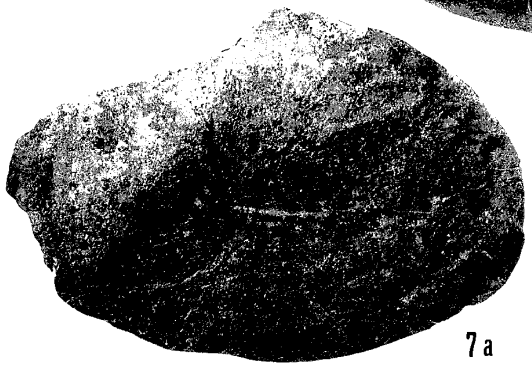
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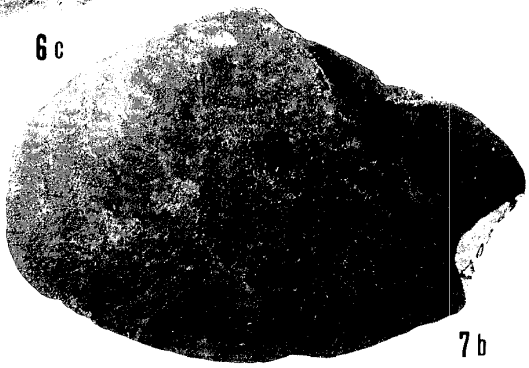
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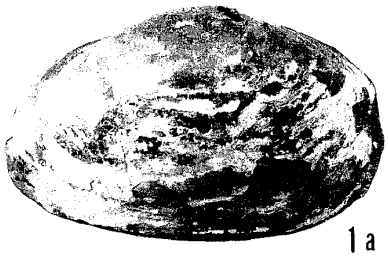
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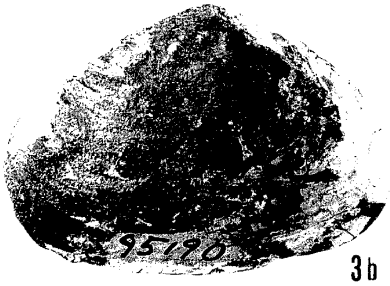
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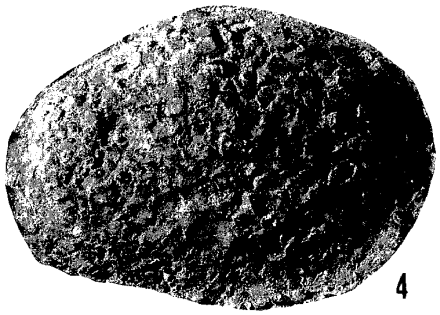
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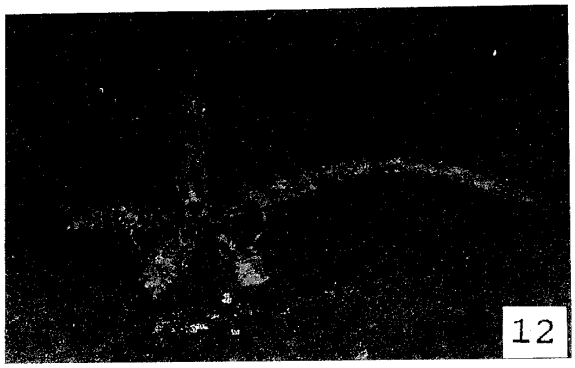
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Plate 8

(All figures in natural size, unless otherwise stated)

Figs. 1, 3, 5. *Mya* (*?Arenomya*) *grewingki grewingki* Makiyama. 1a-b, IGPS coll. cat. no. 95465, Loc. OM-31 ; 3a-b, IGPS coll. cat. no. 95190, Loc. OM-31 ; 5, IGPS coll. cat. no. 99286, Loc. SK-40*

Fig. 2. *Spisula* (*Mactromeris*) *sorachiensis* Uozumi. IGPS coll. cat. no. 95708, Loc. B-08.

Fig. 4. *Macoma* sp. IGPS coll. cat no. 99287, Loc. SK-41, ×0.8.

Figs. 6a-b. *Conchocele nipponica* (Yabe and Nomura), IGPS coll. at. no. 95225, Loc. OM-21.

Figs. 7-10. *Solen shitakaraensis*, n. sp. 7, IGPS coll. cat. 99288, Loc. B-Y ; 8a-c, IGPS coll. cat. no. 95438, Loc. B-08 ; 9, IGPS coll cat. no. 95129-1 (Holotype), Loc. B-08 ; 10, IGPS coll. cat. no. 95129-2 (Paratype), Loc. B-08.

Fig. 11. *Phaxas* sp. IGPS coll. cat no. 97122, Loc. SK-25.

Fig. 12. Myophiuridae, gen. et sp., indet. IGPS coll. cat. no. 99289, a float of the Muri-gawa, Ombetsu district, probably derived from the Omagari Formation.

Plate 9

(All figures in natural size, unless otherwise stated)

Fig. 1. *Eocylichna multistriata* (Takeda). IGPS coll. cat. no. 99290, Loc. NB-09.

Figs. 2, 7. *Turritella* sp. 2, IGPS coll. cat no. 99291, Loc. NB-17 ; 7, IGPS coll. cat no. 99292, Loc. CH-77, ×1.5 (rubber cast).

Figs. 3-5, 11. *Turritella* (*Hataiella*) *nuibetsuensis*, n. sp. 3a-b, IGPS coll. cat. no. 95603, Loc. D-35 ; 4a-b, IGPS coll. cat. no. 99293, Loc. 60070217 ; 5a-b, IGPS coll. cat. no. 99294, Loc. 60070217 ; 11, IGPS coll. cat. no. 96779 (Holotype), Loc. D-Y.

Figs. 6a-b. *Turritella* (*Hataiella*) *poronaiensis* Takeda. IGPS coll. cat. no. 95184, Loc. D-33.

Figs. 8a-b. *Molopophorus kusiroensis* Takeda. IGPS coll. cat. no. 99295, Loc. NB-63, ×2.

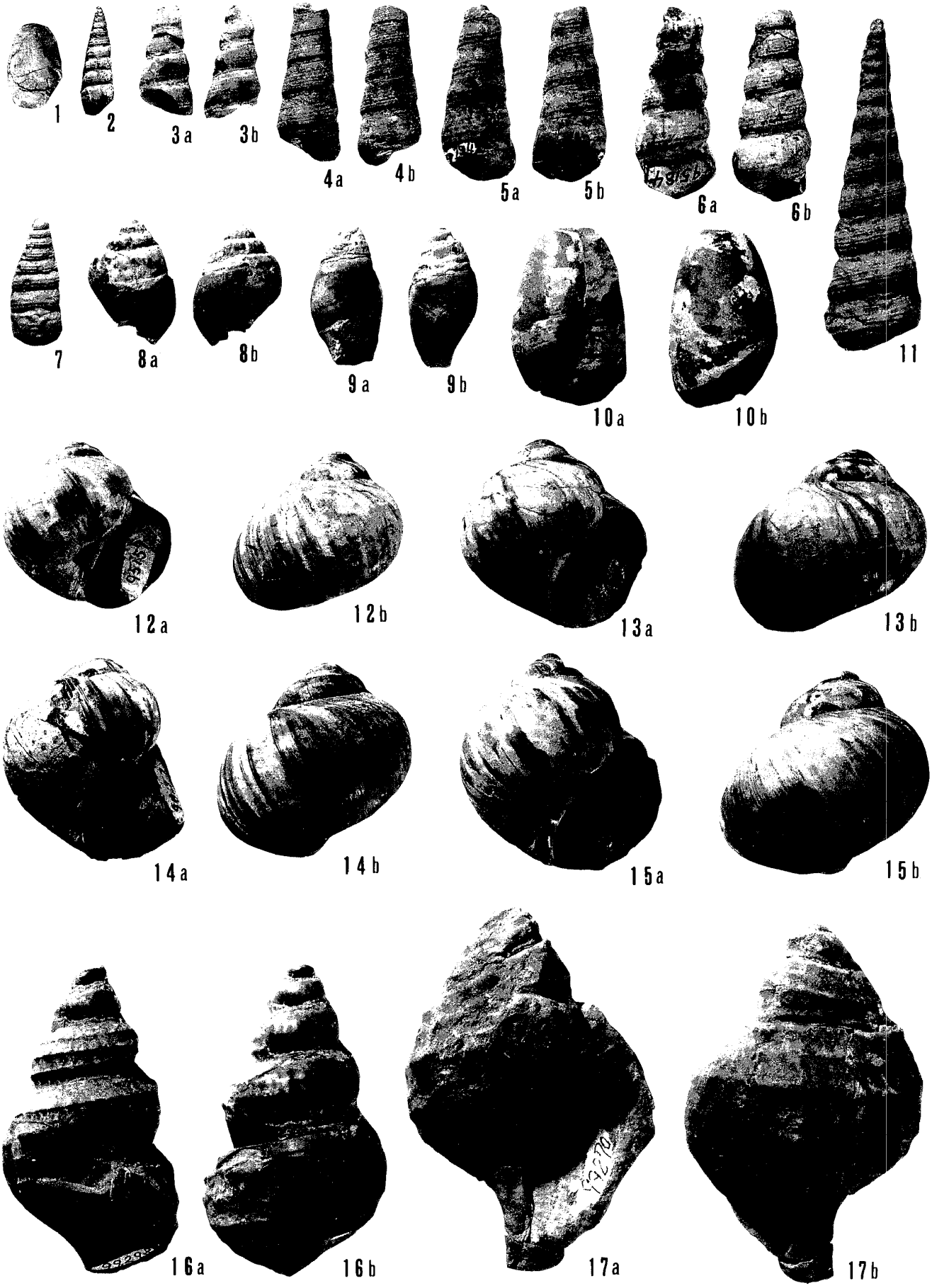
Figs. 9a-b. *Olivella ezoana* Matsui. IGPS coll. cat no. 99296, Loc. NB-48*, ×2.

Figs. 10a-b. *Eocylichna ezoana* (Matsui). IGPS coll. cat. no. 99297, Loc. NB-48*, ×2.

Figs. 12-15. *Neverita* (*Neverita*) *asagaiensis* (Makiyama). 12a-b. IGPS coll. cat. no. 95159-9, Loc. OM-28 ; 13a-b, IGPS coll. cat. no. 95159-4, Loc. OM-28 ; 14a-b, IGPS coll. cat no. 95159-1, Loc. OM-28 ; 15a-b, IGPS coll. cat. no. 95159-2, Loc. OM-28.

Figs. 16a-b. *Neptunea ogasawarai*, n. sp. IGPS coll. cat. no. 99298 (Holotype), Loc. CH-25.

Figs. 17a-b. *Neptunea* sp. IGPS coll. cat no. 99270, Loc. OMH-H.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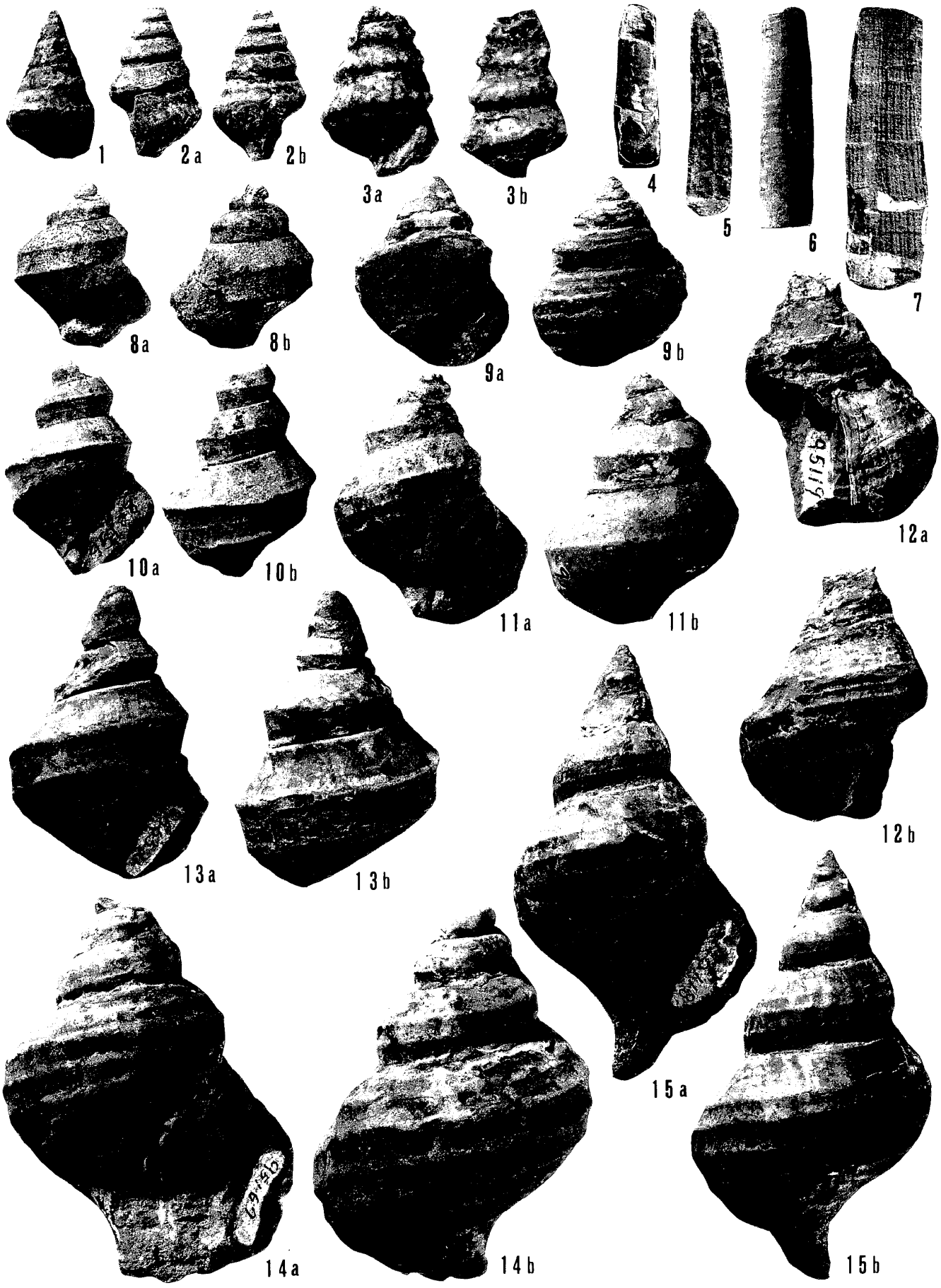
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Plate 10

(All figures in natural size, unless otherwise stated)

Figs. 1, 3. *Orectospira wadana* (Yokoyama). 1, IGPS coll. cat. no. 97117, Loc. NB-63 ; 3a-b, IGPS coll. cat. no. 97130, Loc. CH-83, ×3.

Figs. 2a-b. *Riuguhdrillia rugosa* (Takeda). IGPS coll. cat. no. 95621, Loc. D-17.

Figs. 4, 7. *Dentalium* (*Fissidentalium*) *numomae* (Takeda). 4, IGPS coll. cat no. 97104, Loc. NB-69 ; 7, IGPS coll. cat. no. 99299, Loc. NB-f, ×2 (external mold).

Figs. 5, 6. *Dentalium* sp. 5, IGPS coll. cat. no. 99300, Loc. CH-36, ×2 ; 6, IGPS coll. cat. no. 99301, Loc. CH-08, ×2.

Figs. 8a-b. *Neptunea dispar* Takeda. IGPS coll. cat. no. 95166, Loc. D-35, ×1.5.

Figs. 9, 14, 15. *Neptunea ezoana* Takeda. 9a-b, IGPS coll. cat. no. 95205, Loc. OM-19 ; 14a-b, IGPS coll. cat. no. 95167, Loc. OM-05 ; 15a-b, IGPS coll. cat. no. 95118, Loc. D-47.

Figs. 10a-b. *Trominina ishikariensis* (Hayasaka and Matsui). IGPS coll. cat no. 95128, Loc. D-35.

Figs. 11a-b. *Trominina hokkaidoensis* (Hayasaka and Uozumi). IGPS coll. cat. no. 95123, Loc. D-15.

Figs. 12a-b. *Trominina umbelliformis* (Hayasaka and Uozumi). IGPS coll. cat. no. 95119, Loc. D-19.

Figs. 13a-b. *Trominina japonica* (Takeda). IGPS coll. cat. no. 95652, Loc. D-04.