

● Bulletin of the Tohoku University Museum

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cord impressions” . Original photograph by Miki Kikuchi.

Contents

Shuji Niko, Masayuki Ehiro and Yukihiro Takaizumi : <i>Trematoceras hikichii</i> sp. nov., an Early Triassic orthocerid cephalopod from the Osawa Formation, Miyagi Prefecture, Northeast Japan	1
Shuji Niko : <i>Bandoceras</i> , a new Late Silurian genus of orthocerid cephalopod from the Hitoegane Formation, Gifu Prefecture, Central Japan	5
Shin'ichi Sato, Tomoki Chiba, Takai Yamanaka, Jun Nemoto, Masanori Shimamoto and Takashi Matsubara : A catalogue of name-bearing type specimens of fossil Bivalvia (Mollusca) registered in the Tohoku University Museum	9
Takashi Matsubara : <i>Nicaniella</i> (<i>Trautscholdia</i>) <i>nagaoi</i> , a new replacement name for <i>Astarte minor</i> Nagao, 1934, <i>non Astarte sulcata</i> var. <i>minor</i> Jeffreys, 1864 ["1863"] (Mollusca: Bivalvia: Astartidae)	107
Yuki Kitagawa, Reishi Takashima and Yasuto Itoh : Paleomagnetism of the Sorachi and Yezo Group in the Ashibetsu area, central Hokkaido, Japan.	109
Kaoru Akoshima, Hyewon Hong : Standard use-wear chart of TUMRT(2):Microflaking (2)	127

***Trematoceras hikichii* sp. nov., an Early Triassic orthocerid cephalopod from the Osawa Formation, Miyagi Prefecture, Northeast Japan**

Shuji Niko*, Masayuki Ehiro** and Yukihiro Takaizumi***

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Abstract: A new Olenekian (late Early Triassic) species of orthocerid cephalopod, *Trematoceras hikichii*, is described from the Osawa Formation in the Utatsu area, Miyagi Prefecture, Northeast Japan. The new species more or less resembles *T. mangishlakense* Schastlivtceva, 1981, from Kazakhstan and *T. insperatum* Schastlivtceva, 1988, from Caucasus. Diagnostic characters of the species from these similar species are following; 4° in angle of conch expansion and very fine transverse lirae on the shell surface. This discovery represents the first record of the genus *Trematoceras* in Japan.

Introduction

So far only limited orthocerid cephalopods from the Mesozoic have been reported, namely Triassic *Paratrematoceras* Schastlivtceva, 1981, *Pseudotemperoceras* Schastlivtceva, 1986 and *Trematoceras* Eichwald, 1851, and Cretaceous *Zhuravlevia* Doguzhaeva, 1994. Among them *Trematoceras* is the most common and best-known genus whose records are recognized in the Olenekian (late Early Triassic) to Rhaetian (late Late Triassic) marine faunas of the Tethys, Boreal and Panthalassa regions. The present paper describes a new Olenekian species of *Trematoceras* from the Osawa Formation in Northeast Japan.

Abbreviations used for repositories are IGPS (Institute of Geology and Paleontology, Faculty of Science, Tohoku University, Sendai; kept in the Tohoku University Museum) and UIM (Utatsu Ichthyosaur Museum, Minamisanriku Town).

Systematic Paleontology

Order Orthocerida Kuhn, 1940
Superfamily Orthoceratoidea M'Coy, 1844
Family Orthoceratidae M'Coy, 1844
Subfamily Michelinoceratinae Flower, 1945
Genus ***Trematoceras*** Eichwald, 1851

Type species.—*Orthocera* [sic] *elegans* Münster, 1841; Carnian (lower Upper Triassic) in Carnic Alps.

***Trematoceras hikichii* sp. nov.**
Figure 1

Diagnosis.—Species of *Trematoceras* with approximately 4° in angle of conch expansion and relatively short camerae with 1.6–2.3 in from ratios (maximum width per length); transverse lirae on shell surface are very fine.

Description.—Longiconic orthocones with circular cross sections; conch expansion is gradual for the family and moderate for the genus, indicating approximately 4° in angle; holotype is incomplete phragmocone with 68 mm in length; the largest specimen (paratype, IGPS coll. cat. no. 111571) attains 99 mm in length and 7 mm in approximate diameter (reconstructed), adoral 51 mm of which specimen represents body chamber; no apical part of conch and peristome preserved; shell surface ornamented by very fine transverse lirae; there are 12–16 ridges in 1 mm of conch length. Sutures are essentially straight and transverse; septa indicate moderate curvature; camerae are relatively short for the genus indicating from ratios (maximum width per length) of 1.6–2.3; siphuncle is nearly central (faintly ventral from center); position ratios of siphuncle (distance of central axis of septal foremen from ventral shell surface per corresponding conch diameter) are 0.45–0.47; siphuncular wall consists of orthochoanitic (to suborthochoanitic) septal necks and cylindrical connecting rings; length of necks is short, 0.19–0.23 mm. Endosiphuncular deposits absent; cameral deposits are well-developed, episeptal-mural, and thicker in venter than dorsum; in later stages, cameral deposits exhibit mammillary growth and extend to hyposeptal area.

Material examined.—Holotype, IGPS coll. cat. no. 111572. Paratypes, IGPS coll. cat. nos. 111569–111571 and UIM

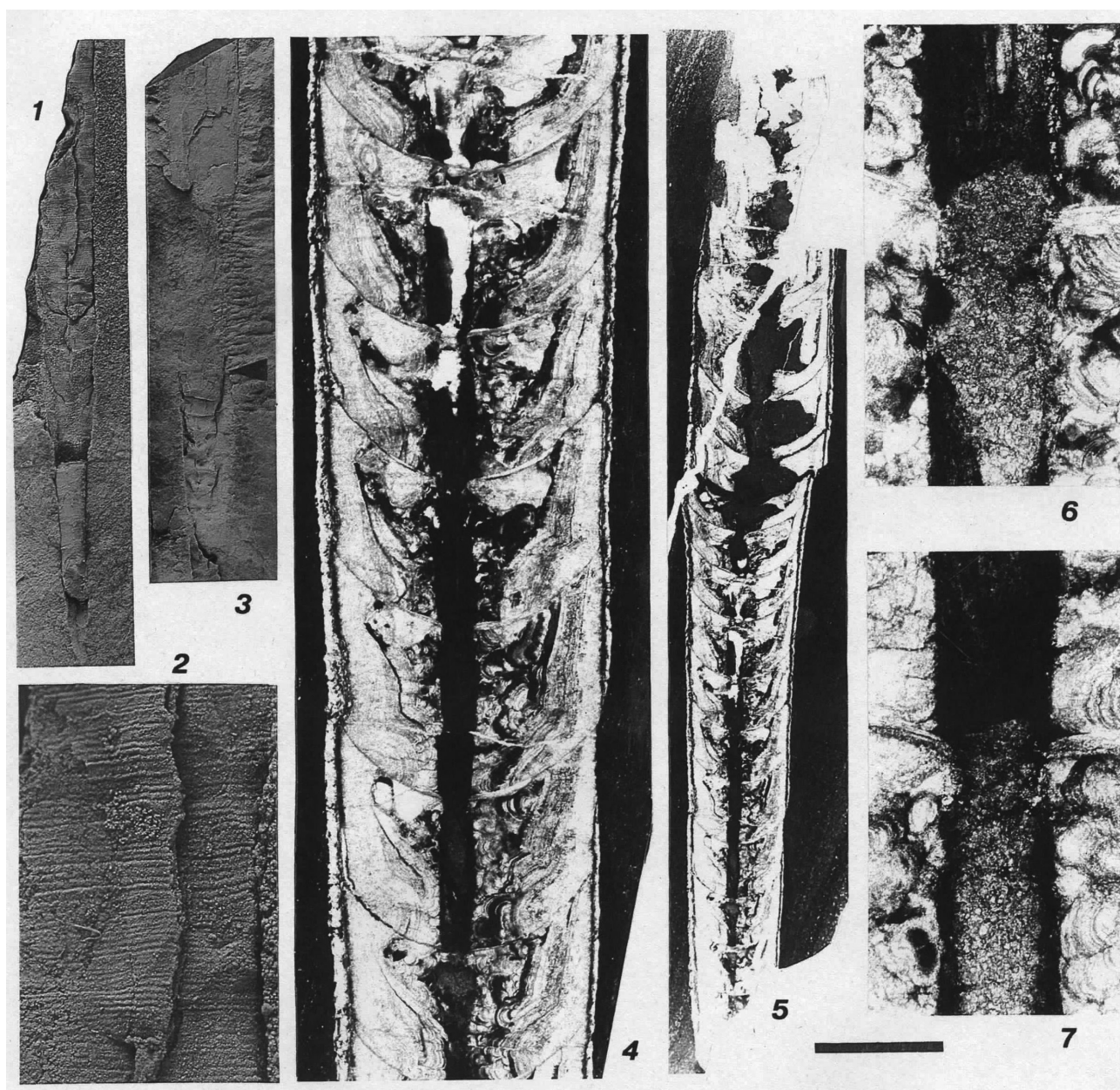


Figure 1. *Trematoceras hikichii* sp. nov. from the Early Triassic Osawa Formation in the Utatsu area, Minamisanriku Town, Miyagi Prefecture. **1, 2.** Paratype, IGPS coll. cat. no. 111569: **1**, side view of mold; **2**, partial enlargement of Figure 1.1 to show details of surface ornamentation, external mold. **3.** Paratype, IGPS coll. cat. no. 111571, side view of mold, arrow indicates the last septum. **4–7.** Holotype, IGPS coll. cat. no. 111572: **4**, partial enlargement of Figure 1.5, to show details of cameral deposits; **5**, dorsoventral thin section, venter on left; **6, 7**, partial enlargements of Figure 1.5 to show details of septal necks. Scale bar is 10 mm in Figure 1.1; 2 mm in Figure 1.2; 20 mm in Figure 1.3; 1.4 mm in Figure 1.4; 4 mm in Figure 1.5; 0.4 mm in Figures 1.6, 1.7.

30622. In addition, two poorly preserved specimens, IGPS coll. cat. no. 111573 and UIM 30623, were also examined.

Etymology.—The specific name honors Mr. Yasuhiro Hikichi, who discovered the holotype of the new species.

Occurrence.—All specimens of *Trematoceras hikichii* sp. nov. were collected from laminated mudstones of the Osawa Formation at the Tatezaki locality (38°42'50"N, 141°32'07"E) in the Utatsu area, Minamisanriku Town, Miyagi Prefecture,

Northeast Japan (see figures 1, 2 in Ehiro et al., 2015 for its geographic point). The specific components of the Osawa ammonoid fauna were revealed by Bando and Shimoyama (1974), Bando and Ehiro (1982), Ehiro (1993), Ehiro (2016), and Ehiro et al. (2016 in press). These results suggest that the formation is correlative with the upper Olenekian (= Spathian; upper Lower Triassic).

Discussion.—In examined specimens, only the apical shell of the holotype is undistorted. Thus, some important characters, such as profile of the conch, siphuncular structure and biotic deposits, in the above description are based on this specimen.

In its ratios of the cameral form and siphuncular position, *Trematoceras hikichii* sp. nov. resembles *T. mangishlakense* Schastlivtceva (1981, p. 79, 80, pl. 1, figs. 3a, b, 4a, b) from the Olenekian of Kazakhstan. The most important features to separate these two species are external morphologies. *Trematoceras mangishlakense* possesses slightly larger angle of conch expansion (6°–7°) and lacks evident surface ornamentation. Transverse surface lirae are developed also in *T. insperatum* Schastlivtceva (1988, p. 67, 68, pl. 2, figs. 12a, b, v) from the Anisian (lower Middle Triassic) of Caucasus, but its interspaces of the liare are much wider, 2–3 ridges in 1 mm, than those of the new species. The type species of the genus, *T. elegans* (Münster, 1841, p. 125, pl. 14, figs. 2a–c; Bizzarini and Gnoli, 1991, p. 112, pl. 1, figs. 1–4, pl. 2, figs. 1, 2) clearly differs from the new species in having strongly oblique surface liare and longer camerae.

This discovery from the upper Olenekian Osawa Formation is noteworthy because it represents the first record of *Trematoceras* in Japan. In addition, previous Early Triassic occurrences of the genus were restricted in Albania, Kazakhstan, northeastern Siberia, Primorye, and Vietnam (Kiparisova, 1961; Schastlivtceva, 1988; Shigeta and Nguyen, 2014).

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We are greatly indebted to Mr. Yasuhiro Hikichi. The present research is not possible without his discovery and donation of an exceptionally well-preserved specimen (holotype). We also thank Dr. Harumasa Kano for collecting some specimens. Thanks extend to the Educational Committee of Minamisanriku Town and Abei-Gumi Co. Ltd. for permissions to excavate fossiliferous beds at the Tatezaki locality. Reviewer Dr. Yasufumi Iryu kindly provided helpful comments on a previous version of this paper.

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***Bandoceras*, a new Late Silurian genus of orthocerid cephalopod from the Hitoegane Formation, Gifu Prefecture, Central Japan**

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Abstract: A new genus of orthocerid cephalopod, *Bandoceras*, is proposed on the basis of *B. gifuense* sp. nov. from the Ludlow (early Late Silurian) calcareous shale of the upper Hitoegane Formation in the Shinhirayonsen area, Takayama City, Gifu Prefecture, Central Japan. Its morphologies of septal necks, connecting rings, endosiphuncular deposits suggest the new genus and species belong to the subfamily Spyroceratinae. *Bandoceras gifuense* differs from the possible ancestor, *Gordonoceras* Teichert and Glenister, 1953, from the Lower (or Middle) Silurian of Tasmania, in having transverse surface lirae.

Introduction

The Hitoegane Formation, named by Nakai (1984), crops out in the Hitoegane and Shinhirayonsen area, Takayama City, Gifu Prefecture, Central Japan. A diverse fauna of middle to late Ludlow (or Pridoli; Late Silurian) age, including tabulate corals (Niko, 2001, 2004, 2007, 2008), trilobites (Kobayashi and Hamada, 1974, 1987) and machaerid (Kobayashi and Hamada, 1976), have been described from calcareous beds (= the Hitoegane Limestone Member in Igo, 1990) of the upper part of the formation. Recently, a single orthocerid specimen was collected from this fossiliferous member as the first occurrence of cephalopod from the formation. The intent of this paper is to propose a new genus and species, *Bandoceras gifuense*, on the basis of the new material.

Systematic Paleontology

Order Orthocerida Kuhn, 1940

Superfamily Pseudorthoceratoidea Flower and Caster, 1935

Family Pseudorthoceratidae Flower and Caster, 1935

Subfamily Spyroceratinae Shimizu and Obata, 1935

Genus *Bandoceras* gen. nov.

Type species.—*Bandoceras gifuense* sp. nov. by monotypy.

Diagnosis.—Exogastric cyrticone with gradual conch expansion and subcircular cross section; shell surface ornamented by transverse lirae; sutures straight and

transverse; camerae short; siphuncle relatively narrow, subcentral with suborthochoanitic to cyrtchoanitic septal necks and subcylindrical connecting rings; endosiphuncular deposits form continuous lining; cameral deposits mostly episeptal-mural.

Etymology.—The generic name honors the late Dr. Yuji Bando, in recognition of his contributions to the taxonomic and biostratigraphic studies on fossil cephalopods.

Discussion.—The siphuncular morphologies of this cephalopod, such as the suborthochoanitic to cyrtchoanitic septal necks, subcylindrical connecting rings and continuous lining of the endosiphuncular deposits, suggest that the new genus belongs to the Spyroceratinae of the family Pseudorthoceratidae. In the subfamily, *Gordonoceras* Teichert and Glenister (1953; type species, *G. bondi* Teichert and Glenister, 1953, p. 39, 40, pl. 4, figs. 1–3, text-fig. 2C) from the Lower (or Middle) Silurian of Tasmania, shows close similarity with *Bandoceras* gen. nov. in its exogastric conch with gradual expansion, subcentral siphuncle and short camerae, but is differentiated by the latter in lacking distinct surface ornamentation. The author believes that *Gordonoceras* is the ancestor of *Bandoceras*.

The Early Carboniferous genus *Pseudocyrtoceras* Schindewolf (1943; type species, *Cyrtoceras acus* Koninck, 1880, p. 28, 29, pl. 35, figs. 6, 6a, 7, pl. 36, fig. 3; Schindewolf, 1943, fig. 15) differs from the new genus in having more rapid expansion of the conch with dorsoventrally depressed profiles and the well-inflated subglobular connecting rings. Among them, the

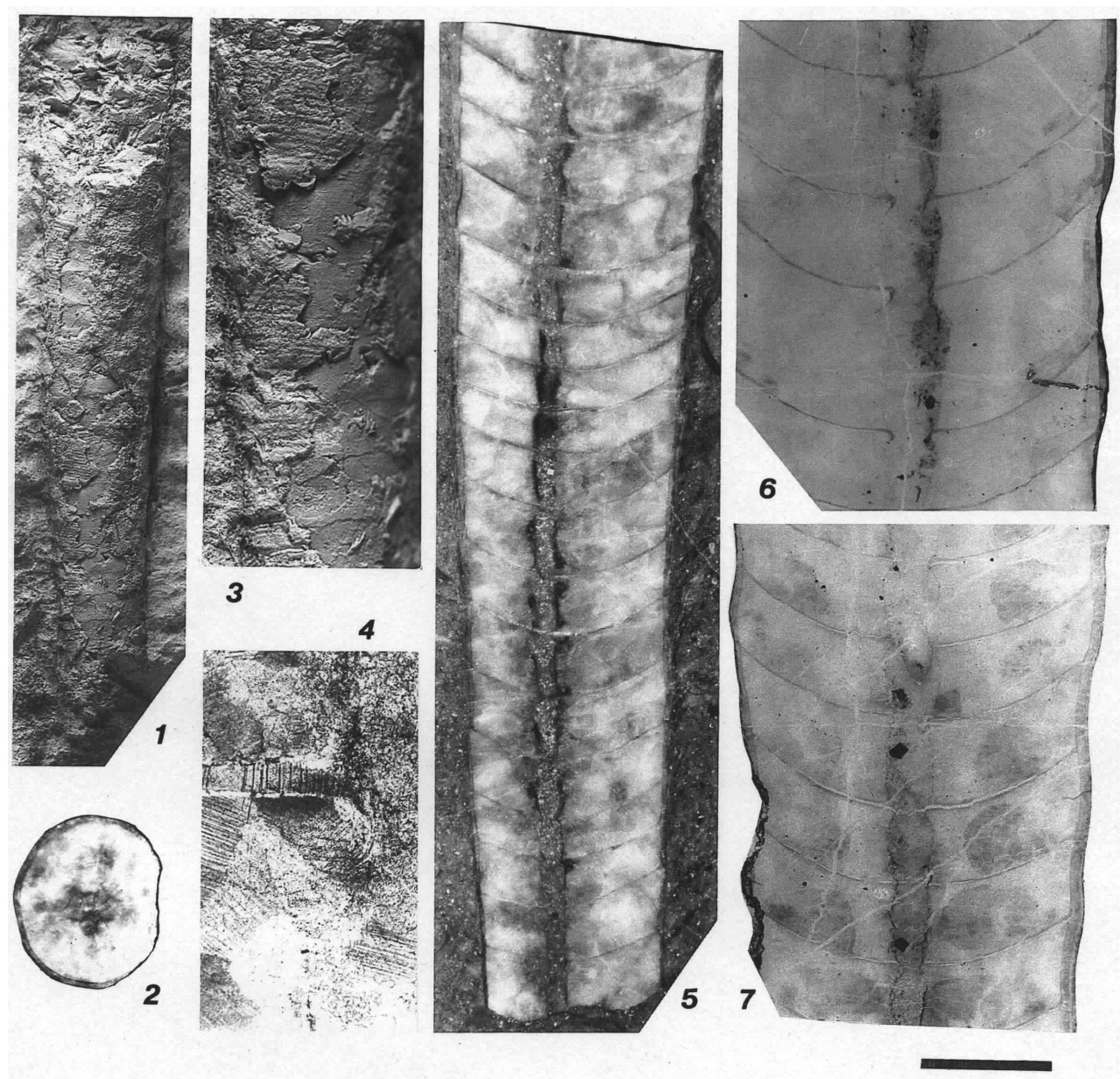


Figure 1. *Bandoceras gifuense* gen. et sp. nov., holotype, IGPS coll. cat. no. 111568, from the Upper Silurian Hitoegane Formation in Takayama City, Gifu Prefecture. **1.** Lateral view, venter on left. **2.** Transverse polished section, venter down. **3.** Partial enlargement of Figure 1.1 to show details of surface ornamentation. **4.** Longitudinal thin section, showing details of septal neck. **5.** Dorsoventral polished section of apical shell, venter on left. **6, 7.** Longitudinal thin sections of adoral shell, venter on left (but oblique to dorsoventral plane), showing details of siphuncle, endosiphuncular deposits (in Figure 1.6), and cameral deposits. Scale bar is 5 mm in Figure 1.1; 4 mm in Figure 1.2; 2 mm in Figures 1.3, 1.6, 1.7; 0.2 mm in Figure 1.4; 2.5 mm in Figure 1.5.

latter is one of the important characters of the subfamily Pseudorthoceratinae Flower and Caster, 1935.

Similar surface ornamentation with *Bandoceras* is found in a Middle Silurian species *Orthoceras wauwatosense*

Whitfield (1882, p. 297, pl. 19, fig. 2; Foerste, 1928, p. 250–252, pl. 53, figs. 2A–D, 3(?), pl. 56, fig. 9(?) as *Geisonoceras wauwatosense*) that is the type species of *Geisonocerina* Foerste, 1935. Internal features of the species are

incompletely known but reportedly it has an orthoconic conch with circular cross section and very deeply concaved septa. Familial placement of *Geisonoceras* is still uncertain.

The Middle Ordovician genus *Centroonoceras* Kobayashi (1934; emended by Niko, 2005; type species, *Ooceras? tokunagai* Kobayashi, 1927, p. 202, 203, pl. 18, figs. 10a, b; Niko, 2005, p. 1028–1030, figs. 1.1–1.8) also resembles *Bandoceras*. However, the relatively wide siphuncle of *Centroonoceras* suggests that it belongs to the family Proteoceratidae Flower, 1962. Similarities between the two genera are probably superficial.

***Bandoceras gifuense* sp. nov.**

Figure 1

Diagnosis.—Same as for the genus.

Description.—A single longiconic phragmocone, 53 mm in approximate length and 3.5 mm in diameter at apical end, is available for study. It is faintly exogastric cyrtocone with gradual conch expansion, whose angle is approximately 6°; apical shell and body chamber are not preserved; cross sections of conch are subcircular indicating weak lateral compression; ratios of lateral conch diameter per dorsoventral one are approximately 0.88; surface ornamentation consists of transverse lirae that are slightly oblique and incline toward dorsum; there are approximately 8 ridges in 1 mm of conch length. Sutures are essentially straight and transverse; septal curvature is shallow and closely spaced to form short camerae; form ratios of camerae (maximum width per length in dorsoventral plane) range from 2.5 to 5.6; siphuncle is subcentral (ventral from center) in position and relatively narrow; ratios of siphuncular position (distance of central axis of septal foramen from ventral shell surface per corresponding conch diameter in dorsoventral plane) are 0.39–0.41; siphuncular wall consists of suborthochoanitic to cyrtocchoanitic septal necks and thin connecting rings; septal neck length is short, 0.19–0.27 mm; connecting rings weakly expanded in camerae and indicate subcylindrical shape. Endosiphuncular deposits partly preserved in adoral shell, and form continuous lining on ventral siphuncular wall; cameral deposits well-developed, episeptal-mural (or mural in rare cases).

Material examined.—Holotype, IGPS coll. cat. no. 111568. The specimen is kept in the Tohoku University Museum, Sendai.

Etymology.—The specific name is derived from Gifu Prefecture.

Occurrence.—The new species described herein is from the middle to late Ludlow (early Late Silurian) calcareous shale at west bank of the Takahara-gawa River in the Shinhirayunsen area. The site is at 36°14'10"N latitude and 137°31'28"E longitude, whose position on geographic map

was given in figure 1 in Niko (2008).

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A catalogue of name-bearing type specimens of fossil Bivalvia (Mollusca) registered in the Tohoku University Museum

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Abstract: Since 1911, more than 110,000 fossil specimens have been studied and registered in the Institute of Geology and Paleontology, Tohoku University, Sendai (IGPS). This catalogue includes 452 name-bearing type specimens (i.e. holotype, lectotype, syntype and neotype) of fossil Bivalvia, registered in the Tohoku University Museum. Each taxon data includes the following items: 1) species name with its author name(s) and date of publication, 2) bibliographic data of the original description, 3) kind of type specimen(s) and present condition of specimen(s), 4) type locality, 5) stratigraphic unit, 6) geologic age. This database and color pictures of the existing type specimens are searchable on the website of the Tohoku University Museum (http://webdb2.museum.tohoku.ac.jp/t_bivalve/). The lectotype of *Thyasira tokunagai* Kuroda and Habe, 1951 is designated herein.

Key words: database, fossil bivalves, name-bearing type specimens, the Tohoku University Museum

Introduction

Tohoku University was established in 1907 as the third Imperial University of Japan, and the Institute of Geology and Paleontology (abbreviated as IGPS) was founded in 1911 with Hisakatsu Yabe as the first professor. Since then, the institute has produced a number of distinguished molluscan paleontologists, such as Ichiro Hayasaka, Takumi Nagao, Sitihei (or Shichihei) Nomura, Saburo Shimizu, Katora Hatai, Tamio Kotaka, Yasuhiko Kamada, Kôichirô Masuda, Masafumi Murata, Hiroshi Noda, Kenshiro Ogasawara, and Yutaka Honda, and until today, a lot of new molluscan taxa have been described by the professors and students of the institute.

The type and referred molluscan fossil specimens had been deposited in the institute with the IGPS registration numbers. In 1998, more than 110,000 paleontological specimens deposited in the institute were moved to the Tohoku University Museum, which was newly established in this year. The details of each IGPS molluscan type specimen

can be seen in the past checklists and monographs such as Hatai and Nisiyama (1952), Oyama *et al.* (1960), Masuda and Noda (1976) and Ogasawara (2001, 2002) for Cenozoic; Hayami (1975), Tanaka and Toshimitsu (2003), Toshimitsu and Tanaka (2003) for Mesozoic; and Nakazawa and Newell (1968), Hayami and Kase (1977) and Kase (2004) for Paleozoic; in addition to Hanzawa *et al.* (eds., 1961). However, no institutional or museum catalogue of the IGPS molluscan collection has been published, and the present condition of the specimens has not been clear. Moreover, we can not find the precise morphological characters of the type specimens from some original descriptions, because of the indistinct pictures. Therefore, the thoroughly curatorial survey of the IGPS paleontological collection is needed.

As a first step of the making the complete catalogue of the IGPS paleontological collection, we herein present a catalogue of fossil Bivalvia, which occupies the large amount of the collection. The present catalogue includes all information about the name-bearing type specimens of fossil Bivalvia in the IGPS collection with photographs.

Methods

On the basis of Ogasawara (2001, 2002), Matsuoka and Ugai (2001), Toshimitsu and Tanaka (2003), Tanaka and Toshimitsu (2003) and Kase (2004), we compiled a basic checklist of name-bearing type specimens of fossil Bivalvia preserved in the Tohoku University Museum. Several species-group names missing in these previous catalogues were added with their name-bearing type specimen data. All data were rechecked by the bibliographic survey of the original descriptions. To confirm the present condition (existing or missing) of the name-bearing type specimens, we compared the candidate type specimens and their registration numbers with figures and registration numbers shown in the original description. We also checked for consistency of taxon name, locality, lithostratigraphic unit (or formation name), geologic age between label attached to the specimens and original description. Recent Bivalvia was excluded from the present catalogue. The photographs of all existing name-bearing type specimens were taken to make database, and they were illustrated in the plates of the present catalogue.

Format

The name-bearing type specimens were arranged alphabetically in the genus- and species-group names to make easy for reference. Each taxonomic entry in the present catalogue is composed of the following data as given in descending order: 1) original spelling of the taxon name, together with author name(s) and publication date, 2) plate number and figure number(s) in the plates of the present catalogue, 3) bibliographic data of the original description, including abbreviation of the publication, volume, page, plate number(s) and figure number(s), 4) category of the name-bearing type specimen (holotype, lectotype, syntype or neotype), together with IGPS (Institute of Geology and Paleontology, Faculty of Science, Tohoku University, Sendai) registration number and present condition (existing or missing), 5) type locality given as names of prefecture, city, town, village and more details both in the way they appeared in the original description and currently known, 6) stratigraphic unit (formation name) from which the type specimen was obtained, 7) geologic age, 8) taxonomic remarks including synonymous status of a given taxon and correction for original spelling and registration number.

The name-bearing type specimen shifted from DGS (abbreviation of the Department of Geology, Faculty of Education, Tohoku University, Sendai; abolished in 1994) to IGPS, the previous DGS registration number was indicated in round brackets behind the IGPS registration number. The literature in which the lectotype or neotype was designated was also added in round brackets. We indicated current

names of city, town and village in square brackets, as well as correction of them from the original description. The updated information on stratigraphic unit and geologic age were also added in square brackets.

The photographs of existing name-bearing type specimens were illustrated in the plates at the end of the present catalogue.

The database and color pictures of the existing type specimens are also searchable on the website of the Tohoku University Museum (http://webdb2.museum.tohoku.ac.jp/t_bivalve/).

Abbreviation of publications

- Bull. Biogeogr. Soc. Japan: *Bulletin of the Biogeographical Society of Japan*.
 Bull. Tohoku Univ. Mus.: *Bulletin of the Tohoku University Museum*.
 Geol. Palaeont. Southeast Asia: *Geology and Palaeontology of Southeast Asia*.
 Illust. Cat. Jpn. Shells: *Illustrated Catalogue of Japanese Shells*.
 Japan. Jour. Geol. Geogr.: *Japanese Journal of Geology and Geography*.
 Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4: *Journal of the Faculty of Science, Hokkaido Imperial University. Series 4, Geology and Mineralogy*.
 Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2: *Journal of the Faculty of Science, Imperial University of Tokyo, Section 2, Geology, Mineralogy, Geography, Seismology*.
 Jour. Geol. Soc. Japan: *Journal of the Geological Society of Japan*.
 Jour. Paleont.: *Journal of Paleontology*.
 Jub. Publ. Commem. Prof. H. Yabe 60th Birthday: *Jubilee Publication in the Commemoration of Professor H. Yabe, M.I.A. Sixtieth Birthday*.
 Mem. Coll. Sci. Univ. Kyoto, Ser. B: *Memoirs of the College of Science, Kyoto University, Series B*.
 Miner. Geol.: *Kôbutu-to-Tisitu (Mineral and Geology)*.
 Paleontol. Res.: *Paleontological Research*.
 Palaeont. Soc. Japan, Spec. Pap.: *Palaeontological Society of Japan, Special Papers*.
 Proc. Imp. Acad.: *Proceedings of the Imperial Academy*.
 Prof. S. Kanno Mem. Vol.: *Professor Saburo Kanno Memorial Volume*.
 Rep., Geol. Surv. Japan: *Report, Geological Survey of Japan*.
 Res. Rep. Kochi Univ., Nat. Sci.: *Research Reports of the Kochi University, Natural Science*.
 Saito Ho-on Kai Mus. Nat. Hist. Res. Bull.: *Saito Ho-on Kai Museum of Natural History Research Bulletin*.
 Saito Ho-on Kai Mus. Res. Bull.: *Saito Ho-on Kai Museum Research Bulletin*.

Saito Ho-on Kai Spec. Pub., no. 2 (Prof. T. Kotaka Commem. Vol.): *Saito Ho-on Kai Special Publication, no. 2 (Professor Tamio Kotaka Commemorative Volume on Molluscan Paleontology)*.

Sci. Rep., Fac. Arts and Liter., Nagasaki Univ.: *Science Reports of the Faculty of Arts and Literature, Nagasaki University*.

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.): *Science Reports of the Tôhoku Imperial University, Second Series (Geology)*.

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.): *Science Reports of the Tohoku University, Second Series (Geology)*.

Sci. Rep. Tôhoku Univ., 2nd Ser. (Geol.), Spec. Vol.: *Science Reports of the Tôhoku University, Second Series (Geology), Special Volume*.

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol.: *Science Reports of the Tohoku University, Second Series (Geology), Special Volume*.

Short Pap. Inst. Geol. Paleont., Tôhoku Univ.: *Short Papers from the Institute of Geology and Paleontology, Tôhoku University, Sendai*.

Trans. Proc. Palaeont. Soc. Japan, N.S.: *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*.

U.S. Geol. Surv., Prof. Pap.: *United States Geological Survey Professional Paper*.

Venus: *Venus (Japanese Journal of Malacology)*.

registered in the Tohoku University Museum. Among them, 412 specimens are still existing.

Details of the type of the name-bearing types are as follows (Fig. 1):

Holotypes:	381 specimens
Lectotypes:	36 specimens
Syntypes:	34 specimens
Neotype:	1 specimen.

Details on geologic ages are as follows (Fig. 2):

Cenozoic:	366
Quaternary:	71
Holocene:	3
Pleistocene:	68
Neogene:	191
Pliocene:	35
Miocene:	156
Paleogene:	104
Oligocene:	58
Eocene:	46
Mesozoic:	60
Cretaceous:	52
Jurassic:	1
Triassic:	7
Paleozoic:	23
Permian:	20
Carboniferous:	1
Devonian:	0
Silurian:	0
Ordovician:	2
Unknown:	3.

Summary

As a result of the present survey, it became obvious that 452 name-bearing type specimens of fossil Bivalvia are

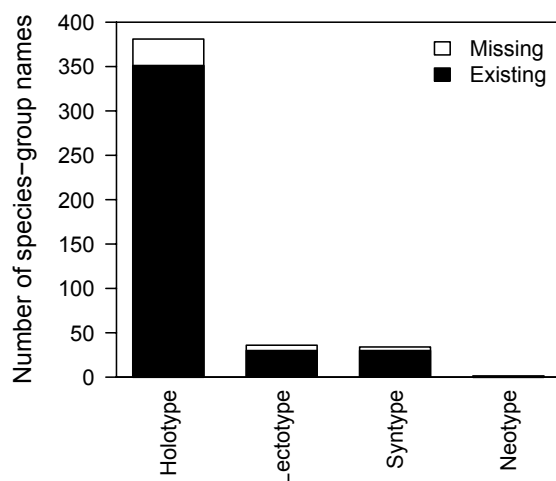


Fig. 1. Total number of species-group names in each category of the name-bearing type specimens of fossil Bivalvia deposited in the Tohoku University Museum and their present conditions.

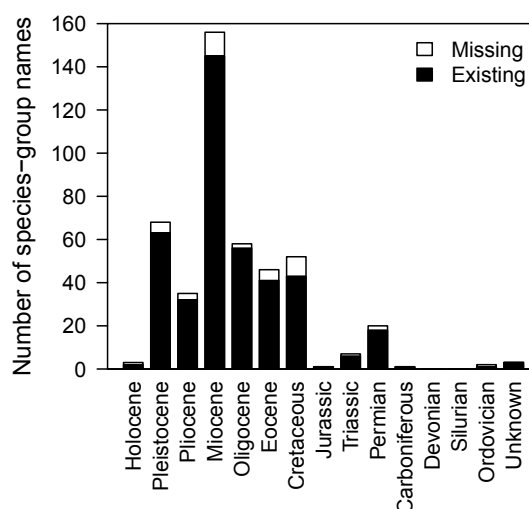


Fig. 2. Total number of species-group names in each geologic age, from which the name-bearing type specimens of fossil Bivalvia deposited in the Tohoku University Museum were obtained.

The chronologic succession of the number of the bivalve studies, in which new species-group names were proposed and the name-bearing types were repositated at IGPS, are as follows (Fig. 3):

1911–1920:	6
1921–1930:	115
1931–1940:	87
1941–1950:	23
1951–1960:	42
1961–1970:	128
1971–1980:	25
1981–1990:	15
1991–2000:	9
2000–2010:	1
2011 and later:	1.

These results suggest that 1) 91.2% of the name-bearing type specimens of fossil Bivalvia of the IGPS collection are still existing in the Tohoku University Museum, 2) 81.0% of them were obtained from Cenozoic, and 34.5% were from Miocene, and 3) 25.4% and 28.3% of them were proposed in 1921–1930 mainly by I. Hayasaka, T. Nagao and H. Yabe and in 1961–1970 by K. Masuda, M. Murata and H. Noda, respectively.

A total of 33 researchers proposed new species-group names of fossil Bivalvia as the first author, and deposited the name-bearing type specimens in IGPS. Of them, T. Nagao described 76 new species-group names as the first author during 1928 and 1943, and S. Nomura and K.

Masuda described 63 species-group names in 1932–1939 and 1952–1994, respectively (Fig. 4). H. Yabe and H. Noda described 40 new species-group names in 1926–1942 and 1962–1971 respectively, and K. Hatai also described 32 species-group names in 1940–1974.

Among the name-bearing type specimens of fossil Bivalvia in the IGPS collection, 26 specimens were those of members of the genus *Anadara*, followed by those of the genus *Chlamys* (22 species-group names) and *Pecten* (20 species-group names) (Fig. 5). Nineteen new species-group names of *Anadara* were described by H. Noda, and 20 of *Chlamys* were described by K. Masuda. In the genus *Glycymeris*, *Patinopecten* and *Venericardia*, 13 new species-group names and their name-bearing type specimens were also proposed and registered in IGPS.

According to Ogasawara (2004), 68 species-group names described under the genus *Chlamys* and 54 species-group names of *Anadara* were described from Japanese Islands and its adjacent areas during the 20th Century. Among their name-bearing type specimens, 32.3% of *Chlamys* and 48.1% of *Anadara* were deposited in the Tohoku University Museum.

These results suggest that many researchers of Tohoku University especially proposed new species-group names of *Anadara*, *Chlamys* and *Pecten* for their studies on the taxonomy, biostratigraphy, paleobiogeography, evolutionary paleobiology and paleoenvironmental analyses. In particular, a number of new species-group names were proposed during the two "golden ages", namely 1921–1940 and 1961–1970 (Fig. 3), in this university.

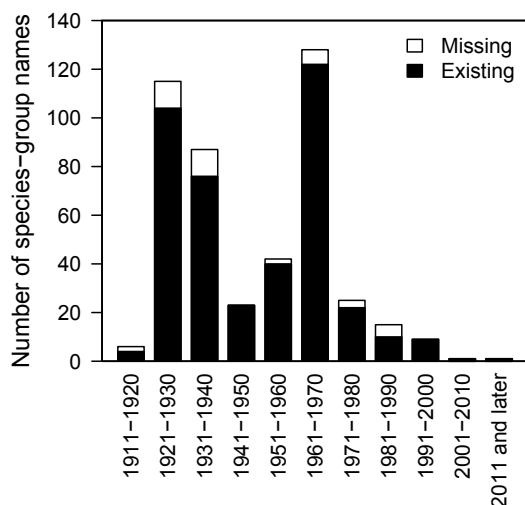


Fig. 3. Total number of species-group names in each chronological period, in which new species-group names of fossil Bivalvia were proposed and their name-bearing type specimens were deposited in the Tohoku University Museum.

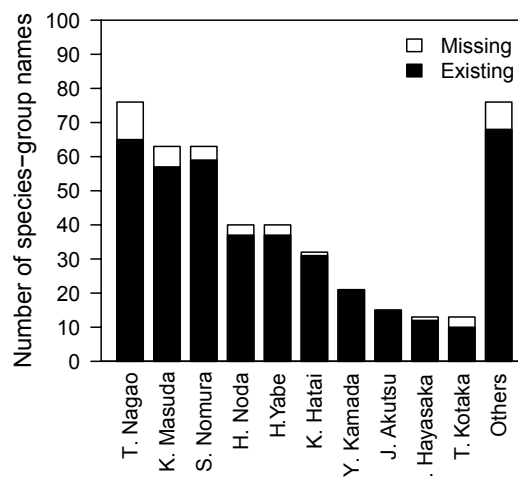


Fig. 4. Total number of species-group names in each author, who proposed new species-group names of fossil Bivalvia as the first author and deposited their name-bearing type specimen in the Tohoku University Museum.

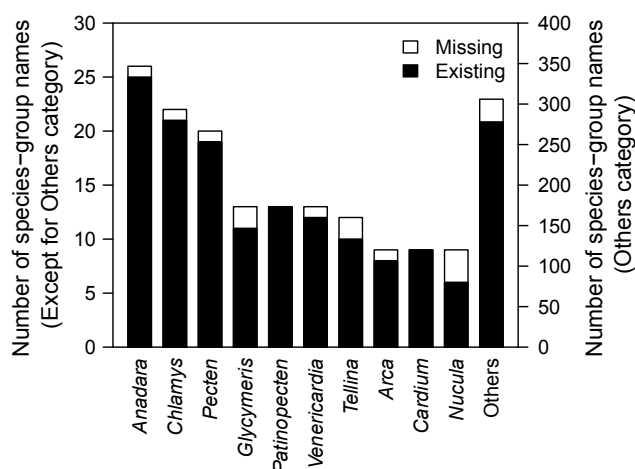


Fig. 5. Total number of species-group names in each genus of the name-bearing type specimens of fossil Bivalvia deposited in the Tohoku University Museum.

Catalogue

Acanthopecten onukii Murata, 1964

Plate 1, Figure 1

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 54, p. 222, pl. 35, fig. 1a–b. Holotype: IGPS no. 85745 (Existing). Type locality: IGPS loc. no. Mi 117 (Murata, 1964), Shigejizawa, Kamiyasse, Kesenuma City, Miyagi Prefecture. Stratigraphic unit: Lower part of Kanokura Formation. Geologic age: Middle Permian.

Acanthopecten spinosus Hayasaka, 1925b

Plate 1, Figure 2

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 8, no. 2, p. 10, pl. 8, fig. 6. Lectotype: IGPS no. 22388 (designated by Murata, 1964; Existing). Type locality: Imō, Yahagi-mura, Kesen-gōri, prov. Rikuzen [currently Imo, Yahagicho, Rikuzentakata City, Iwate Prefecture]. Stratigraphic unit: Lower part of Kanokura Formation. Geologic age: Lower Permian [Middle Permian].

Acila divaricata chitosensis Noda, 1962b

Plate 1, Figure 3

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 34, no. 3, p. 227, pl. 16, fig. 9. Holotype: IGPS no. 79060 (Existing). Type locality: Loc. No. 344 (Noda, 1962b), cliff of the Shibumi River, just under the Chitose Bridge, Chitose, Matsudai-machi, Higashikubiki-gun [currently Tokamachi City], Niigata Prefecture. Stratigraphic unit: Higashigawa Formation. Geologic age: “Middle” Pliocene.

Acila (Acila) kiiensis Masuda and Katto, in Katto and Masuda, 1978

Plate 1, Figures 4a–b

Res. Rep. Kochi Univ., Nat. Sci., vol. 27, p. 104, pl. 3, figs. 1a–3b. Holotype: IGPS no. 96071 (Existing). Type locality: Loc. no. 2 (Katto and Masuda, 1978), Tanozaki, about 1 km SWS of Tanami, Kushimoto-cho, Nishimuro-gun [currently Higashimuro-gun], Wakayama Prefecture. Stratigraphic unit: Tanami Formation. Geologic age: Oligocene [Early Miocene].

Aequipecten matsunagensis Masuda, 1966b

Plate 1, Figure 5

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 64, p. 323, pl. 35, figs. 4–6. Holotype: IGPS no. 90089 (formerly DGS no. 4506; Existing). Type locality: No. 32 (Masuda, 1966a), small road side exposure, about 200 m S of the Matsunagi Primary School, [Matsunagi-machi], Suzu City, Ishikawa Prefecture. Stratigraphic unit: Higashi-innai Formation. Geologic age: Miocene [latest Early Miocene].

Amussiopecten akiyamae Masuda, 1962a

Plate 1, Figure 6

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 33, p. 224, pl. 27, figs. 1–3. Holotype: IGPS no. 90658 (formerly DGS no. 3854; Existing). Type locality: Sea cliff at Fudōiwa, Kanaya, Amaha-machi, Kimitsu-gun [currently Futtsu City], Chiba Prefecture. Stratigraphic unit: Inagozawa Formation [Nokogiriyama Formation]. Geologic age: Miocene [latest Late Miocene–earliest Early Pliocene].

Anadara (Scapharca) akitaensis Noda, 1966a

Plate 1, Figures 7a–d

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 106, pl. 5, figs. 9, 10, 19, 20. Holotype: IGPS no. 16330 (Existing). Type locality: Tayazawa, Wakimoto-mura, Minamiakita-gun [sic, Wakimoto, Oga City], Akita Prefecture. Stratigraphic unit: Sasaoka Formation. Geologic age: Pliocene [latest Late Pliocene–early Early Pleistocene].

Anadara (Anadara) amicula elongata Noda, 1966a

Plate 1, Figures 8a–b

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 84, pl. 5, figs. 2–7. Holotype: IGPS no. 85907 (originally stated IGPS no. 62435; Existing). Type locality: Upstream of Kanakusare [sic, Kanakusari] River, Makimachi, Kanazawa City, Ishikawa Prefecture. Stratigraphic unit: Omma Formation. Geologic age: Pliocene [Early Pleistocene].

Anadara (Anadara) arasawaensis Noda, 1966a

Plate 1, Figures 9a–b

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1,

p. 86, pl. 4, figs. 13, 15–17. Holotype: IGPS no. 90046 (Existing). Type locality: Arasawa, Gomyojin-mura [*sic*, Omyojin], Shizukuishi-machi [*sic*, Shizukuishi-cho], [Iwate-gun], Iwate Prefecture. Stratigraphic unit: Sakamotogawa Formation. Geologic age: Miocene.

***Anadara (Anadara) gentaroensis* Noda, 1966a**

Plate 1, Figure 10

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 87, pl. 7, figs. 19–21. Holotype: IGPS no. 86411 (Existing). Type locality: Gentaro, Kozai-mura [*sic*, Kosai], Ouchimachi [*sic*, Marumori-machi], Igu-gun, Miyagi Prefecture. Stratigraphic unit: Yoshizawa Formation [*sic*, Yoshigasawa Formation]. Geologic age: Miocene [latest Early–earliest Middle Miocene].

***Anadara (Anadara) hatai* Noda, 1966a**

Plate 1, Figures 11a–c; Plate 2, Figures 1a–b

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 88, pl. 6, figs. 1, 4–7. Holotype: IGPS no. 73210 (Existing). Type locality: Nishigoto [*sic*, Nishigodo], Hanawamachi, Higashishirakawa-gun, Fukushima Prefecture. Stratigraphic unit: Tanagura Formation [=Kubota Formation]. Geologic age: Miocene [early Late Miocene].

***Anadara (Anadara) hokkaidoensis* Noda, 1966a**

Plate 2, Figures 2a–c

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 90, pl. 4, figs. 18, 19, pl. 5, fig. 14, pl. 8, figs. 1, 8. Holotype: IGPS no. 86408 (Existing). Type locality: Upstream of the Ishii-sawa [*sic*, Ishiizawa], Atsunai, Horonobe-machi [*sic*, Urahoro-cho], Tokachi-gun, Tokachi Province, Hokkaido. Stratigraphic unit: Chokubetsu Formation [=Ishiizawa Formation]. Geologic age: Miocene [early Middle Miocene].

***Anadara (Scapharca?) iwashibaraensis* Noda, 1965**

Plate 2, Figure 3

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 59, p. 104, pl. 10, fig. 15. Holotype: IGPS no. 29050 (Existing). Type locality: Iwashibara, Kamitareki-mura, Ogasa-gun [*sic*, Yashibara, Shimotaruki, Kakegawa City], Shizuoka Prefecture. Stratigraphic unit: Dainichi Formation. Geologic age: Pliocene [Early Pleistocene].

***Anadara (Anadara) iwatensis* Noda, 1966a**

Plate 2, Figures 4a–b

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 91, pl. 4, figs. 21, 22. Holotype: IGPS no. 90048 (Existing). Type locality: Arasawa, Myojin-mura, Shizukuishi-machi [*sic*, Omyojin, Shizukuishi-cho], Iwate-gun, Iwate Prefecture. Stratigraphic unit: Sakamotogawa Formation.

Geologic age: Miocene.

***Anadara (Anadara) iwatonoensis* Noda, 1966a**

Plate 2, Figures 5a–b

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 92, pl. 9, fig. 21, pl. 11, fig. 19. Holotype: IGPS no. 63342 (Existing). Type locality: Jakotsuzawa, Saruhashi, Kitatsuru-gun [*sic*, Saruhashimachi, Otsuki City], Yamanashi Prefecture. Stratigraphic unit: Iwatono Formation. Geologic age: Miocene.

***Anadara (Anadara) kakehataensis* Hatai and Nisiyama, 1949**

Plate 2, Figures 6a–d

Jour. Paleont., vol. 23, no. 1, p. 88, pl. 23, figs. 8–10. Holotype: IGPS no. 72510 (Existing). Although Ogasawara (2001) stated IGPS no. 72511 as the holotype, it is the holotype of *Anadara (Anadara) kurosedaniensis* Hatai and Nisiyama, 1949. Type locality: West cliff, about 50 m S of the bridge at Kakehata, Unohana-mura, Nei-gun [currently Yatsuomachi, Toyama City], Toyama Prefecture. Stratigraphic unit: Susahara Formation [=Kurosedani Formation]. Geologic age: Miocene [latest Early Miocene]. Remarks: The present species is a type species of *Hataiarca* Noda, 1966a (by original designation).

***Anadara (Hataiarca) kogachiensis* Noda, 1971**

Plate 2, Figures 7a–c; Plate 3, Figures 1a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 81, p. 37, pl. 6, figs. 1–5, 8–17. Holotype: IGPS no. 86757 (Existing). Type locality: Loc. no. 109 (Noda, 1971), west of Kogachi, Haneji-son, [Kunigami-gun] [currently Kogachi, Nago City], Okinawa-jima, Okinawa Prefecture. Stratigraphic unit: Kogachi Member of Haneji Formation. Geologic age: Pliocene [Pleistocene].

***Anadara (Anadara) kurosedaniensis* Hatai and Nisiyama, 1949**

Plate 3, Figures 2a–b

Jour. Paleont., vol. 23, no. 1, p. 89, pl. 23, figs. 11, 12. Holotype: IGPS no. 72511 (Existing). Type locality: West cliff, about 50 m south of the bridge at Kakehata, Unohana-mura, Nei-gun [currently Yatsuomachi, Toyama City], Toyama Prefecture. Stratigraphic unit: Susahara Formation [=Kurosedani Formation]. Geologic age: Miocene [latest Early Miocene].

***Anadara makiyamai* Hatai and Nisiyama, 1939 [“1938”]**

Japan. Jour. Geol. Geogr., vol. 16, nos. 1–2, p. 143–144, pl. 9, fig. 7. Holotype: IGPS no. 62430 (Missing). Type locality: Nanseki, Meisen-gun, Kankyō-dō, North Tyōsen [currently Myongchon-gun, Hamgyongpuk-to, North

Korea]. Stratigraphic unit: Heiroke Beds of Meisen Series [Heiroke Formation of Meisen Group]. Geologic age: Miocene [latest Early–earliest Middle Miocene]. Remarks: This species is a junior synonym of *Anadara abdita* (Makiyama, 1926).

***Anadara (Scapharca) masudai* Noda, 1966a**

Plate 3, Figures 3a–b

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 118, pl. 5, figs. 16–17, pl. 13, figs. 2, 4. Holotype: IGPS no. 51550 (Existing). Type locality: Subsurface about 4–5 m below the Star Hotel, Honmoku, [Naka-ku], Yokohama City, Kanagawa Prefecture. Stratigraphic Unit: Tokyo Formation. Geologic age: Pleistocene [Late Pleistocene].

***Anadara (Anadara) naganoensis* Noda, 1966a**

Plate 3, Figure 4

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 95, pl. 3, fig. 8. Holotype: IGPS no. 86410 (Existing). Type locality: Stream cliff of a tributary of the Saikawa, Fukudo, about 10 m E of the Fukudo Bridge, Shinanoshin-machi [sic, Shinshushin-machi], Kamiminouchi-gun [currently Shinshushinmachi, Nagano City], Nagano Prefecture. Stratigraphic unit: Gonda Formation. Geologic age: Late Miocene.

***Anadara (Tegillarca) obessa* Kotaka, 1953**

Plate 3, Figures 5a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 10, p. 35, pl. 4, figs. 1a–6c. Holotype: IGPS no. 66536 (Existing). IGPS no. 66356 given by original description as the holotype is incorrect. Type locality: Coast near Nago-machi [sic, Nago-cho], Kunigami-gun, [Government of the Ryukyu Islands] [currently Nago City, Okinawa Prefecture]. Stratigraphic unit: Raised beach deposits. Geologic age: [Late Pleistocene or Holocene].

***Anadara (Scapharca) omaruensis* Sasaki, 1991**

Plate 3, Figures 6a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 161, p. 710, figs. 11.2a–b, 12.5a–12.8b. Holotype: IGPS no. 101325 (Existing). Type locality: Iwasebashi, Matsubara, [Heida], Kawaminami-machi [sic, Kawaminami-cho], Koyu-gun, Miyazaki Prefecture. Stratigraphic unit: Koyu Formation. Geologic age: Pliocene [late Late Pliocene–early Early Pleistocene].

***Anadara (Hataiarca) pseudosubcrenata* Ogasawara, 1977**

Plate 3, Figures 7a–b

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 47, no. 2, p. 92, pl. 6, figs. 1–2b, 5a–6. Holotype: IGPS no. 95070 (Existing). Type locality: Loc. no. KO-01 (Ogasawara, 1977), river floor

of Sai-gawa, 350 m SE of Okuwa Bridge, Okuwa, Kanazawa City, Ishikawa Prefecture. Stratigraphic unit: Omma Formation. Geologic age: Pliocene [Early Pleistocene].

***Anadara (Scapharca?) shizuokaensis* Noda, 1965**

Plate 3, Figures 8a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 59, p. 103, pl. 11, figs. 7, 8. Holotype: IGPS no. 78919 (Existing). Type locality: Hosoya, Kitaogasa-mura, Ogasa-gun [currently Kakegawa City], Shizuoka Prefecture. Stratigraphic unit: Nango Sandstone and Mudstone Alternation. Geologic age: Pliocene.

***Anadara (Scapharca) taiwanica* Noda, 1966a**

Plate 3, Figure 9; Plate 4, Figures 1a–c

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 112, pl. 10, figs. 1, 4–6. Holotype: IGPS no. 42357 (Existing). Type locality: About 1,450 m W of Hoko [sic, Hokkô, Ôbokô], Byoritsu-gun, Shinchiku-shu [currently Yamukeng, Jinshih Village, Hsihu Township, Miaoli County], Taiwan. Lithostratigraphic unit: Tokazan Formation [=Toukoushan Formation]. Geologic age: Pliocene. Remarks: *Anadara taiwanica* Hu, 1992, from the raised coral reefs in Taiwan, is a junior homonym (Huang and Masuda, 2001).

***Anadara (Scapharca) takanabensis* Sasaki, 1991**

Plate 4, Figures 2a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 161, p. 710, figs. 11.4a–b, 12.1a–12.4b. Holotype: IGPS no. 101327 (Existing). Type locality: Toriyama, [Heida], Kawaminami-machi [sic, Kawaminami-cho], Koyu-gun, Miyazaki Prefecture. Stratigraphic unit: Koyu Formation. Geologic age: Pliocene [late Late Pliocene–early Early Pleistocene].

***Anadara (Hataiarca) takayamai* Noda, 1966a**

Plate 4, Figures 3a–b

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 120, pl. 2, figs. 18, 22, pl. 13, figs. 5, 6, 17, 18. Holotype: IGPS no. 86403 (Existing). Type locality: Kubusu River cliff, Kakehata, Yatsuo-machi, Nei-gun [currently Yatsuomachi, Toyama City], Toyama Prefecture. Stratigraphic unit: Kurosedani Formation. Geologic age: Miocene [latest Early Miocene].

***Anadara (Anadara) tanakuraensis* Noda, 1966a**

Plate 4, Figures 4a–b

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 100, pl. 8, figs. 11, 12. Holotype: IGPS no. 28404 (Existing). Type locality: Kamitoyonosawa, [Nagare], Tanagura-machi, Higashishirakawa-gun, Fukushima Prefecture. Stratigraphic unit: Tanagura Formation [=Kubota

Formation]. Geologic age: Miocene [early Late Miocene].

***Anadara (Tosarca) tosaensis* Noda, 1965**

Plate 4, Figure 5

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 59, p. 105, pl. 11, figs. 11–13. Holotype: IGPS no. 54609 (Existing). Type locality: Oono, Yasuda-mura [*sic*, Yasuda-machi], Aki-gun, Kochi Prefecture. Stratigraphic unit: Ananai Formation. Geologic age: Pliocene [late Late Pliocene–early Early Pleistocene]. Remarks: The present species is a type species of *Tosarca* Noda, 1965 (by original designation).

***Anadara (Anadara) tsudai* Noda, 1966a**

Plate 4, Figures 6a–c

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 103, pl. 2, figs. 19–21. Holotype: IGPS no. 86396 (Existing). Type locality: Hirabayashi, Yatsuo-machi, Nei-gun [currently Yatsuomachi, Toyama City], Toyama Prefecture. Stratigraphic unit: Joyama Formation. [=Higashibessho Formation]. Geologic age: Miocene [latest Early–early Middle Miocene].

***Anadara (Hataiarca) yatsuoensis* Noda, 1966a**

Plate 4, Figures 7a–c

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 122, pl. 13, figs. 1, 3, 9, 16, 19–20. Holotype: IGPS no. 86402 (Existing). Type locality: Kubusu River cliff, Kakehata, Yatsuo-machi, Nei-gun [currently Yatsuomachi, Toyama City], Toyama Prefecture. Stratigraphic unit: Kurosedani Formation. Geologic age: Miocene [latest Early Miocene].

***Angulararca yubaensis* Noda, 1966b**

Saito Ho-on Kai Mus. Res. Bull., no. 35, p. 16, figs. 7, 8, 17, 18. Holotype: IGPS no. 72884 (Missing). Type locality: Road side cliff, west of Yuba, Rifu-mura [currently Sugaya, Rifu-cho], Miyagi-gun, Miyagi Prefecture. Stratigraphic unit: Aoso Formation. Geologic age: Miocene [Late Miocene]. This species is the type species of *Angulararca* Noda, 1966b.

***Angulus maximus submaximus* Mizuno, 1964**

Plate 5, Figures 1a–b

Rep., Geol. Surv. Japan, no. 204, p. 60. Syntypes: IGPS no. 36452 (Existing) [=paratypes of *Tellina maxima* Nagao, 1928b figured in Nagao, 1928b, pl. 4, figs. 8, 11]. Type locality: Taya, [Yamaga], Ashiya-machi, Onga-gun, Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Yamaga Beds [Yamaga Formation]. Geologic age: Oligocene.

***Anisocorbula ohiroi* Masuda, 1966b**

Plate 5, Figures 2a–c

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 64, p. 329, pl. 35, figs. 35a–36b. Holotype: IGPS no. 90734 (formerly DGS no. 4546; Existing). Type locality: Loc. No. 36 (Masuda, 1966a), river cliff near small road, about 600 m SSE of Kakuma, [Otanimachi], Suzu City, Ishikawa Prefecture. Stratigraphic unit: Higashi-innai Formation. Geologic age: Miocene [latest Early Miocene].

***Annuliconcha kitakamiensis* Murata, 1964**

Plate 5, Figure 3

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 54, p. 227, pl. 34, fig. 12a, b. Holotype: IGPS no. 22389 (Existing). Type locality: IGPS loc. no. It 044 (Murata, 1964), Imô, Yahagi-machi, Rikuzen-takada City [currently Imo, Yahagicho, Rikuzentakata City], Iwate Prefecture. Stratigraphic unit: Lower part of Kanokura Formation. Geologic age: Middle Permian.

***Anomia pseudotruncata* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 5, Figures 4–5

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 62, pl. 12, figs. 26, 27, pl. 13, figs. 26, 27, 36, 37. Syntypes: IGPS no. 22522 (Existing). Type locality: Bômekizawa, Ôhinata[-mura], [currently Ohinata, Sakuho-machi], Minamisaku-gun, Province of Shinano [Nagano Prefecture]. Stratigraphic unit: Ishidô Group [Shiroyi Formation]. Geologic age: Cretaceous [Early Cretaceous].

***Arca (Arca) andoi* Nomura, 1933**

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 33, pl. 3, fig. 8a–b. Holotype: IGPS no. 48383 (Missing). Type locality: Station no. 42 (Nomura, 1933), 550 m E of Sankwakô, Tsûshô-shô, Byôritsu-gun, Shinchiku-shû [currently Sanwo-kou, Tongwan Village, Tongsiao Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byôritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Arca (Arca) kikaizimana* Nomura and Zinbô, 1934**

Plate 5, Figures 6a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 2, p. 152 (44), pl. 5 (1), figs. 4a–5b. Holotype: IGPS no. 50198 (Existing). Type locality: Plateaux area near Kamikatetu, Kikai-zima, [Kikai-cho, Oshima-gun], Kagoshima Prefecture. Lithostratigraphic unit: “Ryûkyû Limestone”. Geologic age: Pleistocene. Remarks: This species is the type species of *Kikaia* Noda, 1966a (by original designation).

***Arca (Arca) miurensis* Noda, 1966a**

Plate 5, Figures 7a–b

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p.

57, pl. 12, figs. 11, 12, 14, 15. Holotype: IGPS no. 23846 (Existing). Type locality: Urage, Taura-machi, Miura-gun [currently Uragecho, Yokosuka City], Kanagawa Prefecture. Stratigraphic unit: Miyata Formation. Geologic age: Pliocene [Pleistocene]. Remarks: Because Noda (1966) thought *Arca miyatensis* Oyama, 1951b to be unavailable, he proposed *Arca (Arca) miyatensis* for the same taxon. However, *A. miyatensis* Oyama, 1951b is available, because Oyama (1951b) proposed this new name in association with a bibliographic reference to *Arca kobeltiana* Pilsbry *sensu* Yokoyama (1920). Habe (1967) considered these two species are hardly distinguished from the Recent *Arca boucardi* Jousseaume, 1894.

***Arca (Noetia) pondaungensis* var. *transversa* Nagao, 1928b**

Plate 17, Figure 13

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 26, pl. 6, figs. 8–10. Holotype: IGPS no. 36012 (Existing). Type locality: Hôshuyama Mine, Hôshuyama-mura [currently Tôhō-mura], Asakura-gun, Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Doshi Beds [=Doshiyama Formation]. Geologic age: Eocene [Late Eocene]. Remarks: A new replacement name, ***Noetia nagaoi* MacNeil, 1938**, was proposed for this taxon since it is a primary junior homonym of *Arca transversa* Say, 1822.

***Arca sakamizuensis* Hatai and Nisiyama, 1952**

Plate 5, Figure 8

Sci. Rep. Tôhoku Univ., 2nd Ser. (Geol.), Spec. Vol., no. 3, p. 30. Holotype: IGPS no. 35996 (Existing). Type locality: Beach-rocks along the sea coast [about 500 m N of] Sakamizu, Shimago-mura, Onga-gun [currently An'ya, Wakamatsuku, Kitakyushu City], Fukuoka Prefecture. Stratigraphic unit: Sakamizu Formation. Geologic age: Oligocene. Remarks: This species was proposed as “n. sp.” without description, but is regarded to be elected as “nom. nov.” for ***Arca (Arca) sp. a* of Nagao (1928b)**: Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 27, pl. 3, figs. 9, 9a).

***Arca shinanoensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 5, Figures 9–11

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 42, pl. 13, figs. 33–35. Syntypes: IGPS no. 22521 (Existing). Type locality: Bômekizawa, Ôhinata[-mura], [currently Ohinata, Sakuho-machi], Minamisaku-gun, Province of Shinano [Nagano Prefecture]; and Shiroy, [Narahara], Ueno-mura, Tano-gun, Province of Kôzuke [Gumma Prefecture]. Stratigraphic unit: Ishidô Group [Shiroy Formation]. Geologic age: Cretaceous [Early Cretaceous].

***Arca (Arca) sokeishiensis* Nomura, 1933**

Plate 5, Figure 12

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 38, pl. 2, fig. 10a, b. Holotype: IGPS no. 47770 (Existing). Type locality: Sôkeishi, Kwanden-shô, Sobun-gun, Tainan-shû [currently Shuangshih, Daci Village, Kuantien District, Tainan City], Taiwan. Lithostratigraphic unit: Byôritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Arca (Arca) takaoensis* Nomura, 1933**

Plate 5, Figure 13

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 39, pl. 3, figs. 2–5. Holotype: IGPS no. 37444 (Existing). Type locality: Shinsui, Ensô-shô, Okayama-gun, Takao-shû [currently Shengshui, Shengshui Village, Yangchao District, Kaohsiung City], Taiwan. Stratigraphic unit: “Kaizan Beds”. Geologic age: Miocene [Late Miocene].

***Arca (Barbatia) yokoyamai* Nomura, 1933**

Plate 5, Figures 14a–e

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 41, pl. 1, fig. 3a–d. Holotype: IGPS no. 42588 (Existing). Type locality: Station no. 38 (Nomura, 1933), Wangwa, Kôryû-shô, Chikunan-gun, Shinchiku-shû [currently Wanwa, Zhonghe Village, Houlong Township, Miaoli County], Taiwan. Lithostratigraphic unit: “Byôritsu Beds”. Geologic age: Pliocene [Pleistocene]. Remarks: This species is thought to be a junior synonym of *Striarca interplicata* (Grabau and King, 1928) (Habe, 1958; Noda, 1966a).

***Astarte minor* Nagao, 1934**

Plate 17, Figures 12a–b

Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4, vol. 2, no. 3, p. 220, pl. 28, figs. 5–10. Lectotype: IGPS no. 66425 (designated by Hayami, 1965b; Existing). Type locality: Southern coast of Hiraiga Inlet [Wano, Tanohata-mura, Shimohei-gun, Iwate Prefecture]. Stratigraphic unit: Hiraiga Sandstone [Hiraiga Formation]. Geologic age: Cretaceous [Early Cretaceous]. Remarks: The species name is preoccupied by *Astarte sulcata* var. *minor* Jeffreys, 1864 [“1863”]. See ***Nicaniella (Trautscholdia) nagaoi* Matsubara, 2016**.

***Astarte miyakoensis* Nagao, 1934**

Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4, vol. 2, no. 3, p. 218, pl. 30, fig. 8, pl. 32, figs. 1, 3–5. Lectotype: IGPS no. 7105 (designated by Hayami, 1965b; Missing). Type locality: Southern coast of Hiraiga [Raga, Tanohata-mura, Shimohei-gun, Iwate Prefecture]. Stratigraphic unit: Hiraiga Sandstone [Hiraiga Formation]. Geologic age: Cretaceous [Early Cretaceous].

***Astarte shinanoensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 5, Figure 15

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 47, pl. 13, figs. 29, 30. Lectotype: IGPS no. 22544 (designated by Hayami, 1965b; Existing). Type locality: Ishidō, near Ōhinata[-mura] [currently Ōhinata, Sakuho-machi], Minamisaku-gun, Province of Shinano [Nagano Prefecture]. Stratigraphic unit: Ishidō Group [Ishidō Formation]. Geologic age: Cretaceous [Early Cretaceous].

***Astarte subomalioides* Nagao, 1934**

Plate 5, Figure 16

Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4, vol. 2, no. 3, p. 219, pl. 27, figs. 3, 4. Lectotype: IGPS no. 66446 (designated by Hayami, 1965b; Existing). Type locality: Southern coast of Hiraiga Inlet [Wano, Tanohata-mura, Shimohei-gun, Iwate Prefecture]. Stratigraphic unit: Hiraiga Sandstone [Hiraiga Formation]. Geologic age: Cretaceous [Early Cretaceous].

***Astarte subsenecta* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 47, pl. 13, figs. 14–16, pl. 14, fig. 11. Lectotype: IGPS no. 22534 (designated by Hayami, 1965b; Missing). Type locality: Ishidō, near Ōhinata[-mura] [currently Ishidō, Ōhinata, Sakuho-machi], Minamisaku-gun, Province of Shinano [Nagano Prefecture]. Stratigraphic unit: Ishidō Group [Ishidō Formation]. Geologic age: Cretaceous [Early Cretaceous].

***Astarte subsenecta* var. *costata* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 5, Figure 17

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 48, pl. 14, fig. 10. Holotype: IGPS no. 22483 (Existing). Type locality: Ōze, near Kagahara, Nakazato-mura [currently Kanna-machi], Tano-gun, Province of Kōzuke [Gumma Prefecture]. Stratigraphic unit: Kawarazawa Group [Ishido Formation]. Geologic age: Cretaceous [Early Cretaceous].

***Aviculopecten hataii* Murata, 1964**

Plate 5, Figures 18a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 54, p. 221, pl. 34, fig. 10a, b. Holotype: IGPS no. 85732 (Existing). Type locality: IGPS loc. no. Mi 116 (Murata, 1964), Toya-zawa [Toyasawa], Kamishishiori [Shiraishi], Kesenuma City, Miyagi Prefecture. Stratigraphic unit: Shigeji-zawa Member, Kanokura Formation. Geologic age: Middle Permian.

***Aviculopecten hayasakai* Murata, 1964**

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 54, p. 219, pl.

34, fig. 4a, b. Holotype: IGPS no. 85737 (Missing). Type locality: IGPS loc. no. Mi 116 (Murata, 1964), Toya-zawa [Toyasawa], Kamishishiori [Shiraishi], Kesenuma City, Miyagi Prefecture. Stratigraphic unit: Shigeji-zawa Member, Kanokura Formation. Geologic age: Middle Permian.

***Aviculopecten minoensis* Hayasaka, 1925b**

Plate 5, Figure 19

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 8, no. 2, p. 5, pl. 8, fig. 1. Lectotype: IGPS no. 22412 (designated by Nakazawa, 1967; Existing). Type locality: Kinshōzan, Akasaka-machi, Province of Mino [currently Akasakacho, Ogaki City, Gifu Prefecture]. Lithostratigraphic unit: the *Fusulina* limestone [Akasaka Limestone]. Geologic age: Middle Permian. Remarks: The name of species was originally spelled as *minōensis*, and is corrected.

***Aviculopecten?* *onukii* Murata, 1969**

Plate 5, Figures 20a–b

Saito Ho-on Kai Mus. Res. Bull., no. 38, p. 17, pl. 3, figs. 1a–d, 2a, b. Holotype: IGPS no. 91380 (Existing). Type locality: Senmatsu, [Okago], Fujisawa-cho, Higashi-Iwai-gun [currently Fujisawacho, Ichinoseki City], Iwate Prefecture. Stratigraphic unit: Upper part of Toyoma Formation. Geologic age: Late Permian.

***Aviculopecten reticularis* Hayasaka, 1925b**

Plate 5, Figure 21

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 8, no. 2, p. 6, pl. 8, fig. 2. Holotype: IGPS no. 22227 (Existing). Type locality: Kinshōzan, Akasaka-machi, Province of Mino [currently Akasakacho, Ogaki City, Gifu Prefecture]. Lithostratigraphic unit: the *Fusulina* limestone [Akasaka Limestone]. Geologic age: Middle Permian.

***Aviculopecten sasakii* Murata, 1964**

Plate 5, Figures 22a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 54, p. 218, pl. 34, fig. 1a, b. Holotype: IGPS no. 85730 (Existing). Type locality: IGPS loc. no. Mi 117 (Murata, 1964), the upper course of the Shigeji-zawa, Kamiyasse, Kesenuma City, Miyagi Prefecture. Stratigraphic unit: Kanokura Formation. Geologic age: Middle Permian.

***Azorius philippianus* Kotaka and Noda, 1977**

Plate 5, Figure 23

Geol. Palaeont. Southeast Asia, vol. 18, p. 142, pl. 25, figs. 9, 10. Holotype: IGPS no. 95087 (Existing). Type locality: Road-side cliff, about 500 m S of Amuntay [Tagkawayan Municipality, Province of Quezon], western part of the Bondoc Peninsula, Philippines. Stratigraphic unit: "Gumaca Formation". Geologic age: Miocene.

***Barbatia (Acar) hayasakai* Noda, 1966a**

Plate 5, Figures 24a–b

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 67, pl. 4, figs. 10, 11. Holotype: IGPS no. 76249 (Existing). Ogasawara (2001) erroneously cited IGPS no. 76429 as the holotype. Type locality: Ogi, Nishikoshi-mura [currently Izumozaki-machi], Santo-gun, Niigata Prefecture. Stratigraphic unit: Funabashi Sandstone [=Haizume Formation]. Geologic age: Late Pliocene [Pleistocene].

***Barbatia kanezawaensis* Akutsu, 1964**

Plate 5, Figure 25

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 282, pl. 59, fig. 2. Holotype: IGPS no. 85501 (Existing). Type locality: About 1.8 km upstream from Kanezawa, the Fukasawa valley, Shiobara-machi, Shioya-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene].

***Barbatia (Acar) numaensis* Noda, 1966a**

Plate 5, Figures 26a–b

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 68, pl. 5, figs. 11–12. Holotype: IGPS no. 86137. (Existing) Type locality: Numa, Tateyama City, Chiba Prefecture. Stratigraphic unit: Numa Coral Bed. Geologic age: Holocene.

***Barbatia (Pugilarca) tsurushizakiensis* Noda, 1966a**

Plate 5, Figure 27

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 70, pl. 10, figs. 9, 10. Holotype: IGPS no. 17271 (Existing). Type locality: Sea cliff, Tsurushizaki [sic, Tsurushu-misaki], [Higashicho], Hitachi City, Ibaragi [sic, Ibaraki] Prefecture. Stratigraphic unit: Hatsuzaki Formation [=Hitachi Formation]. Geologic age: Pliocene [Early Pliocene].

***Barbatia (Barbatia) uetsukiensis* Hatai and Nisiyama, 1949**

Plate 5, Figure 28

Jour. Paleont., vol. 23, no. 1, p. 89, pl. 23, figs. 6, 7. Holotype: IGPS no. 72522 (Existing). Type locality: Road side cutting about 100 m NE of the shrine at Dainichi-saka, Uetsuki-mura [sic, Uetsuki-son] [currently Sho'o-cho], Katsuta-gun, Okayama Prefecture. Stratigraphic unit: Uetsuki Formation [=Yoshino Formation]. Geologic age: Miocene [latest Early Miocene].

***Barbatia (Pugilarca) yabei* Noda, 1966a**

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 1, p. 71, pl. 2, figs. 14, 15. Holotype: IGPS no. 25787 (Missing). Type locality: Sea cliff, Tsurushizaki [sic, Tsurushu-misaki], [Higashicho], Hitachi City, Ibaragi [sic, Ibaraki] Prefecture. Stratigraphic unit: Hatsuzaki Formation [=Hitachi

Formation]. Geologic age: Pliocene [Early Pliocene].

***Bassina (Callanatis) hayasakai* Kotaka, 1977**

Geol. Palaeont. Southeast Asia, vol. 18, p. 128, pl. 22, figs. 3–15. Holotype: IGPS no. 94933 (Missing). Type locality: Yuanli Shell Mound, near Miaoli, [currently Yuanli Township, Miaoli County], Taiwan. Geologic age: Holocene.

***Batissa nagaoi* Suzuki, 1941**

Plate 5, Figures 29a–b; Plate 6, Figure 1

Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2, vol. 6, no. 3, p. 46, text-figs. 1a–3b, pl. 1, figs. 1a–2. Holotype: IGPS no. 35777 (Existing). Type locality: Kakize Mine, Takashima, Takashima-machi [sic, Takashima-cho], Nishisonogi-gun [currently Takashimacho, Nagasaki City], Nagasaki Prefecture. Stratigraphic unit: Hashima Formation. Geologic age: Eocene [Middle Eocene]. Remarks: This species was proposed as nom. nov. for *Cyrena (Batissa) ponderosa* Nagao, 1928a, non *Cyrena ponderosa* Prime, 1860.

***Batissa taiwanensis* Nomura, 1933**

Plate 6, Figures 2a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 68, pl. 1, figs. 1a–d. Holotype: IGPS no. 45087 (Existing). Type locality: Sōkeishi, Kwanden-shō, Sobun-gun, Tainan-shū [currently Shuangsi, Daci Village, Kuantien District, Tainan City], Taiwan. Lithostratigraphic unit: Byōritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Brachidontes takiensis* Kamada, 1962**

Plate 6, Figure 3

Palaeont. Soc. Japan Spec. Pap., no. 8, p. 73, pl. 3, figs. 15, 16. Holotype: IGPS no. 79380 (Existing). Type locality: Sorida, Shimotaki, Tonomachi, Iwaki City, Fukushima Prefecture. Stratigraphic unit: Iwaki Formation. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene].

***Callista chinensis takagii* Masuda, 1955**

Plate 6, Figure 4

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 20, p. 121, pl. 19, fig. 7. Holotype: IGPS no. 90885 (formerly DGS no. 2501; Existing). Type locality: Tokunari, Machino-machi, Fugeshi-gun [currently Wajima City], Ishikawa Prefecture. Stratigraphic unit: Higashi-innai Formation. Geologic age: Miocene [latest Early Miocene].

***Callista pseudoplana* Yabe and Nagao, 1925**

Plate 6, Figure 5

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 7, no. 4, p. 120, pl. 28, figs. 9, 10, pl. 29, figs. 2, 4. Lectotype: IGPS

no. 8553 (designated by Ichikawa and Maeda, 1963; Existing). Type locality: The upper course of Ponnebetsu, a tributary of the Horomui, province of Ishikari [Manji, Kurisawacho, Iwamizawa City], Hokkaido. Stratigraphic unit: The *Trigonia* Sandstone [Middle Yezo Group in Manji area]. Geologic age: Cretaceous [Cenomanian–Turonian].

***Callista sekiyaensis* Akutsu, 1964**

Plate 6, Figure 6

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 285, pl. 59, figs. 8, 12. Syntypes: IGPS no. 85506 (Existing). Type locality: Cliff of the Hoki River, about 100 m down stream from Daikoku-iwa, Sekiya, Shiobara-machi, Shiota-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene].

***Cardiomya (Cardiomya) kotakai* Honda, 1989**

Plate 6, Figure 7

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 60, no. 1, p. 90, pl. 5, fig. 6. Holotype: IGPS no. 99278 (Existing). Type locality: NB-17 (Honda, 1989), riverside cliff along the lowerstream of the Sakudano-sawa, a tributary of the Chambetsu-gawa, Ombetsu-machi [*sic*, Ombetsu-cho], Shiranuka-gun [currently Onbetsu-cho, Kushiro City], Hokkaido. Stratigraphic unit: Nuibetsu Formation. Geologic age: Oligocene.

***Cardita katsumatai* Nagao, 1928b**

Plate 6, Figures 8a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 54, pl. 9, fig. 17. Holotype: IGPS no. 36331 (Existing). Type locality: Namazuta Mine near Iizuka-machi, Kaho-gun [currently Iizuka City], Province of Hizen [Fukuoka Prefecture]. Stratigraphic unit: Namazuta Fossil Bed [=Honso Formation]. Geologic age: Eocene.

***Cardita kondoi* Nagao, 1928b**

Plate 6, Figure 9

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 53, pl. 9, figs. 4–6. Holotype: IGPS no. 36407 (Existing). Type locality: Tokuman, Ōshima, Province of Hizen [currently Oshimacho, Saikai City, Nagasaki Prefecture]. Stratigraphic unit: Kakinoura Beds [Kakinoura Formation]. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene].

***Cardium (Acanthocardia) cancellatum* Nomura, 1933**

Plate 29, Figures 12a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 81, pl. 3, fig. 9a, b. Holotype: IGPS no. 46500 (Existing). Type locality: Station no. 14 (Nomura, 1933), exposure,

550 m SE of Jō-tsūshō-wan, Tsūshō-shō, Byōritsu-gun, Shinchiku-shū [currently Shangtongsiaowan, Tongwan Village, Tongsiao Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byōritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene]. Remarks: A new replacement name *Trifaricardium nomurai* Kuroda and Habe, 1951 was proposed for this species, as it is a primary junior homonym of *Cardium cancellatum* Gmelin, 1791.

***Cardium (Trachycardium) hanpeizanense* Nomura, 1933**

Plate 6, Figure 10

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 77, pl. 1, figs. 7a–8b, pl. 2, figs. 8, 9. Holotype: IGPS no. 37455 (Existing). Type locality: Hanpeizan, Okayama-gun, Takao-shū [currently Ban Pin Shan, Kaohsiung City], Taiwan. Lithostratigraphic unit: “Riukiu Limestone” [correlative of the Ryukyu Limestone]. Geologic age: Pleistocene.

***Cardium (Cerastoderma) hanzawai* Nomura, 1933**

Plate 6, Figures 11a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 79, pl. 3, figs. 18a–19b. Holotype: IGPS no. 46803 (Existing). Type locality: Station no. 25 (Nomura, 1933), exposure, 1,050 m E of Hakushaton, Kōryū-shō, Chikunan-gun, Shinchiku-shū [currently Baishaton, Tongsiao Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byōritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Cardium (Cerastoderma) hizenense* Nagao, 1928b**

Plate 6, Figure 12

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 61, pl. 10, figs. 15–17. Holotype: IGPS no. 36369 (Existing). Type locality: Iō-jima, off Nagasaki, [=Iōjima-mura, Nishisonogi-gun][currently Iōjimamachi, Nagasaki City], Province of Hizen [Nagasaki Prefecture]. Stratigraphic unit: Iō-jima Beds [=Funazu Formation]. Geologic age: Eocene [Late Eocene].

***Cardium (Trachycardium) infantile* Nomura and Zinbō, 1934**

Plate 6, Figures 13a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 2, p. 156 (48), pl. 5 (1), fig. 17a, b. Holotype: IGPS no. 50386 (Existing). Type locality: Plateaux area near Kamikatetu, Kikai-zima, [currently Kikai-cho, Oshima-gun], Kagoshima Prefecture. Lithostratigraphic unit: “Ryūkyū Limestone”. Geologic age: Pleistocene.

***Cardium ishidoense* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 6, Figure 14

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no.

2, p. 48, pl. 12, figs. 9, 16, 18. Lectotype: IGPS no. 22553 (designated by Hayami, 1965b; Existing). IGPS no. 22533 cited by Tanaka and Toshimitsu (2003) is incorrect. Type locality: Ishidô, near Ôhinata [currently Ishidô, Ôhinata, Sakuho-machi], Minamisaku-gun, Province of Shinano [Nagano Prefecture]. Stratigraphic unit: Ishidô Group [Ishidô Formation]. Geologic age: Cretaceous [Early Cretaceous].

***Cardium (Cerastoderma?) kishimaense* Nagao, 1928b**

Plate 6, Figures 15a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 63, pl. 10, figs. 23, 25, 25a–b. Holotype: IGPS no. 36367 (Existing). Type locality: Hanjô, Asahi-mura, Kishima-gun [currently Takeo City], Province of Hizen [Saga Prefecture]. Stratigraphic unit: Kishima Beds [Kishima Formation]. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene].

***Cardium miikense* Nagao, 1928a**

Plate 6, Figure 16

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 111, pl. 18, figs. 5, 5a–b. Lectotype: IGPS no. 35733 (designated by Hatai and Nisiyama, 1952; Existing). Type locality: Ôura [*sic*, Ôuramachi], Ômuta City, Fukuoka Prefecture. Stratigraphic unit: “Upper *Orthaulax japonicus* Zone” [=Nanaura Formation]. Geologic age: Eocene [Middle Eocene].

***Cardium (Nemocardium) torii* Nomura, 1933**

Plate 6, Figures 17a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 79, pl. 2, fig. 6a, b. Holotype: IGPS no. 49000 (Existing). Type locality: Fûsuirei, Station no. 26, Sachin-shô, Shinkwa-gun, Tainan-shû [currently Fengchuiling, Jhongjheng Village, Tsuochen Township], Taiwan. Lithostratigraphic unit: Byôritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Caryocorbula saikawai* Kotaka, 1955**

Plate 6, Figure 18

Saito Ho-on Kai Mus. Res. Bull., no. 24, p. 27, pl. 2, figs. 5, 6. Holotype: IGPS no. 74010 (Existing). Type locality: IGPS loc. no. Ao-15 (Kotaka, 1955), upper course of the Isomatsu-gawa, Wakimoto-mura, Kitatsugaru-gun [currently Wakimoto, Goshogawara City], Aomori Prefecture. Stratigraphic unit: Isomatsu Formation. Geologic age: Oligocene [Early Miocene]. Remarks: The present species is a junior synonym of *Nipponomarcia nakamurai* (Ikebe, 1941) (Matsubara, 1995).

***Chlamys (Chlamys) akutsui* Masuda, 1962a**

Plate 7, Figure 1

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 2, p. 160, pl. 18, fig. 29. Holotype: IGPS no. 28293 (Existing). Type locality: River cliff of the Naka-gawa, south of Ogawa-machi [currently Ogawa, Nakagawa-machi], Nasu-gun, Tochigi Prefecture. Stratigraphic unit: Ogane Formation. Geologic age: Middle Miocene [Late Miocene].

***Chlamys chinkopensis* Masuda and Sawada, 1961**

Plate 7, Figure 2

Japan. Jour. Geol. Geogr., vol. 32, no. 1, p. 21, pl. 4, figs. 6, 7. Holotype: IGPS no. 90595 (formerly DGS no. 3896; Existing). Ogasawara (2001) erroneously cited IGPS no. 90965 as the holotype. Type locality: Right river cliff of the Toshibetsu-gawa, about 1.5 km SE of Chinkope-toge, [=Hanaishi-toge], Imagane-machi [*sic*, Imakane-cho], Setana-gun, Shiribeshi Province, Hokkaido. Stratigraphic unit: Setana Formation. Geologic age: Pliocene [Early Pleistocene].

***Chlamys cosibensis hanzawae* Masuda, 1959**

Plate 7, Figure 3

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 35, p. 125, pl. 13, figs. 10a–15. Holotype: IGPS no. 90648 (formerly DGS no. 3690; Existing). Type locality: Ukibuta, Higashiyuri-mura, Yuri-gun [currently Oikata, Higashiyuri, Yurihonjô City], Akita Prefecture. Stratigraphic unit: Sugota Formation. Geologic age: Early Miocene [early Middle Miocene].

***Chlamys daishakaensis* Masuda and Sawada, 1961**

Plate 7, Figure 4

Japan. Jour. Geol. Geogr., vol. 32, no. 1, p. 23, pl. 4, figs. 8, 9. Holotype: IGPS no. 90708 (formerly DGS no. 3880; Existing). Type locality: Right stream cliff, about 2.3 km N of Daishaka Station along the Ou Line, Namioka-machi, Minamitsugaru-gun [currently Namioka, Aomori City], Aomori Prefecture. Stratigraphic unit: Daishaka Formation. Geologic age: Pliocene [Early Pleistocene]. Remarks: This species is a junior synonym of *Chlamys (Leochlamys) tanassevitschi* (Khomenko, 1934) (Amano, 1994).

***Chlamys (Chlamys) hanaishiensis* Masuda, 1962a**

Plate 7, Figure 5

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 2, p. 166, pl. 22, figs. 1, 2. Holotype: IGPS no. 90565 (formerly DGS no. 3935; Existing). Type locality: Left floor of the Toshibetsu River, about 1 km SW of Pirika Station of the Setana Line, Imagane-machi [*sic*, Imakane-cho], Setana-gun, Shiribeshi Province, Hokkaido. Stratigraphic unit: Setana Formation. Geologic age: Early Pliocene [Early Pleistocene].

***Chlamys (Chlamys) hasimotoi* Masuda, 1962a**

Plate 7, Figure 6

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 2, p. 167, pl. 19, figs. 1, 2. Holotype: IGPS no. 90527 (formerly DGS no. 3867; Existing). IGPS no. 90600 cited as the holotype by Ogasawara (2001) is the paratype. Type locality: Natsukawa-en [=Honbetsu Koen], upstream of the Honbetsu River [Higashihonbetsu], Honbetsu-machi [*sic*, Honbetsu-cho], Nakagawa-gun, Tokachi Province, Hokkaido. Stratigraphic unit: Rawan Conglomerate of Okuashiyoro Formation [=Honbetsu Formation]. Geologic age: Early Pliocene.

***Chlamys hataii* Masuda and Akutsu, 1956**

Plate 7, Figure 7

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 21, p. 130, pl. 20, figs. 1a–6b. Holotype: IGPS no. 90726 (formerly DGS no. 1370; Existing). Type locality: Niiya, Tawara, Kawachi-mura, Kawachi-gun [currently Ishii machi, Utsunomiya City], Tochigi Prefecture. Stratigraphic unit: Nagaoka Formation. Geologic age: Early Miocene [early Middle Miocene]. Remarks: The present species is synonymous with *Chlamys (Nomurachlamys) meisensis* (Makiyama, 1926) (Kurihara, 2010).

***Chlamys (Chlamys) hatakeyamae* Masuda, 1962a**

Plate 7, Figure 8

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 2, p. 168, pl. 18, figs. 18–20. Holotype: IGPS no. 27563 (Existing). Type locality: Ikatsuchi-zawa at Kanayama, Higashi-Takizawa, Yuri-mura, Yuri-gun [currently Ikazuchi, Yurionjō City] Akita Prefecture. Stratigraphic unit: Sugota Formation. Geologic age: Early Miocene [Middle Miocene].

***Chlamys imanishii* Masuda and Sawada, 1961**

Plate 7, Figures 9a–b

Japan. Jour. Geol. Geogr., vol. 32, no. 1, p. 25, pl. 4, figs. 10a–11. Holotype: IGPS no. 72555 (Existing). Type locality: Sea cliff at Hamada, Yokohama-machi, Kamikita-gun, Aomori Prefecture. Stratigraphic unit: Hamada Formation. Geologic age: Early Pliocene [Early Pleistocene].

***Chlamys (Chlamys) ishidae* Masuda, 1962a**

Plate 7, Figure 10

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 2, p. 171, pl. 18, figs. 21–24. Holotype: IGPS no. 90676 (formerly DGS no. 3909; Existing). Type locality: Left cliff of the Do River, Tsuzara, Osawano-machi, Kaminikawa-gun [*sic*, Kaminiikawa-gun] [currently Tsuzuhara, Toyama City], Toyama Prefecture. Stratigraphic unit: Kashio Alternation of Kurosedani Formation. Geologic age: Early Miocene [latest Early Miocene].

***Chlamys (Chlamys) itoigawae* Masuda, 1962a**

Plate 7, Figure 11

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 2, p. 172, pl. 18, figs. 25, 26. Holotype: IGPS no. 90538 (formerly DGS no. 3819; Existing). Type locality: Floor of the Toki River, about 300 m upstream of the Relay Station of Wireless Telegraph at Kamado [Kamadocho], Mizunami City, Gifu Prefecture. Stratigraphic unit: Shukunohora Formation. Geologic age: Early Miocene [latest Early–earliest Middle Miocene].

***Chlamys kitamurai* Kotaka, 1955**

Plate 7, Figure 12

Saito Ho-on Kai Mus. Res. Bull., no. 24, p. 26, pl. 2, fig. 2. Holotype: IGPS no. 74009 (only a plastic cast is existing). Type locality: IGPS loc. no. Ao-15 (Kotaka, 1955), upper course of the Isomatsu-gawa, Wakimoto-mura, Kitatsugaru-gun [currently Wakimoto, Goshogawara City], Aomori Prefecture. Stratigraphic unit: Isomatsu Formation. Geologic age: Oligocene [late Early Miocene].

***Chlamys (Chlamys) kotakae* Masuda, 1962a**

Plate 8, Figure 1

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 2, p. 175, pl. 20, figs. 8, 9. Holotype: IGPS no. 90646 (formerly DGS no. 3832; Existing). Type locality: Cliff of the left side valley of Kamifutamata-zawa, upper course of Biu River, about 5.5 km NE of Biu, Niikappu-machi [*sic*, Niikappu-cho], Niikappu-gun, Hidaka Province, Hokkaido. Stratigraphic unit: Noya Formation. Geologic age: Early Miocene.

***Chlamys kumanodoensis* Masuda, 1953a**

Plate 8, Figure 2

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 12, p. 85, pl. 8, figs. 9a–12b. Holotype: IGPS no. 90522 (formerly DGS no. 1049; Existing). Type locality: Hill side about 500 m W of the Kumano Shrine, Kumanodō, Takadate-mura, Natori-gun, [currently Takadate, Natori City], Miyagi Prefecture. Stratigraphic unit: Moniwa Formation. Geologic age: Early Miocene [early Middle Miocene].

***Chlamys (Chlamys) matsunoi* Masuda, 1962a**

Plate 8, Figure 3

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 2, p. 176, pl. 19, fig. 20, pl. 21, figs. 2–4. Holotype: IGPS no. 90627 (formerly DGS no. 3831; Existing). Type locality: Cliff of the left side valley of Kamifutamata-zawa, upper course of Biu River, about 5.5 km NE of Biu, Niikappu-machi [*sic*, Niikappu-cho], Niikappu-gun, Hidaka Province, Hokkaido. Stratigraphic unit: Noya Formation. Geologic age: Early Miocene.

***Chlamys (Chlamys) nagaoi* Masuda, 1962a**

Plate 8, Figure 4

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 2, p. 179, pl. 20, figs. 4–6. Holotype: IGPS no. 36440 (Existing). Type locality: Beach, west of the Hachiman-zaki [*sic*, Yahata-misaki], about 300 m N of Wakita [*sic*, Waita], Wakamatsu City [currently An'ya, Wakamatsu-ku, Kitakyushu City], Fukuoka Prefecture. Stratigraphic unit: Wakita [*sic*, Waita] Formation. Geologic age: Late Oligocene.

***Chlamys (Chlamys) niikappuensis* Masuda, 1962a**

Plate 8, Figure 5

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 2, p. 180, pl. 21, fig. 5. Holotype: IGPS no. 90536 (formerly DGS no. 3835; Existing). Type locality: Cliff of the left side valley of the Kamifutamata-zawa, upper course of the Biu River, about 5.5 km NE of Biu, Niikappu-machi [*sic*, Niikappu-cho], Niikappu-gun, Hidaka Province, Hokkaido. Stratigraphic unit: Noya Formation. Geologic age: Early Miocene.

***Chlamys oidensis* Hatai, Masuda and Noda, 1974**

Plate 8, Figures 6a–b

Saito Ho-on Kai Mus. Res. Bull., no. 43, p. 36, pl. 4, figs. 1a–2. Holotype: IGPS no. 64419 (Existing). Type locality: Oido, Motowakuya, Wakuya-machi, Toda-gun, Miyagi Prefecture. Stratigraphic unit: Oido Formation. Geologic age: Early Miocene [Middle Miocene]. Remarks: The present species is a junior synonym of *Chlamys (Leochlamys) arakawai* (Nomura, 1935b) (Matsubara, in Matsubara *et al.*, 2014).

***Chlamys otukae* Masuda and Sawada, 1961**

Plate 8, Figures 7a–b

Japan. Jour. Geol. Geogr., vol. 32, no. 1, p. 19, pl. 4, figs. 1a–5. Holotype: IGPS no. 90607 (formerly DGS no. 2616; Existing). Type locality: Road-side exposure at Oido, Motowakuya [currently Kozuka], Wakuya-machi [*sic*, Wakuya-cho], Tōda-gun, Miyagi Prefecture. Stratigraphic unit: Oido Formation. Stratigraphic unit: Oido Formation. Geologic age: Early Miocene [Middle Miocene].

***Chlamys (Chlamys) setsukoeae* Masuda, 1962b**

Plate 8, Figures 8a–b

Saito Ho-on Kai Mus. Res. Bull., no. 31, p. 20, pl. 1, figs. 1a–8, pl. 2, figs. 6–8. Holotype: IGPS no. 90477 (formerly DGS no. 4230; Existing). Type locality: Road-side cutting, about 900 m WSW of the Ken'yoshi Station of the Tohoku Main Line, Ken'yoshi, Nagawa-machi [currently Nanbu-cho], Sannohe-gun, Aomori Prefecture. Stratigraphic unit: Togawa Formation. Geologic age: Early Pliocene.

***Chlamys shitakaraensis* Honda, 1980**

Plate 8, Figures 9a–c

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 117, p. 258, pl. 30, figs. 1, 2, 5, 6. Holotype: IGPS no. 95439 (Existing). Type locality: Loc. B-06 (Honda, 1980), a small northeastern tributary of the Urahoro-gawa, about 3.8 km N of Rushin, Urahoro-machi [*sic*, Urahoro-cho], Tokachi-gun, Hokkaido. Stratigraphic unit: Shitakara Formation. Geologic age: Oligocene [Middle–Late Eocene].

***Chlamys tamurae* Masuda and Sawada, 1961**

Plate 8, Figure 10

Japan. Jour. Geol. Geogr., vol. 32, no. 1, p. 27, pl. 4, figs. 12a–15. Holotype: IGPS no. 90550 (formerly DGS no. 3862; Existing). Type locality: Small hill-side exposure at Maruyama [Shinsei], Kitahiyama-machi [*sic*, Kitahiyama-cho], Setana-gun [currently Kitahiyama-ku, Setana-cho, Kudo-gun], Shiribeshi Province, Hokkaido. Stratigraphic unit: Setana Formation. Geologic age: Pliocene [Early Pleistocene].

***Circe (Circe) triangulus* Kotaka and Noda, 1977**

Plate 8, Figure 11

Geol. Palaeont. Southeast Asia, vol. 18, p. 137, pl. 25, figs. 5, 6, text-fig. 2-2. Holotype: IGPS no. 95085 (Existing). Type locality: Road-side cliff, about 500 m S of Amuntay, [Tagkawayan Municipality, Province of Quezon], western part of the Bondoc Peninsula, Philippines. Stratigraphic unit: "Gumaca Formation". Geologic age: Miocene.

***Clementia japonica* Masuda, 1955**

Plate 8, Figure 12

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 20, p. 121, pl. 19, fig. 8. Holotype: IGPS no. 90405 (formerly DGS no. 1382; Existing). Although Ogasawara (2001) stated IGPS no. 90880 as the holotype, it is a paratype. Type locality: Tokunari, Machino-machi, Fugeshi-gun [currently Wajima City], Ishikawa Prefecture. Stratigraphic unit: Higashi-innai Formation. Geologic age: Miocene [latest Early Miocene].

***Clementia (Clementia) nakosoensis* Kamada, 1962**

Plate 8, Figures 13a–b

Palaeont. Soc. Japan Spec. Pap., no. 8, p. 119, pl. 13, figs. 15a, b. Holotype: IGPS no. 79385 (Existing). Type locality: Kokozura, Nakoso City [currently Nakosomachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Kokozura Formation. Geologic age: Miocene [latest Early Miocene].

***Clinocardium asagaiense arakawae* Kamada, 1962**

Plate 9, Figures 1a–b

Palaeont. Soc. Japan Spec. Pap., no. 8, p. 105, pl. 10, figs. 15–17. Holotype: IGPS no. 79383 (Existing). Type

locality: Mukaida, Yumoto-machi, Joban City [currently Joban-Yumotomachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Asagai Formation. Geologic age: Oligocene [Early Oligocene].

***Clinocardium asagaiense makiyamae* Kamada, 1962**

Plate 9, Figures 2a–b

Palaeont. Soc. Japan Spec. Pap., no. 8, p. 104, pl. 10, figs. 18–21. Holotype: IGPS no. 15800 (Existing). Type locality: Nabezuka [*sic*, Nabetsuka], [Kamikitaba], Hirano-machi, Futaba-gun, Fukushima Prefecture. Stratigraphic unit: Asagai Formation. Geologic age: Oligocene [Early Oligocene].

***Clinocardium chikagawaense* Kotaka, 1950**

Plate 9, Figures 3a–b

Short Pap. Inst. Geol. Paleont., Tôhoku Univ., no. 2, p. 46, pl. 5, figs. 1–6. Holotype: IGPS no. 72999 (Existing). Type locality: IGPS loc. no. Ao-51 (Kotaka, 1950), a sea cliff at the outlet of the Chikagawa River at Chikagawa, Tanabumachi, Shimokita-gun [currently Okunai, Mutsu City], Aomori Prefecture. Stratigraphic unit: Hamada Formation. Geologic age: Pliocene [Early Pleistocene].

***Clinocardium hataii* Hayasaka, 1956**

Plate 9, Figure 4

Saito Ho-on Kai Mus. Res. Bull., no. 25, p. 18, pl. 2, fig. 3a, b. Holotype: IGPS no. 77375 (Existing). Type locality: Loc. No. 1 (Hayasaka, 1956), cliff of the Takasegawa River west of Takakura, [Ide], about 5 km SW of the Namie-machi Railroad station on the Joban Line, Namie-machi, Futaba-gun, Fukushima Prefecture. Stratigraphic unit: Ishiguma Formation. Geologic age: Pliocene.

"*Clinocardium*" *nomurai* Hayasaka, 1956

Plate 9, Figure 5

Saito Ho-on Kai Mus. Res. Bull., no. 25, p. 18, pl. 2, fig. 4a, b. Holotype: IGPS no. 77376 (Existing). Type locality: Loc. 2 (Hayasaka, 1956), path side cutting at Onoda, Namie-machi, Futaba-gun, Fukushima Prefecture. Stratigraphic unit: Ishiguma Formation. Geologic age: Pliocene.

***Clinocardium omagariense* Honda, 1981b**

Plate 9, Figures 6a–c

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 122, p. 130, pl. 15, figs. 1–13. Holotype: IGPS no. 95740-1 (Existing). Type locality: Loc. no. OM-32 (Honda, 1981b), riverside cliff along the Urahorogawa, about 1,250 m NNE from the junction between the Urahorogawa and the Tokomurogawa, Urahoromachi [*sic*, Urahorochô], Tokachi-gun, Hokkaido. Stratigraphic unit: Omagari Formation. Geologic age: Oligocene.

***Codakia kitamurai* Hatai and Nisiyama, 1949**

Plate 9, Figure 7

Jour. Paleont., vol. 23, no. 1, p. 91, pl. 24, figs. 5, 6. Holotype: IGPS no. 72526 (Existing). Type locality: Shukunohora, Hiyoshi-mura, Toki-gun [currently Hiyoshicho, Mizunami City], Gifu Prefecture. Stratigraphic unit: Hiyoshi Formation [=Shukunohora Member of Akeyo Formation]. Geologic age: Miocene [latest Early–earliest Middle Miocene].

***Codakia (Jagonia) okinawazimana* Nomura and Zinbô, 1936**

Plate 9, Figures 8a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 18, no. 3, p. 241, pl. 11, figs. 9a–b. Holotype: IGPS no. 51319 (Existing). Type locality: Gabusoga, Haneji-mura, Kunigami-gun [currently Nago City], Okinawa Prefecture. Stratigraphic unit: Simaziri Beds [=Haneji Formation]. Geologic age: Early Pliocene [Early Pleistocene].

***Codakia semipolita* Nomura, 1933**

Plate 9, Figures 9a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 73, pl. 1, figs. 9a–10b. Holotype: IGPS no. 45086 (Existing). Type locality: The upper course of Sairyôkyô, Sachin-shô, Shinkawa-gun, Tainan-shû [currently Yseiliao Bridge, Yseiliao, Ronghe Village, Tsuochen District, Tainan City], Taiwan. Lithostratigraphic unit: Byôritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Conularia rectangularis* Hayasaka, 1920**

Plate 9, Figures 10a–c

Jour. Geol. Soc. Japan, vol. 27, no. 327, p. 87, text-figs. 1–3. Lectotype: IGPS no. 7320 (designated by Sugiyama, 1942; Existing). Type locality: Iimô, Yahagimura, Kesen-gôri, prov. Rikuchyû [*sic*, Rikuzen] [currently Imo, Yahagicho, Rikuzentakata City, Iwate Prefecture]. Stratigraphic unit: Lower part of Kanokura Formation. Geologic age: Middle Permian. Remarks: This species was originally thought a conulariid (Cnidaria), and a genus *Neoconularia* Sugiyama, 1942 was proposed with *Conularia rectangularis* Hayasaka, 1920 as the type species. However, it is referable to *Aviculopinna* Meek, 1864, and thus *Neoconularia* Sugiyama, 1942 is a junior synonym of *Aviculopinna* (Nakazawa and Newell, 1968; Hayami and Kase, 1977).

***Corbicula (Corbicula) kotakai* Honda, 1981a**

Plate 9, Figures 11a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 121, p. 22, pl. 2, figs. 6, 9, 10, 13–17. Holotype: IGPS no. 96758 (Existing). Type locality: Loc. no. YB-10 (Honda, 1981a), river side cliff along the Rubeshube-zawa, a tributary

of the Chokubetsu-gawa, Urahoro-machi [*sic*, Urahoro-cho], Tokachi-gun, Hokkaido. Stratigraphic unit: Yubetsu Formation. Geologic age: Oligocene [Middle Eocene].

***Corbicula (Veloritina?) sanchuensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 9, Figures 12–15

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 53, pl. 12, figs. 8, 8a, pl. 13, figs. 8–10, 17, 17a. Syntypes: IGPS nos. 22449, 22467 (Existing). Type locality: Bōmeki-zawa, Ōhinata[-mura], [currently Ōhinata, Sakuho-machi], Minamisaku-gun, Province of Shinano [Nagano Prefecture]. Stratigraphic unit: Shiroy Group [Shiroy Formation]. Geologic age: Cretaceous [Early Cretaceous].

***Corbicula (Corbicula) sachalinensis* Suzuki, 1943**

Plate 9, Figures 16a–b

Venus, vol. 12, nos. 3–4, p. 163–165 (in Japanese), p. 167–169 (in Germany), pl. 8, figs. 1–3, 5, 6. Holotype: IGPS no. 8353c (Existing). Type locality: Mittellauf des Tuimis, Nord-Sachalin, USSR [currently Middle reaches of T'yam River in Tymovskoe or Nogliki District, Sakhalin Oblast, Russia (precise locality unknown)]. Stratigraphic unit: Mäch-Gruppe. Geologic age: earliest Miocene (Aquitania).

***Corbicula (Corbicula) shimizui* Suzuki, 1943**

Plate 9, Figures 17a–b

Venus, vol. 12, nos. 3–4, p. 161–162 (in Japanese), p. 166–167 (in Germany), pl. 7, pl. 8, figs. 4, 7. Holotype: IGPS no. 8353a (Existing). Type locality: Mittellauf des Tuimis, Nord-Sachalin, USSR [currently Middle reaches of T'yam River in Tymovskoe or Nogliki District, Sakhalin Oblast, Russia (precise locality unknown)]. Stratigraphic unit: Mäch-Gruppe. Geologic age: earliest Miocene (Aquitania).

***Corbicula takasago* Nomura, 1933**

Plate 9, Figure 18

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 69, pl. 2, figs. 1a–2b. Holotype: IGPS no. 45079 (Existing). Type locality: Station no. 34 (Nomura, 1933), Wangwa, Kōryū-shō, Chikunan-gun, Shinchiku-shū [currently Wanwa, Jhonghe Village, Houlong Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byōritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Corbula (Cunaecorbula) kyushuensis* Nagao, 1928a**

Plate 9, Figure 19

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 116, pl. 21, fig. 16. Lectotype: IGPS no. 35834 (designated by Hatai and Nisiyama, 1952; Existing). Type

locality: Akase, Ōda-mura, Uto-gun, Province of Higo [currently Akasemachi, Uto City, Kumamoto Prefecture]. Stratigraphic unit: “Lower *Orthaulax japonicus* Zone” [=Fukuregi Formation]. Geologic age: Eocene [early Middle Eocene].

***Corbula (Corbula) subtumida* Nagao, 1928a**

Plate 9, Figure 20

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 115, pl. 22, fig. 6. Lectotype: IGPS no. 35828 (designated by Hatai and Nisiyama, 1952; Existing). Type locality: Takesaki, Kōyagi-jima, [Koyagi-mura], Nishisonogi-gun, [currently Koyagimachi, Nagasaki City], Province of Hizen [Nagasaki Prefecture]. Stratigraphic unit: “Lower *Orthaulax japonicus* Zone” [=Futagojima Formation]. Geologic age: Eocene [Middle Eocene].

***Corbula (Corbula) taiwanensis* Nomura, 1933**

Plate 9, Figures 21a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 106, pl. 3, figs. 10a–11b. Holotype: IGPS no. 48966 (Existing). Type locality: Station no. 18 (Nomura, 1933), Wangwa, Kōryū-shō, Chikunan-gun, Shinchiku-shū [currently Wanwa, Jhonghe Village, Houlong Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byōritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Crassatellites asakuraensis* Nagao, 1928b**

Plate 9, Figure 22

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 49, pl. 2, fig. 22. Holotype: IGPS no. 36258 (Existing). Type locality: Hōshuyama Mine, Hōshuyama-mura [currently Tōhō-mura], Asakura-gun, Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Doshi Beds [Doshiyama Formation]. Geologic age: Eocene [Late Eocene].

***Crassatellites formosanus* Nomura, 1933**

Plate 9, Figure 23

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 66, pl. 1, figs. 14, 15. Holotype: IGPS no. 37441 (Existing). Type locality: About 1,500 m NNW of the Police station of Shinsui, Ensō-shō, Okayama-gun, Takao-shū [currently Shengshui, Shengshui Village, Yangchao District, Kaohsiung City], Taiwan. Lithostratigraphic unit: Byōritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Crassatellites inconspicuus* Nagao, 1928b**

Plate 10, Figures 1a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 50, pl. 2, figs. 14, 14a. Holotype: IGPS no. 36308 (Existing). Type locality: Tokuman, Ōshima, [Kurose-mura, Nishisonogi-gun], Province of Hizen [currently Oshimacho,

Saikai City, Nagasaki Prefecture]. Stratigraphic unit: Kakinoura Beds [Kakinoura Formation]. Geologic age: Oligocene [latest Eocene–earliest Oligocene].

***Crassatellites matsuraensis* Nagao, 1928b**

Plate 10, Figures 2a–c

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 50, pl. 3, figs. 20, 20a. Holotype: IGPS no. 36310 (Existing). Type locality: Ôbô, near Arita-machi [currently Arita-cho], Nishimatsura-gun [*sic*, Nishimatsuura-gun], Province of Hizen [Saga Prefecture]. Stratigraphic unit: Kishima Beds [Kishima Formation]. Geologic age: Oligocene [latest Eocene–earliest Oligocene].

***Crassatellites tosanus* Nomura, 1937**

Plate 10, Figures 3a–b

Japan. Jour. Geol. Geogr., vol. 14, nos. 3–4, p. 81, pl. 6, fig. 8a, b. Lectotype: IGPS no. 54638 (designated by Hatai and Nisiyama, 1952; Existing). Type locality: Tônohama, Yasuda-mura [*sic*, Yasuda-cho], Aki-gun, Kôti [=Kochi] Prefecture. Stratigraphic unit: Tosa Pliocene [=Ananai Formation]. Geologic age: Pliocene [latest Late Pliocene–early Early Pleistocene].

***Crassatellites yabei* Nagao, 1928b**

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 48, pl. 2, figs. 19, 19a, b. Holotype: IGPS no. 36388 (Missing). Type locality: Iwaya, Shimagô-mura, [Onga-gun] Province of Hizen [currently Arige, Wakamatsu-ku, Kitakyushu City, Fukuoka Prefecture]. Stratigraphic unit: Wakita Beds [=Waita Formation]. Geologic age: Oligocene.

***Crassostrea gravitesta eoilensis* Kim, Noda and Yoon, 1974**

Plate 10, Figures 4a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 93, p. 274, pl. 38, fig. 15, pl. 39, fig. 1a–c. Holotype: IGPS no. 92938 (Existing). Type locality: Loc. no. 1-1 (Kim *et al.*, 1974), S of Songjeon-ri, Yangbug-myeon, Weolseong-gun [currently Gyeongju City], Gyeongsangbuk-do, Korea. Stratigraphic unit: Eoil Formation. Geologic age: Miocene [latest Early–earliest Middle Miocene]. Remarks: This “subspecies” is thought an ecophenotype of *Crassostrea gravitesta* (Yokoyama, 1926) (Matsubara *et al.*, 2011).

***Crassostrea sunakozakaensis* Ogasawara, 1976**

Plate 10, Figures 5a–b

Sci. Rep. Tôhoku Univ., 2nd Ser. (Geol.), vol. 46, no. 2, p. 45, pl. 11, figs. 19–21, pl. 12, figs. 15, 20. Holotype: IGPS no. 95018 (Existing). Type locality: Loc. no. Su-01 (Ogasawara, 1976), river side cliff of Asano-gawa at Higashi-Ichise [*sic*, Higashi-ichinosemachi], Kanazawa

City, Ishikawa Prefecture. Stratigraphic unit: Sunakozaka Formation. Geologic age: Miocene [latest Early Miocene].

***Crenella (Megacrenella) nuibetsuensis* Honda, 1989**

Plate 10, Figure 6

Sci. Rep. Tôhoku Univ., 2nd Ser. (Geol.), vol. 60, no. 1, p. 60, pl. 4, figs. 4, 17. Holotype: IGPS no. 97096 (Existing). Type locality: Loc. NB-08 (Honda, 1989), Muri-kawa, Ombetsu-machi [*sic*, Ombetsu-cho], Shiranuka-gun [currently Onbetsu-cho, Kushiro City], Hokkaido. Stratigraphic unit: Nuibetsu Formation. Geologic age: Oligocene.

***Crenella (Megacrenella) shitakaraensis* Honda, 1989**

Plate 10, Figure 7

Sci. Rep. Tôhoku Univ., 2nd Ser. (Geol.), vol. 60, no. 1, p. 61, pl. 4, fig. 18. Holotype: IGPS no. 97111 (Existing). Type locality: Loc. SK-46 (Honda, 1989), upstream of Chokubetsu-gawa, Urahoro-machi [*sic*, Urahoro-cho], Tokachi-gun, Hokkaido. Stratigraphic unit: Shitakara Formation. Geologic age: Oligocene [Middle–Late Eocene].

***Crenella striatocostata* Nagao, 1928b**

Plate 10, Figure 8

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 46, pl. 6, figs. 20, 21. Holotype: IGPS no. 36291 (Existing). Type locality: Kojôbaru, Hôshuyama-mura, Province of Chikuzen [currently Tôhō-mura, Asakura-gun, Fukuoka Prefecture]. Stratigraphic unit: Kawamagari Beds [Kawamagari Formation]. Geologic age: Eocene [Middle Eocene].

***Crenella subfornicata* Nagao, 1928b**

Plate 10, Figures 9a–c

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 46, pl. 5, figs. 8–9b. Holotype: IGPS no. 36288 (Existing). Type locality: Taya, [Yamaga], Ashiya-machi, Onga-gun, Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Yamaga Beds [Yamaga Formation]. Geologic age: Oligocene.

***Crenella tomiyaensis* Hatai and Nakamura, 1940**

Plate 10, Figure 10

Bull. Biogeogr. Soc. Japan, vol. 10, no. 7, p. 113, fig. 1. Holotype: IGPS no. 61354 (Existing). Type locality: Tomiya, Tomiya-mura [currently Tomiya-machi], Kurokawa-gun, Miyagi Prefecture. Stratigraphic unit: Nanakita Beds [Nanakita Formation]. Geologic age: Miocene [late Late Miocene].

***Crenipecten kesenensis* Hayasaka, 1925b**

Plate 10, Figure 11

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 8, no. 2, p. 11, pl. 8, figs. 8, 8a. Holotype: IGPS no. 22383

(Existing). Type locality: Imô, [Yahagi-mura], Kesen-gôri, prov. Rikuzen [currently Imo, Yahagi-cho, Rikuzentakata City, Iwate Prefecture]. Stratigraphic unit: Kanokura Formation. Geologic age: Middle Permian. Remarks: The name of genus was originally spelled as *Cenipecten*, and is corrected.

***Ctena hataii* Masuda, 1966b**

Plate 10, Figures 12a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 64, p. 325, pl. 35, figs. 15–20. Holotype: IGPS no. 90729 (formerly DGS no. 4524; Existing). IGPS no. 90865 (=formerly DGS no. 4523) cited as the holotype by Ogasawara (2001) is the paratype. Type locality: Loc. No. 30 (Masuda, 1966a), road side cutting near Koeiji Temple, Otani [sic, Otanimachi], Suzu City, Ishikawa Prefecture. Stratigraphic unit: Higashi-innai Formation. Geologic age: Miocene [latest Early Miocene].

***Ctenodonta manchuriensis* Endo, 1935**

Plate 10, Figures 13a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 4, p. 197, pl. 14, figs. 7–8. Holotype: IGPS no. 55582 (Existing). Type locality: In the black banded limestone at the northern foot of San-len hill, near the Wu-hu-tsui colliery, [Fuzhou County, Fengtian Province], Liaotung, Manchoukuo [currently Wafangdian, Dalian City, Liaoning Province, China]. Stratigraphic unit: Kangyao Formation. Geologic age: Early Ordovician.

***Ctenodonta takahashii* Endo, 1935**

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 4, p. 196, pl. 14, figs. 1–6. Syntype: IGPS no. unknown (Missing). Type locality: In the black banded limestone at the northern foot of San-leng hill, near the Wu-hu-tsui colliery, [Fuzhou County, Fengtian Province], Liaotung, Manchuokuo [currently Wafangdian, Dalian City, Liaoning Province, China]. Stratigraphic unit: Kangyao Formation. Geologic age: Early Ordovician.

***Cucullaea delicatostriata* Yabe and Nagao, 1925**

Plate 10, Figure 14

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 7, no. 4, p. 113, pl. 28, fig. 1. Lectotype: IGPS no. 8555 (designated by Hayami, 1975; Existing). Type locality: The Cape Khoi Bed, exposed along the sea-cliff 1 km S of Cape Khoi, near Alexandrovsk, north Sakhalin [currently Alexandrovsk-Sakhalinsky District, Sakhalin Oblast, Russia]. Stratigraphic unit: Werblud Group ("Cape Khoi beds") in Alexandrovsk area. Geologic age: Cenomanian–Turonian, Cretaceous.

***Cucullaea ezoensis* Yabe and Nagao, 1928**

Plate 10, Figure 15

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 81, pl. 16, figs. 1–3. Syntypes: IGPS nos. 22601, 22611 (Existing). Type locality: Futamatano-sawa, Miruto, [Kurisawa-mura], Sorachi-gun, province of Ishikari [currently Kurisawacho, Iwamizawa City, Hokkaido]. Stratigraphic unit: Mikasa Formation. Geologic age: Cenomanian–Turonian, Cretaceous.

***Cucullaea iriomotensis* Masuda and Sato, 1988**

Saito Ho-on Kai Spec. Pub., no. 2 (Prof. T. Kotaka Commem. Vol.), p. 442, pl. 1, figs. 3–7. Holotype: IGPS no. 99713 (Missing). Type locality: Sea cliff at Nishizaki, about 1 km NW of Nakano, Taketomi-cho, Iriomote-jima, [Yaeyama-gun], Okinawa Prefecture. Stratigraphic unit: Iriomote Formation. Geologic age: early Middle Miocene [latest Early–earliest Middle Miocene].

***Cucullaea nipponica* Nagao, 1928b**

Plate 11, Figures 1a–c

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 25, pl. 6, figs. 1, 1a, b. Holotype: IGPS no. 35999 (Existing). Type locality: Western sea cliff, about 400 m W of the primary school at Ipponmatsu, Iô-jima, Iô-jima-mura, Nishisonogi-gun [currently Nagasaki City], Nagasaki Prefecture. Stratigraphic unit: Funatsu Formation. Geologic age: Eocene [Late Eocene].

***Cultellus? brevis* Nagao, 1928a**

Plate 11, Figure 2

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 114, pl. 22, fig. 1. Holotype: IGPS no. 35788 (Existing). Type locality: Koyagi-jima, [Koyagi-mura], Nishisonogi-gun, Province of Hizen [currently Koyagimachi, Nagasaki City, Nagasaki Prefecture]. Stratigraphic unit: "Upper *Orthaulax japonicus* Zone" [=Futagojima Formation]. Geologic age: Eocene [early Middle Eocene].

***Cultellus? leguminoides* Nagao, 1928b**

Plate 11, Figure 3

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 84, pl. 4, fig. 21. Holotype: IGPS no. 36447 (Existing). Type locality: Iô-jima, off Nagasaki [Iojima-mura], Nishisonogi-gun [currently Iojimamachi, Nagasaki City], Province of Hizen [Nagasaki Prefecture]. Stratigraphic unit: Iôjima Beds [Funatsu Formation]. Geologic age: Eocene [Late Eocene].

***Cyclina (Cyclina) asagaiensis* Kamada, 1952**

Plate 11, Figures 4a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 6, p. 169,

pl. 15, fig. 3a–c. Holotype: IGPS no. 72955 (Existing). Type locality: IGPS loc. no. Fs-11, in the Ômachi abandoned shaft of the Joban Coal Mining Co., N of Takasaka, Uchigô-machi, Iwaki-gun [currently Uchigotakasakamachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Asagai Formation. Geologic age: Oligocene [Early Oligocene].

***Cyclina compressa* Nagao, 1928b**

Plate 11, Figure 5

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 76, pl. 10, fig. 11. Holotype: IGPS no. 36415 (Existing). Type locality: Ôbô, Arita-machi [currently Arita-cho], Nishimatsuura-gun, Province of Hizen [Saga Prefecture]. Stratigraphic unit: Kishima Beds [Kishima Formation]. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene].

***Cyclina (Cyclina) japonica* Kamada, 1952**

Plate 11, Figures 6a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 6, p. 168, pl. 15, figs. 1a–b, 2 [non fig. 4; =*Cyclina (Cyclina) jobanica* (Yokoyama, 1924), *fide* Kamada, 1962]. Holotype: IGPS no. 72952 (Existing). Type locality: IGPS loc. no. Iw-3 (Kamada, 1952), 200 m W of Tokunari, Machino-machi, Fugeshi-gun [currently Machinomachi, Wajima City], Ishikawa Prefecture. Stratigraphic unit: Higashi-innai Formation. Geologic age: Miocene [latest Early Miocene].

***Cyclina? nodai* Nagao, 1928b**

Plate 11, Figures 7a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 75, pl. 7, figs. 19, 20, 26. Holotype: IGPS no. 36442 (Existing). Type locality: The Namazuta Mine near Iizuka-machi, Kaho-gun [currently Iizuka City], Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Namazuta Fossil Bed [=Honso Formation]. Geologic age: Eocene [Middle Eocene].

***Cyclina (Cyclina) umbonata* Kotaka and Noda, 1977**

Plate 11, Figure 8

Geol. Palaeont. Southeast Asia, vol. 18, p. 141, pl. 25, fig. 15. Holotype: IGPS no. 95090 (Existing). Type locality: Road-side cliff, about 500 m S of Amuntay, [Tagkawayan Municipality, Province of Quezon], western part of the Bondoc Peninsula, Philippines. Stratigraphic unit: "Gumaca Formation". Geologic age: Miocene.

***Cyclocardia fujinaensis* Ogasawara and Nomura, 1980**

Plate 11, Figure 9

Prof. S. Kanno Mem. Vol., p. 90, pl. 9, figs. 11a–17. Holotype: IGPS no. 96024 (Existing). Type Locality: Loc. no. Fj-10 (Ogasawara and Nomura, 1980), road side

cliff about 400 m E of Shinji Station of National Railway, Shinji-cho, Yatsuka-gun [currently Shinjicho, Matsue City], Shimane Prefecture. Stratigraphic unit: Fujina Formation. Geologic age: Miocene [late Middle Miocene].

***Cyrena mirabilis* Nagao, 1928b**

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 52 (42), pl. 7, fig. 27. Holotype: IGPS no. unknown (Missing). Although Ogasawara (2001) cited the holotype as IGPS no. 36264, it is the paratypes. Type Locality: Iwaya Mine, Kiuragi-mura, Higashimatsura-gun [*sic*, Higashimatsuura-gun] [currently Iwaya, Kyuragimachi, Karatsu City], Saga Prefecture. Stratigraphic unit: Yoshinotani Beds [Yoshinotani Formation]. Geologic age: Oligocene [Late Eocene].

***Cyrena otsukai* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 11, Figures 10–13

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 50, pl. 13, figs. 20–24. Syntypes: IGPS nos. 22453, 22476 (Existing). Type Locality: Bômekizawa, Ohinata[mura] [currently Sakuho-machi], Minamisaku-gun, Province of Shinano [Nagano Prefecture]; Kagikake, Ohinata-mura [currently Kagikakezawa, Ohinata, Sakuho-machi], Minamisaku-gun, Province of Shinano [Nagano Prefecture]; and Shiroy, Ueno-mura, Tano-gun, Province of Kôzuke [Gumma Prefecture]. Stratigraphic unit: Shiroy Group [Shiroy Formation]. Geologic age: Cretaceous [Early Cretaceous].

***Cyrena (Batissa) ponderosa* Nagao, 1928a**

Plate 5, Figures 29a–b; Plate 6, Figure 1

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 108, pl. 20, figs. 10, 30, pl. 21, fig. 21, pl. 22, figs. 16–19. Syntypes: IGPS nos. 35685, 35691, 35708, 35709, 35777, 35811, 35812 (Existing). Type locality: Urakoshi, Oniki-mura, Amakusa-Shimo-shima [currently Oniki-machi, Ushibuka City, Kumamoto Prefecture]; Kakize Mine, Takashima off Nagasaki, province of Hizen [currently Takashimacho, Nagasaki City, Nagasaki Prefecture]; Kôyagi-jima off Nagasaki, province of Hizen [currently Kouyagi-machi, Nagasaki City, Nagasaki Prefecture]. Stratigraphic unit: Toishi Beds [Toishi Formation]; Hashima Beds [Hashima Formation]. Geologic age: Eocene [early Middle Eocene]. Remarks: Suzuki (1941) proposed *Batissa nagaoi* as nom. nov. for *Cyrena (Batissa) ponderosa* Nagao, 1928a because the latter name is a primary junior homonym of *Cyrena ponderosa* Prime, 1860.

***Cyrena radiatostriata* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no.

2, p. 51, pl. 12, figs. 29–35. Lectotype: IGPS no. 35523 (designated by Hayami, 1965b; Missing). Type locality: Hachimanzawa [currently Kagahara, Kanna-machi], Tano-gun, Province of Kôzuke [Gumma Prefecture]. Stratigraphic unit: Shiroy Group [Sebayashi Formation]. Geologic age: Cretaceous [late Early Cretaceous (Aptian–Albian)].

***Cyrena shiroiensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 11, Figures 14–16

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 52, pl. 14, figs. 4–6, 19, 20, 22, 25. Syntypes: IGPS no. 22451 (Existing). Type locality: Bômekizawa, Ohinata[-mura], Saku-machi [currently Sakuho-machi], Minamisaku-gun, [Nagano Prefecture], Province of Shinano; and Shiroy, Ueno-mura, Tano-gun, Province of Kôzuke [Gumma Prefecture]. Stratigraphic unit: Shiroy Group [Shiroy Formation]. Geologic age: Cretaceous (early Early Cretaceous).

***Cyrena shiroiensis* var. *alata* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 11, Figures 17–19

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 53, pl. 13, fig. 26, pl. 14, figs. 15, 28. Syntypes: IGPS nos. 22443, 22447 (Existing). Type locality: Shiroy, Ueno-mura, Tano-gun, Province of Kôzuke [Gumma Prefecture]; and Bômekizawa, Ohinata[-mura], Saku-machi [currently Sakuho-machi], Minamisaku-gun, Province of Shinano [Nagano Prefecture]. Stratigraphic unit: Shiroy Group [Sebayashi and Shiroy formations]. Geologic age: Cretaceous [Early Cretaceous].

***Daonella densisulcata* Yabe and Shimizu, 1927**

Plate 11, Figure 20

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 11, no. 2, p. 124, pl. 12, fig. 9a. Holotype: IGPS no. 7571 (Existing). Type locality: Zôhoin near Sakawa, Province of Tosa [currently Ko, Sakawa-cho, Takaoka-gun, Kochi Prefecture]. Stratigraphic unit: Zohoin Group [Kochigatani Group]. Geologic age: Ladinian, Triassic.

***Daonella densisulcata* var. *subquadrata* Yabe and Shimizu, 1927**

Plate 11, Figure 21

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 11, no. 2, p. 124, pl. 12, fig. 8. Holotype: IGPS no. 7890 (Existing). Type locality: Zôhoin near Sakawa, Province of Tosa [currently Ko, Sakawa-cho, Takaoka-gun, Kochi Prefecture]. Stratigraphic unit: Zohoin Group [Kochigatani Group]. Geologic age: Ladinian, Triassic.

***Daonella kotoi* var. *alta* Yabe and Shimizu, 1927**

Plate 11, Figure 22

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 11, no. 2, p. 122, pl. 12, fig. 10. Holotype: IGPS no. 5298 (Existing). Type locality: Zôhoin near Sakawa, Province of Tosa [currently Ko, Sakawa-cho, Takaoka-gun, Kochi Prefecture]. Stratigraphic unit: Zohoin Group [Kochigatani Group]. Geologic age: Ladinian, Triassic.

***Daonella kotoi* var. *multistriata* Yabe and Shimizu, 1927**

Plate 11, Figures 23–24

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 11, no. 2, p. 123, pl. 11, figs. 12, 14, pl. 13, fig. 11. Syntypes: IGPS nos. 22998, 7892, 35278 (Existing). Type locality: Railway cuttings NE of the Rifu Station, Okinoi (IGPS no. 22998), Yawata, Tagajô-mura [currently Tagajo City]; NE of Rifu Station (IGPS no. 7892) and Hamada (IGPS no. 35278), Rifu-mura [currently Rifu-cho], Miyagi-gun, Miyagi Prefecture. Stratigraphic unit: Rifu Formation. Geologic age: Ladinian, Triassic.

***Diplodonta confusa* Nagao, 1928b**

Plate 11, Figure 25

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 60, pl. 10, figs. 8, 10, 10a. Holotype: IGPS no. 36351 (Existing). Type locality: Asakawa, Shimagô-mura, Onga-gun [currently Yahatanishi-ku, Kitakyushu City], Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Yamaga Beds [Yamaga Formation]. Geologic age: Oligocene.

***Diplodonta?* *problematica* Nagao, 1928a**

Plate 11, Figure 26

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 110, pl. 22, figs. 4, 4a. Lectotype: IGPS no. 35827 (designated by Hatai and Nisiyama, 1952; Existing). Type locality: Mirokudake [=Jiromaru-dake], Amakusa-Kamishima, Amakusa-gun [currently Matsushimamachi, Kamiyamakusa City], Kumamoto Prefecture. Stratigraphic unit: “Lower *Orthaulax japonicus* Zone” [=Fukuregi Formation]. Geologic age: Eocene [early Middle Eocene].

***Dosinia chikuzenensis* Nagao, 1928b**

Plate 11, Figure 27

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 64, pl. 10, fig. 5. Holotype: IGPS no. 36277 (Existing). Type locality: Sakamizu, Shimagô-mura, Onga-gun [currently Wakamatsu-ku, Kitakyushu City], Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Sakamizu Beds [Sakamizu Formation]. Geologic age: Oligocene.

***Dosinia ettyuensis* Hatai and Nisiyama, 1939 [“1938”]**

Plate 11, Figure 28

Japan. Jour. Geol. Geogr., vol. 16, nos. 1–2, p. 150,

pl. 9, fig. 4. Holotype: IGPS no. 62429 (Existing). Type locality: A cliff of the Zintu-gawa [=Jintsû-gawa] at Zyônô [=Jônô], Sugihara-mura, Nei-gun, Ettyû Province [currently Jônô, Yatsuomachi, Toyama City, Toyama Prefecture] Stratigraphic unit: Zyônô Beds [=Otogawa Formation]. Geologic age: Pliocene [Late Miocene].

***Dosinia (Phacosoma) hataii* Masuda, 1963**

Plate 12, Figures 1a–c

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 49, p. 34, pl. 6, figs. 1a–2. Holotype: IGPS no. 72476 (Existing). Type locality: Hattomaki, Hanawa-machi, Higashishirakawa-gun, Fukushima Prefecture. Stratigraphic unit: Kubota Formation. Geologic age: Middle Miocene [Late Miocene].

***Dosinia (Kaneharaia) kaneharai fujinaensis* Masuda, 1967**

Plate 12, Figure 2

Saito Ho-on Kai Mus. Res. Bull., no. 36, p. 24, pl. 1, fig. 9, pl. 2, fig. 3. Holotype: IGPS no. 90888 (Existing). Type locality: S of Morinoko [sic, Mominoko], Fujina, Tamayumachi [sic, Tamayu-cho], Yatsuka-gun [currently Tamayucho, Matsue City], Shimane Prefecture. Stratigraphic unit: Fujina Formation. Geologic age: Middle Miocene.

***Dosinia (Kaneharaia) kannoi* Masuda, 1963**

Plate 12, Figures 3a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 49, p. 35, pl. 6, figs. 6a–b, 7a–b. Holotype: IGPS no. 64682 (Existing). Type locality: Kinseidô, Kinshôdô, Eihokumen, Kisshu-gun, Kankyô-hokudo [currently Yonpuk, Kilju-gun, Hamgyongpuk-to], North Korea. Stratigraphic unit: Heiroku Formation. Geologic age: Early Miocene [latest Early–earliest Middle Miocene].

***Dosinia (Phacosoma) okinawaensis* Masuda and Sato, 1988**

Saito Ho-on Kai Spec. Pub., no. 2 (Prof. T. Kotaka Commem. Vol.), p. 446, pl. 3, figs. 12–17. Holotype: IGPS no. 99716 (Missing). Type locality: Sea cliff at Nishizaki, about 1 km NW of Nakano, Taketomi-cho, Iriomote-jima, [Yaeyama-gun], Okinawa Prefecture. Stratigraphic unit: Iriomote Formation. Geologic age: early Middle Miocene [latest Early–earliest Middle Miocene].

***Dosinia tatunokutiensis* Nomura, 1938**

Plate 12, Figures 4a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 19, no. 2, p. 256, pl. 34, figs. 2–6, pl. 35, fig. 11a, b. Holotype: IGPS no. 15944 (Existing). Type locality: Gôroku cliff along the right bank of the Hirosegawa-River, western border of Sendai [Gôroku, Hirose-mura, Miyagi-gun] [currently Gôroku, Aoba-ku, Sendai City], Miyagi Prefecture. Stratigraphic unit: Tatunokuti Shell Bed [=Tatsunokuchi

Formation]. Geologic age: Early Pliocene [latest Late Miocene–earliest Early Pliocene].

***Ennucula praenipponica* Kamada, 1962**

Plate 12, Figures 5a–c

Palaeont. Soc. Japan Spec. Pap., no. 8, p. 42, pl. 1, figs. 8–11. Holotype: IGPS no. 79375 (Existing). Type locality: Hieda, Shimokajiro, Ena-machi [currently Nagasaki], Iwaki City, Fukushima Prefecture. Stratigraphic unit: Honya Formation. Geologic age: Miocene [Early Miocene].

***Entomonotis kurosawai* Sakaguti, 1939**

Jub. Publ. Commem. Prof. H. Yabe 60th Birthday, vol. 1, p. 229, pl. 15, figs. 1–6. Syntypes: IGPS no. unknown (Missing). Type locality: Nisi-Togaki, Hosoura [currently Shizugawa, Minamisanriku-cho], Motoyosi-gun, Miyagi Prefecture. Stratigraphic unit: Saragai beds [Saragai Group]. Geologic age: Norian, Triassic. Remarks: The name of genus was originally spelled as *Entomotis*, and is corrected.

***Ezocallista kurodae* Kamada, 1962**

Plate 12, Figures 6a–b

Palaeont. Soc. Japan Spec. Pap., no. 8, p. 110, pl. 12, figs. 1a–3. Holotype: IGPS no. 79384 (Existing). Type locality: Karasawa, Kuroda, Tabito-mura [currently Tabitomachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Iwaki Formation. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene].

***Fimbria yaeyamaensis* Masuda and Sato, 1988**

Saito Ho-on Kai Spec. Pub., no. 2 (Prof. T. Kotaka Commem. Vol.), p. 445, pl. 3, figs. 7, 8. Holotype: IGPS no. 99714 (Missing). Type locality: Sea cliff at Nishizaki, about 1 km NW of Nakano, Taketomi-cho, Iriomote-jima, [Yaeyama-gun], Okinawa Prefecture. Stratigraphic unit: Iriomote Formation. Geologic age: early Middle Miocene [latest Early–earliest Middle Miocene].

***Fortipecten kuroishiensis* Kotaka and Noda, 1967**

Plate 13, Figure 1

Saito Ho-on Kai Mus. Res. Bull., no. 36, p. 40, pl. 1, fig. 21. Holotype: IGPS no. 90767 (Existing). Type locality: Loc. no. 10 (Kotaka and Noda, 1967), downstream of the Karasuzawa Dam of Nakano-gawa, [Okawara], Kuroishi City, Aomori Prefecture. Stratigraphic unit: Ogawara Formation. Geologic age: Middle Natotian [Late Miocene].

***Gafrarium (Circe) hanzawai* Nomura and Zinbô, 1936**

Plate 13, Figures 2a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 18, no. 3, p. 245, pl. 11, figs. 14a–15b. Holotype: IGPS no.

51348 (Existing). Type locality: Gabusoga, Haneji-mura, Kunigami-gun [currently Nago City], Okinawa Prefecture. Stratigraphic unit: Simaziri Beds [=Haneji Formation]. Geologic age: Early Pliocene [Early Pleistocene].

***Gari (Gari) pitogoensis* Kotaka and Noda, 1977**

Plate 13, Figure 3

Geol. Palaeont. Southeast Asia, vol. 18, p. 145, pl. 25, fig. 8. Holotype: IGPS no. 95086 (Existing). Type locality: Road-side cliff, about 500 m S of Amuntay, [Tagkawayan Municipality, Province of Quezon], western part of the Bondoc Peninsula, Philippines. Stratigraphic unit: "Gumaca Formation". Geologic age: Miocene.

***Gervillia shinanoensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 13, Figure 4

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 59, pl. 14, figs. 17, 18. Syntypes: IGPS no. 22507 (Existing). Type locality: Kagikake and Bômekizawa, Ohinata[-mura] [currently Ohinata, Sakuho-machi], Minamisaku-gun, Province of Shinano [Nagano Prefecture]. Stratigraphic unit: Shiroy Group [=Ishido Formation]. Geologic age: Cretaceous [early Early Cretaceous].

***Glans naomiae* Masuda, 1966b**

Plate 13, Figures 5a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 64, p. 325, pl. 35, figs. 13a–14. Holotype: IGPS no. 90181 (formerly DGS no. 4517; Existing). Type locality: Loc. No. 35 (Masuda, 1966a), sea coast, about 500 m N of the outlet of the Fushimi-gawa, Konami, [Misakimachi], Suzu City, Ishikawa Prefecture. Stratigraphic unit: Higashi-innai Formation. Geologic age: Miocene.

***Gloripallium izurense* Masuda, 1958a**

Plate 13, Figure 6

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 31, p. 227, pl. 32, figs. 4–5b. Holotype: IGPS no. 90541 (formerly DGS no. 3577; Existing). Type locality: Izura, Ôtsu-machi [sic, Otsucho], Kitaibaraki City, Ibaraki Prefecture. Stratigraphic unit: Kokozura Formation. Geologic age: Miocene [latest Early Miocene]. Remarks: The name of species was originally spelled as *izurense*. However, the corrected original spelling should be *izurense* because *Gloripallium* is a neuter noun.

***Glycymeris altoumbonata* Nagao, 1928b**

Plate 13, Figure 7

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 28, pl. 3, fig. 14. Holotype: IGPS no. 36013 (Existing). Type locality: Hôshuyama Mine, Hôshuyama-

mura [currently Tôhō-mura], Asakura-gun, Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Doshi Beds [=Doshiyama Formation]. Geologic age: Eocene. Remarks: The original spelling of the genus name is an error for *Glycymeris*.

***Glycymeris amakusensis* Nagao, 1930**

Plate 13, Figures 8–10

Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4, vol. 1, no. 1, p. 15, pl. 2, figs. 4–7. Syntypes: IGPS no. 42727 (Existing). Type locality: Wadanohana, Takado-mura, Amakusa-Kamishima [Amakusa-gun] [currently Takado, Ryugatakemachi, Kamiamakusa City, Kumamoto Prefecture]. Stratigraphic unit: Himenoura Group. Geologic age: Coniacian–Santonian, Cretaceous. Remarks: The original spelling of the genus name is an error for *Glycymeris*.

***Glycymeris cisshuensis* var. *compressa* Nagao, 1928b**

Plate 13, Figures 11a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 30, pl. 3, figs. 25, 25a–c. Holotype: IGPS no. 36001 (Existing). Type locality: Sakamizu, Shimagô-mura, Onga-gun, Province of Chikuzen [currently An'ya, Wakamatsuku, Kitakyushu City, Fukuoka Prefecture]. Stratigraphic unit: Wakita Beds [Waita Formation]. Geologic age: Oligocene. Remarks: The original spelling of the genus name is an error for *Glycymeris*. Although this name is a secondary junior homonym of *Glycymeris compressa* (Weller, 1907), a new replacement name is unnecessary, because it is synonymous with *Glycymeris (Veletuceta) cisshuensis* (Makiyama, 1926). *Glycymeris compressa* Kanno, 1956 [non Weller, 1907, *nec* Nagao, 1928b], was renamed as *Glycymeris kannoi* Matsukuma, 1979.

***Glycymeris gorokuensis* Nomura, 1938**

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 19, no. 2, p. 246, pl. 33, figs. 12–14. Holotype: IGPS no. 16142 (Missing). Type locality: Gôroku cliff along the right bank of the Hirosegawa-River, [Gôroku, Hirose-mura, Miyagi-gun] [currently Gôroku, Aoba-ku, Sendai City], Miyagi Prefecture. Stratigraphic unit: Tatunokuti Shell Bed [=Tatsunokuchi Formation]. Geologic age: Pliocene [latest Late Miocene–earliest Early Pliocene].

***Glycymeris hanzawai* Nomura and Zinbô, 1934**

Plate 13, Figures 12a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, p. 152 (44), pl. 5 (1), fig. 3a, b. Holotype: IGPS no. 50196 (Existing). Type locality: Plateaux area near Kamikatetu, Kikai-zima, [Kikai-cho, Oshima-gun], Kagoshima Prefecture. Lithostratigraphic unit: "Ryûkyû Limestone". Geologic age: Pleistocene.

***Glycymeris iriomotensis* Masuda and Sato, 1988**

Saito Ho-on Kai Spec. Pub., no. 2 (Prof. T. Kotaka Commem. Vol.), p. 443, pl. 1, figs. 8–14. Holotype: IGPS no. 99712 (Missing). Type locality: Sea cliff at Nishizaki, about 1 km NW of Nakano, Taketomi-cho, Iriomote-jima, [Yaeyama-gun], Okinawa Prefecture. Stratigraphic unit: Iriomote Formation. Geologic age: early Middle Miocene [latest Early–earliest Middle Miocene].

***Glycymeris nakosoensis* Hatai and Nisiyama, 1949**

Plate 13, Figures 13a–b

Jour. Paleont., vol. 23, no. 1, p. 88, pl. 25, figs. 15, 16. Holotype: IGPS no. 72502 (Existing). Type locality: A small cliff in front of the dormitory of the Nippon Coal Mining Company, Nakoso-machi, Iwaki-gun [currently Nakosomachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Iwaki Formation. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene].

***Glycymeris nozokiensis* Hatai and Nisiyama, 1951**

Plate 13, Figure 14

Saito Ho-on Kai Mus. Res. Bull., no. 21, p. 1, Figs. 1, 2. Holotype: IGPS no. 72883 (Existing). Type locality: Road side cutting on the main highway about 500 m S of the Nozoki Primary School, Nozoki-mura [currently Nozoki, Mamurogawa-machi, Mogami-gun], Yamagata Prefecture. Stratigraphic unit: Nozoki Formation. Geologic age: Miocene [early Middle Miocene].

***Glycymeris ogawaraensis* Kotaka and Noda, 1967**

Plate 13, Figure 15

Saito Ho-on Kai Mus. Res. Bull., no. 36, p. 38, pl. 2, fig. 1. Holotype: IGPS no. 90739 (Existing). Type locality: Loc. no. 10 (Kotaka and Noda, 1967), down stream of the Karasuzawa Dam of the Nakanogawa, Ogawara [sic, Okawara], Kuroishi City, Aomori Prefecture. Stratigraphic unit: Ogawara Formation. Geologic age: “Middle Natorian” [Late Miocene].

***Glycymeris oshimaensis* Noda, 1962b**

Plate 13, Figure 16

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 34, no. 3, p. 229, pl. 16, fig. 8. Holotype: IGPS no. 79057 (Existing). Type locality: Loc. No. 924 (Noda, 1962b), road side cliff, about 300 m E of the pass between Oshima and Hosono, Matsunoyama-machi [sic, between Oshima-mura and Yasuzuka-machi], Higashikubiki-gun [currently between Kamitate, Oshimaku and Hosono, Yasuzukaku, Joetsu City], Niigata Prefecture. Stratigraphic unit: Kubiki Formation. Geologic age: Middle Miocene.

***Glycymeris rhynconelloides* Nomura and Hatai, 1939 [“1938”]**

Plate 13, Figure 17

Japan. Jour. Geol. Geogr., vol. 16, nos. 1–2, p. 5, pl. 1, fig. 6. Holotype: IGPS no. 60022 (Existing). Type locality: Husina [sic, Huzina][=Fujina], Tamayu-mura Yatuka-gun [=Yatsuka-gun], Izumo [currently Tamayumachi, Matsue City, Shimane Prefecture]. Stratigraphic unit: Izumo Neogene [=Fujina Formation]. Geologic age: Middle Miocene. Remarks: Matsukuma and Okamoto (1986) regarded this species as *nomen dubium* because the holotype is poorly preserved.

***Glycymeris suspectiniformis* Nomura and Zinbô, 1934**

Plate 13, Figures 18a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, p. 151 (43), pl. 5 (1), fig. 2a, b. Holotype: IGPS no. 50200 (Existing). Type locality: Plateaux area near Kamikatetu, Kikai-zima, [Kikai-cho, Oshima-gun], Kagoshima Prefecture. Lithostratigraphic unit: “Ryûkyû Limestone”. Geologic age: Pleistocene.

***Glycymeris yamaguchii* Hayasaka, 1956**

Plate 13, Figures 19a–b

Saito Ho-on Kai Mus. Res. Bull., no. 25, p. 16, pl. 2, figs. 1a–2c. Holotype: IGPS no. 77373 (Existing). Type locality: Loc. No. 1 (Hayasaka, 1956), cliff of the Takasegawa River west of Takakura, about 5 km SW of the Namie-machi Railroad Station on the Joban Line, Namie-machi, Futaba-gun, Fukushima Prefecture. Stratigraphic unit: Ishiguma Formation. Geologic age: Pliocene.

***Grammatodon yokoyamai* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 13, Figure 20

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 44, pl. 12, figs. 12–13, 25. Lectotype: IGPS no. 22555 (designated by Hayami, 1965a; Existing). Type locality: Ishidô, near Ohinata[-mura] [currently Ishidô, Ohinata, Sakuho-machi], Minamisaku-gun, Nagano Prefecture. Stratigraphic unit: Ishidô Group [Ishidô Formation]. Geologic age: Cretaceous [late Early–early Late Cretaceous].

***Halicardia akitaensis* Ogasawara and Takayasu, 1982**

Plate 13, Figures 21a–b

Venus, vol. 41, no. 3, p. 199, pl. 1, fig. 1a–f. Holotype: IGPS no. 96013 (Existing). Originally cited as “monotype”. Type locality: A road-side cliff about 500 m downstream from Fudotaki (water-fall), Iwami-Sannai, Kawabe-machi, Kawabe-gun [currently Kurosawa, Taihei, Akita City], Akita Prefecture. Stratigraphic unit: Sunakobuchi Formation.

Geologic age: late Early–early Middle Miocene.

***Halicardia miyagiensis* Fujiwara, 1992**

Plate 13, Figures 22a–b

Saito Ho-on Kai Mus. Nat. Hist. Res. Bull., no. 60, p. 9, figs. 1–4. Holotype: IGPS no. 101555 (Existing). Type locality: Nishino-iri, Tomiya-cho [*sic*, Tomiya-machi], Kurokawa-gun, Miyagi Prefecture. Stratigraphic unit: Nanakita Formation. Geologic age: late Late Miocene.

***Homomya? dubia* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 14, Figures 1–3

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 55, pl. 12, figs. 11, 39, pl. 14, fig. 1. Syntypes: IGPS no. 22505 (Existing). Type locality: Hachimanzawa [currently Kagahara, Kanna-machi], Tano-gun, Province of Kōzuke [Gumma Prefecture]. Stratigraphic unit: Shiroy Group [Sebayashi Formation]. Geologic age: Cretaceous [late Early Cretaceous (Albian–Aptian)].

***Horiopleura yaegashii* Yehara, 1920**

Jour. Geol. Soc. Japan, vol. 27, no. 321, p. 41, pl. 1, figs. 1–3, pl. 2, figs. 1–3. Syntypes: IGPS nos. 22348, 22349 (Missing). Type locality: Moshi, Iwaizumi [currently Omoto, Iwaizumi-cho] and Hiraiga, Tanohata-mura, Shimohei-gun, Iwate Prefecture. Stratigraphic unit: Miyako Group. Geologic age: Aptian, Cretaceous.

***Inoceramus balticus* var. *toyajoanus* Nagao and Matumoto, 1940**

Plate 14, Figure 4

Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4, vol. 6, no. 1, p. 20, pl. 9, fig. 3. Lectotype: IGPS no. 4540 (designated by Matsumoto in Takai and Matsumoto, 1961; Existing). Type locality: Toyazyō, Province of Kii [currently Toyajo, Aridagawa-cho, Arida-gun, Wakayama Prefecture]. Stratigraphic unit: Toyajo Formation. Geologic age: Santonian–Camapanian, Cretaceous.

***Inoceramus concentricus* var. *nipponicus* Nagao and Matumoto, 1939**

Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4, vol. 4, nos. 3–4, p. 267, pl. 24, fig. 2, pl. 25, figs. 1–6. Lectotype: IGPS no. 58017? (designated by Pergament, 1966; Missing). Type locality: Ugoizawa, a tributary of the Naibuti [*sic*, Ugui-zawa, Naibuchi] [Ochiai-machi, Sakaehama-gun, Karafuto Prefecture], south Sakhalin, [currently Nayba River, Bykov, Dolinsky District, Sakhalin Oblast], Russia. Stratigraphic unit: Middle Yezo Group. Geologic age: Cenomanian–Turonian, Cretaceous.

***Inoceramus pedalionoides* Nagao and Matumoto, 1939 ex Inai (MS)**

Plate 14, Figure 5

Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4, vol. 4, nos. 3–4, p. 277, pl. 26, figs. 8, 9. Syntype: IGPS no. 22720 (Existing). Type locality: Pombetu, [Mikasayama-mura, Sorachi-gun], Province of Ishikari [currently Mikasa City], Hokkaido. Stratigraphic unit: Middle Yezo Group to lowest part of the Upper Yezo Group. Geologic age: Turonian, Cretaceous.

***Inoceramus yabei* Nagao and Matumoto, 1940**

Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4, vol. 4, nos. 3–4, pl. 34, figs. 5–7 [*nomen nudum*]; Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4, vol. 6, no. 1, p. 1, pl. 1, figs. 1–6. Lectotype: IGPS no. 22685 (designated by Matsumoto and Harada, 1964; Missing). Type locality: Ikusyunbetu district, Province of Isikari [currently Ikushumbetsu, Mikasa City], Hokkaido. Stratigraphic unit: Mikasa Formation. Geologic age: Cenomanian–Turonian, Cretaceous.

***Isognomon (Isognomon) hataii* Noda and Furuichi, 1972**

Plate 14, Figure 6

Venus, vol. 31, no. 3, p. 120, text-fig. 1. Holotype: IGPS no. 91766 (Existing). Type locality: W of Abuzaki, [Teshima], Tonosho-cho, Shozu-gun, Kagawa Prefecture. Stratigraphic unit: Teshima Formation. Geologic age: Miocene [Late Eocene].

***Katelysia (Nipponomarcia) endoi* Hatai and Kotaka, 1952**

Plate 14, Figure 7

Short Pap. Inst. Geol. Paleont., Tōhoku Univ., no. 4, p. 84, pl. 7, fig. 25. Holotype: IGPS no. 74341 (Existing). Type locality: Paiponchon, Shinsoruton, San-u-nanmyon, Myonchon District, Hamukyon-pukuton, Korea [currently Hwasong-gun, Hamgyongpuk-to, North Korea]. Stratigraphic unit: Heiroku Formation. Geologic age: Early Miocene [latest Early–earliest Middle Miocene].

***Leptochondria? hataii* Murata, 1973**

Plate 14, Figure 8

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol., no. 6 (Prof. K. Hatai Memorial Vol.), p. 273, pl. 29, figs. 1–3. Holotype: IGPS no. 92661 (Existing). Type locality: Hikado, Motoyoshi-cho, Motoyoshi-gun [currently Motoyoshicho, Kesenuma City], Miyagi Prefecture. Stratigraphic unit: Osawa Formation. Geologic age: Scythian, Triassic.

***Leukomoides nipponicus* Ogasawara, 1976**

Plate 14, Figure 9

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 46, no. 2, p. 52, pl. 11, figs. 3, 4. Holotype: IGPS no. 95190 (Existing). Type locality: Loc. no. Su-3 (Ogasawara, 1976), small

road side cutting, about 1000 m W from Futamata-machi, Kanazawa City, Ishikawa Prefecture. Stratigraphic unit: Sunakozaka Formation. Geologic age: Miocene [latest Early Miocene]. Remarks: The present species is a type species of *Leukomoides* Ogasawara, 1976 (by original designation).

***Lima amaxensis* var. *kumasoana* Nagao, 1928a**

Plate 14, Figures 10a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 104, pl. 20, figs. 31, 31a, 32. Lectotype: IGPS no. 35808 (designated by Hatai and Nisiyama, 1952; Existing). Type locality: Amakusa-Shimoshima, precise locality being unknown (probably cliff behind houses immediately W of the main road, about 450 m NW of the contact point of the main road and the road at Imada, Itchoda-mura, Amakusa-gun [currently Kawauramachi, Amakusa City], Kumamoto Prefecture: Hatai and Nisiyama, 1952). Stratigraphic unit: Sakasegawa Formation. Geologic age: Eocene [Late Eocene].

***Lima eocenica* Nagao, 1928a**

Plate 14, Figure 11

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 105, pl. 21, figs. 1–3. Lectotype: IGPS no. 35817 (designated by Hatai and Nisiyama, 1952; Existing). Type locality: Cliff behind the house immediately W of the main road about 450 m NW of the contact point of the main road at Imada, Itchoda-mura, Amakusa-Shimoshima, Amakusa-gun [currently Kawauramachi, Amakusa City], Kumamoto Prefecture. Stratigraphic unit: Sakasegawa Formation. Geologic age: Eocene [Late Eocene].

***Lima* (*Limatula*) *ishidoensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 14, Figure 12

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 60, pl. 14, figs. 7, 16. Lectotype: IGPS no. 22539 (designated by Hayami, 1965a; Existing). Type locality: Ishidō, near Ōhinata[-mura] [currently Ishidō, Ōhinata, Sakuho-machi], Minamisaku-gun, Province of Shinano [Nagano Prefecture]. Stratigraphic unit: Ishidō Group. Geologic age: Cretaceous [Early Cretaceous].

***Lima* (*Limea*) *limopsis* Nomura and Zinbō, 1934**

Plate 14, Figures 13a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 2, p. 154 (46), pl. 5 (1), figs. 11a–12b. Holotype: IGPS no. 50368 (Existing). Type locality: Plateaux area near Kamikatetu, Kikai-zima, [Kikai-cho, Oshima-gun], Kagoshima Prefecture. Lithostratigraphic unit: "Ryūkyū Limestone". Geologic age: Pleistocene.

***Limatula sakoi* Masuda and Katto, in Katto and Masuda, 1978**

Plate 14, Figure 14

Res. Rep. Kochi Univ., Nat. Sci., vol. 27, p. 104, pl. 5, fig. 13. Holotype: IGPS no. 96073 (Existing). Type locality: Loc. no. 9 (Katto and Masuda, 1978), sea coast of Uematsu, Kushimoto-cho, Nishimuro-gun [currently Higashimuro-gun], Wakayama Prefecture. Stratigraphic unit: Uematsu Formation. Geologic age: Miocene [latest Early–early Middle Miocene].

***Limipecten bandoi* Murata, 1969**

Plate 14, Figures 15a–b

Saito Ho-on Kai Mus. Res. Bull., no. 38, p. 18, pl. 4, fig. 1a–c. Holotype: IGPS no. 91384 (Existing). Type locality: Nagahata [*sic*, Nakahata], Towa-cho, Tome-gun [currently Tome City], Miyagi Prefecture. Stratigraphic unit: The lower part of Toyoma Formation. Geologic age: Late Permian.

***Lioconcha tosana* Nomura, 1937**

Plate 15, Figures 1a–b

Japan. Jour. Geol. Geogr., vol. 14, nos. 3–4, p. 82, pl. 6, fig. 14a–b. Holotype: IGPS no. 54674 (Existing). Type locality: Tōnohama, Yasuda-mura [*sic*, Yasuda-cho], Aki-gun, Kōti [=Kochi] Prefecture. Stratigraphic unit: "Tosa Pliocene" [=Ananai Formation]. Geologic age: Pliocene [latest Late Pliocene–early Early Pleistocene].

***Lithophaga otukai* Nomura and Hatai 1936**

Saito Ho-on Kai Mus. Res. Bull., no. 10, p. 211, text-figs. 1–3. Holotype: IGPS no. 62437 (*vide* Hatai and Nisiyama, 1939 ["1938"]; (Missing). Type locality: Southeast valley of Siratori, Nisatai-mura, Ninohe-gun, Mutu [=Mutsu] Province [currently Shiratori, Ninohe City, Iwate Prefecture]. Stratigraphic unit: Lower Kadonosawa Series [=Tate Sandstone Member of Kadonosawa Formation]. Geologic age: Miocene [latest Early Miocene].

***Loripes tonohamanus* Nomura, 1937**

Plate 15, Figures 2a–b

Japan. Jour. Geol. Geogr., vol. 14, nos. 3–4, p. 82, pl. 6, fig. 5a, b. Holotype: IGPS no. 54645 (Existing). Type locality: Tōnohama, Yasuda-mura [*sic*, Yasuda-cho], Aki-gun, Kōti [=Kochi] Prefecture. Stratigraphic unit: "Tosa Pliocene" [=Ananai Formation]. Geologic age: Pliocene [latest Late Pliocene–earliest Early Pleistocene]. Remarks: Although the name of species was originally spelled as *tonohamana*, it should be corrected as *tonohamanus* because *Loripes* is a masculine noun.

***Lucina kunigamiensis* Nomura and Zinbō, 1936**

Plate 15, Figures 3a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 18, no. 3, p. 241, pl. 11, figs. 10a–11b. Holotype: IGPS no. 51350 (Existing). Type locality: Gabusoga, Haneji-mura, Kunigami-gun, Okinawa-jima [currently Nago City], Okinawa Prefecture. Stratigraphic unit: Simaziri Beds [=Haneji Formation]. Geologic age: Early Pliocene [Early Pleistocene].

***Lucinoma otukai* Hatai and Nisiyama, 1949**

Plate 15, Figures 4a–b

Jour. Paleont., vol. 23, no. 1, p. 91, pl. 24, fig. 10.

Holotype: IGPS no. 72501 (Existing). Type locality: Fukuda, Sekimoto-mura, Taga-gun [currently Sekimotocho, Kitaibaraki City], Ibaraki Prefecture. Stratigraphic unit: Kamenoo Formation. Geologic age: Miocene [Early Miocene]. Remarks: This species is a junior synonym of *Lucinoma kamenooensis* (Otuka, 1943).

***Lucinopsis? boshihoensis* Nomura, 1933**

Plate 15, Figures 5a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 98, pl. 2, fig. 17a, b. Holotype: IGPS no. 48007 (Existing). Type locality: Station no. 13 (Nomura, 1933), Bôshiho, Shiko-shô, Byôritsu-gun, Shinchiku-shû [currently Maozihbu, Wuhwu Village, Shihwu Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byôritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Lucinopsis kosuiensis* Nomura, 1933**

Plate 15, Figure 6

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 99 (no indication). Holotype: IGPS no. 48001 (Existing; broken). Type locality: Kôsui, Hokuseikwa, Tsûshô-shô, Byôritsu-gun, Shinchiku-shû [currently Peishihwo, Fulong Village, Tongsiao Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byôritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Macoma (Macoma) atsunaiensis* Honda, 1988**

Plate 15, Figures 7a–b

Saito Ho-on Kai Spec. Pub., no. 2, (Prof. T. Kotaka Commem. Vol.), p. 360, pl. 2, figs. 1–6. Holotype: IGPS no. 97106-2 (Existing). Type locality: Loc. no. AN-20 (Honda, 1988), about 4.5 km NNE from Onbetsu-machi, upper stream of the Shakubetsu-gawa, Onbetsu-machi [sic, Onbetsu-cho], Shiranuka-gun [currently Onbetsucho, Kushiro City], Kushiro Province, Hokkaido. Stratigraphic unit: Atsunai Formation. Geologic age: Middle Miocene.

***Macoma hakushatonensis* Nomura, 1933**

Plate 15, Figures 8a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 103, pl. 1, fig. 6a, b. Holotype: IGPS no. 48589

(Existing; broken). Type locality: Station no. 12 (Nomura, 1933), 700 or 800 m NE of Hakushaton, Koryu-sho, Chikunan-gun, Shinchiku-shu [currently Baishaton, Baidong Village, Tongsiao Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byôritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Macoma hokiensis* Akutsu, 1964**

Plate 15, Figure 9

Sci. Rep. Tôhoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 287, pl. 60, fig. 8. Holotype: IGPS no. 85512 (Existing). Type locality: Along the Hôki River, Sekiya, Shiobara-machi, Shioya-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene]. Remarks: This species is synonymous with *Rexithaerus sector* (Oyama, 1950) (Amano *et al.*, 1999).

***Macoma yamadae* Nagao, 1928b**

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 81, pl. 6, fig. 3. Holotype: IGPS no. unknown (Missing). Type locality: Third Namazuta Mine near Iizuka-machi, Kaho-gun [currently Iizuka City], Province of Hizen [Fukuoka Prefecture]. Stratigraphic unit: Namazuta Fossil Bed [=Honso Formation]. Geologic age: Eocene [Middle Eocene].

***Macrocallista ariakensis* Nagao, 1928a**

Plate 15, Figure 10

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 112, pl. 18, fig. 16, pl. 20, figs. 26–29. Lectotype: IGPS no. 35758 (designated by Hatai and Nisiyama, 1952; Existing). Type locality: Akase, Ôda-mura, Uto-gun, Province of Hizen [currently Akasemachi, Uto City, Kumamoto Prefecture]. Stratigraphic unit: “Lower *Orthaulax japonicus* Zone” [=Fukuregi Formation]. Geologic age: Eocene [early Middle Eocene].

***Macrocallista hanzawai* Nagao, 1928b**

Plate 15, Figure 11

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 69, pl. 13, fig. 7. Holotype: IGPS no. 36236 (Existing). Type locality: Meinohama[-machi], Sawara-gun [currently Nishi-ku, Fukuoka City], Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Meinohama Sandstone [Meinohama Formation]. Geologic age: Oligocene.

***Macrocallista kahoensis* Nagao, 1928b**

Plate 15, Figures 12a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 67, pl. 11, fig. 8, a, b. Holotype: IGPS no. 36389 (Existing). Type locality: Third Namazuta Mine, near Iizuka-

machi, Kaho-gun [currently Iizuka City], Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Namazuta Fossil Bed [=Honso Formation]. Geologic age: Eocene. Remarks: Original incorrect spelling *kahoensis* is corrected.

***Macrocallista matsuraensis* Nagao, 1928b**

Plate 15, Figures 13a–c
Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 66, pl. 11, figs. 7, 7a, b. Holotype: IGPS no. 36209 (Existing). Type locality: Pass-side cutting on the boundary between Oyama-mura and Arita-machi [currently between Hiroseyama and Obo in Arita-cho], about 500 m NW of the shrine at Obo, Arita-machi [currently Arita-cho], Nishimatsuura-gun, Saga Prefecture. Stratigraphic unit: Kishima Formation. Geologic age: Oligocene [latest Eocene–earliest Oligocene].

***Mactra (Spisula) asperaeformis* Nomura and Zinbô, 1934**

Plate 15, Figures 14a–b
Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 2, p. 156 (48), pl. 5 (1), fig. 20a, b. Holotype: IGPS no. 50396 (Existing). Type locality: Plateaux area near Kamikatetu, Kikai-zima, [Kikai-cho, Oshima-gun], Kagoshima Prefecture. Lithostratigraphic unit: “Ryûkyû Limestone”. Geologic age: Pleistocene.

***Mactra nakayamaensis* Kamada, 1962**

Plate 15, Figures 15a–b
Palaeont. Soc. Japan Spec. Pap. no. 8, p. 123, pl. 14, figs. 1, 2. Holotype: IGPS no. 79386 (Existing). Type locality: W of Tatsuzawa, Iino, Taira City [currently Iwaki City], Fukushima Prefecture. Stratigraphic unit: Nakayama Formation. Geologic age: Miocene [latest Early Miocene].

***Mactra sulcataroides* Akutsu, 1964**

Plate 15, Figure 16
Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 286, pl. 59, fig. 5. Holotype: IGPS no. 85509 (Existing). Type locality: Shimotokurazawa, Sekiya, Shiobara-machi, Shiota-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene].

***Margaritifera owadaensis* Noda, 1970**

Plate 15, Figures 17a–b
Trans. Proc. Palaeont. Soc. Japan, N.S., no. 77, p. 240, pl. 25, fig. 3a–c. Holotype: IGPS no. 86893 (Existing). Type locality: Loc. No. 1 (Noda, 1970), exposure along the National Road side near Owada, Rumoi City, Hokkaido. Stratigraphic unit: Owada Formation. Geologic age: Eocene.

***Meretrix deguchii* Hayasaka and Hayasaka, 1960**

Plate 15, Figures 18a–b
Trans. Proc. Palaeont. Soc. Japan, N.S., no. 38, p. 267, pl. 31, fig. 8a–b. Holotype: IGPS no. 77512 (Existing). Type locality: Tungyüping in the Penghu Islands, [Dongping Village, Wang'an Township, Penghu County], Taiwan. Lithostratigraphic unit: “Sandstone bed”. Geologic age: Pleistocene.

***Meretrix meretrix ninoensis* Hatai, 1940**

Plate 15, Figures 19a–b
Bull. Biogeogr. Soc. Japan, vol. 10, no. 9, p. 128, pl. 1, fig. 1. Holotype: IGPS no. 61351 (Existing). Type locality: Yazawa, Nisatai-mura, Ninohe-gun [currently Nisatai, Ninohe City], Iwate Prefecture. Lithostratigraphic unit: Shiratori Beds [=Tate Sandstone Member of Kadonosawa Formation]. Geologic age: Miocene [latest Early Miocene].

***Meretrix pseudomeretrix* Nagao, 1928b**

Plate 15, Figure 20
Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 65, pl. 9, figs. 7, 7a. Holotype: IGPS no. 36361 (Existing). Ogasawara (2001) erroneously stated IGPS no. 35381 as the holotype. Type locality: Wakita, Shimagô-mura, Onga-gun [currently Wakamatsu-ku, Kitakyushu City], Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Wakita Beds [=Waita Formation]. Geologic age: Oligocene.

***Meretrix tochiensis* Akutsu, 1964**

Plate 15, Figures 21a–b
Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 285, pl. 60, figs. 1, 2. Holotype: IGPS no. 85507 (Existing). Type locality: Cliff of the Hoki River, about 100 m down stream from Daikoku-iwa, Sekiya, Shiobara-machi, Shiota-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene].

***Miyagipecten matsumoriensis* Masuda, 1952**

Plate 16, Figures 1a–b
Trans. Proc. Palaeont. Soc. Japan, N.S., no. 8, p. 252, pl. 24, figs. 4a–7b. Lectotype: IGPS no. 90690 (formerly DGS 1015; designated by Masuda, 1957; Existing). Type locality: The foot of the dam of the water reservoir at Dôgasawa, about 700 m N of Matsumori, Nanakita-mura, Miyagi-gun [currently Izumi-ku, Sendai City], Miyagi Prefecture. Stratigraphic unit: Nanakita Formation. Geologic age: Middle Miocene [late Late Miocene]. Remarks: This species is a type species of *Miyagipecten* Masuda, 1952 (by original designation).

***Mizuhopecten kimurai kagaensis* Ogasawara, 1976**

Plate 16, Figure 2

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 46, no. 2, p. 43, pl. 14, figs. 10, 17, pl. 15, figs. 8, 9, 12, 16, 18. Holotype: IGPS no. 95012 (Existing). Type locality: River floor of Sai-kawa, about 1000 m upstream, Omma Bridge [*sic*, Okuwa Bridge], Omma [*sic*, Okuwa], Kanazawa City, Ishikawa Prefecture. Stratigraphic unit: Saikawa Formation. Geologic age: Miocene [Middle Miocene].

***Mizuhopecten paraplebejus murataensis* Masuda and Takegawa, 1965**

Plate 16, Figures 3a–b

Saito Ho-on Kai Mus. Res. Bull., no. 34, p. 10, pl. 1, figs. 7–10. Holotype: IGPS no. 90826 (formerly DGS no. 4681; Existing). Type locality: Loc. no. 17 (Masuda and Takegawa, 1965), road cliff at Nanamagari Pass, about 250 m SE of the junction of two main roads at the boundary of Murata-machi and Kawasaki-machi, Shibata-gun, Miyagi Prefecture. Stratigraphic unit: Fukuda Member of Kanagase Formation. Geologic age: Middle Miocene [late Late Miocene].

***Modiola? ishidoensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 16, Figure 4

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 63, pl. 13, fig. 42. Holotype: IGPS no. 8570 (Existing). Tanaka and Toshimitsu (2003) erroneously stated IGPS no. 8750 as the holotype. Type locality: Ishidō, near Ōhinata[*-mura*] [currently Ishido, Ohinata, Sakuho-machi], Minamisaku-gun, Province of Shinano [Nagano Prefecture]. Stratigraphic unit: Ishidō Group [Ishido Formation]. Geologic age: Cretaceous [late Early Cretaceous].

***Modiolus ezoensis* Yabe and Nagao, 1928**

Plate 16, Figures 5a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 89, pl. 17, fig. 11. Holotype: IGPS no. 22627 (Existing). Type locality: Washino-sawa, Horomui [currently Kurisawacho, Iwamizawa City], Ishikari Province, Hokkaido. Stratigraphic unit: Mikasa Formation. Geologic age: Cenomanian, Cretaceous.

***Modiolus wanizakiensis* Masuda, 1966b**

Plate 16, Figures 6a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 64, p. 324, pl. 35, figs. 8a–9. Holotype: IGPS no. 90180 (formerly DGS no. 4510; Existing). Although Ogasawara (2001) stated IGPS no. 90876 as the holotype, it is the paratype. Type locality: Loc. No. 33 (Masuda, 1966a), road cutting at Wanizaki, Suzu City, Ishikawa Prefecture. Stratigraphic unit: Higashi-innai Formation. Geologic age: Miocene.

***Modiolus (Modiolatus) yasuiroi* Kamada, 1962**

Plate 16, Figures 7a–b

Palaeont. Soc. Japan Spec. Pap., no. 8, p. 72, pl. 3, figs. 13–14b. Holotype: IGPS no. 79379 (Existing). Type locality: Numanouchi Harbor, Toyoma-machi, Taira City [currently Numanouchi, Taira, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Numanouchi Formation. Geologic age: Miocene [latest Early–earliest Middle Miocene].

***Monia denselineata* Hatai, Masuda and Suzuki, 1961**

Plate 16, Figures 8a–d

Saito Ho-on Kai Mus. Res. Bull., no. 30, p. 26, pl. 2, figs. 1a–3. Holotype: IGPS no. 90505 (Existing). Type locality: Loc. no. M 1 (Hatai *et al.*, 1961), left cliff of Maekawa River, near the outlet of Maekawa, Chikagawa [*sic*, Nakanosawa], Mutsu City, Aomori Prefecture. Stratigraphic unit: Hamada Formation. Geologic age: Pliocene [Early Pleistocene].

***Mya arenaria kitahukuokaensis* Hatai, 1940**

Plate 16, Figure 9

Bull. Biogeogr. Soc. Japan, vol. 10, no. 9, p. 131, pl. 1, fig. 9. Holotype: IGPS no. 61363 (Existing). Type locality: Anaushi, Kitahukuoka-mati [*sic*, Ishikiridokoro-mura], Ninohe-gun [currently Ishikiridokoro, Ninohe City], Iwate Prefecture. Stratigraphic unit: Kadonosawa Beds [Kadonosawa Formation]. Geologic age: Miocene [earliest Middle Miocene].

***Mya convexa* Noda, 1992**

Plate 16, Figure 10

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 62, nos. 1–2, p. 90, pl. 7, figs. 1–9. Holotype: IGPS no. 100877 (Existing). Type locality: Loc. no. SK11 (Noda, 1992), middle stream of the Chepotsunai River [=Chiebotsunai River], a tributary of the Kotanbetsu River, Haboro-machi [*sic*, Kogawa, Tomamae-cho], [Tomamae-gun], Rumoi Province, Hokkaido. Stratigraphic unit: Lower part of Sankebetsu Formation. Geologic age: Early Miocene [Late Eocene]. Remarks: The species name is preoccupied by *Mya convexa* Wood, 1815 (Matsubara, 2016).

***Myadora okadae* Hatai and Masuda, 1960**

Plate 16, Figures 11a–b

Saito Ho-on Kai Mus. Res. Bull., no. 29, p. 33, figs. 1, 2. Holotype: IGPS no. 90184 (Existing). Type locality: Road side cutting south of Takada about 1 km NW of the junction of the two roads at Moniwa, [Taihaku-ku], Sendai City, Miyagi Prefecture. Stratigraphic unit: Moniwa Formation. Geologic age: Early Miocene [early Middle Miocene].

***Myadora suzuensis* Masuda, 1966b**

Plate 17, Figure 1

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 64, p. 324, pl. 35, figs. 10, 11. Holotype: IGPS no. 90776 (formerly DGS no. 4513; Existing). IGPS no. 90777 cited as the holotype by Ogasawara (2001) is the paratype. Type locality: Loc. No. 24 (Masuda, 1966a), river cliff about 500 m E of Fujio, Suzu City, Ishikawa Prefecture. Stratigraphic unit: Higashin-nai Formation. Geologic age: Early Miocene [latest Early Miocene].

***Myoconcha hamadaensis* Yabe and Shimizu, 1927**

Plate 17, Figure 2

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 11, no. 2, p. 134, pl. 13, figs. 13–16. Holotype: IGPS no. 35286 (Existing). Type locality: Hamada, Rifu-mura [currently Rifu-cho], Miyagi-gun, Province of Rikuzen [Miyagi Prefecture]. Stratigraphic unit: *Monophyllites* Zone in Rifu Formation. Geologic age: Ladinian, Triassic.

***Myophoria japonica* Hayasaka, 1925b**

Plate 17, Figure 3

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 8, no. 2, p. 16, pl. 8, fig. 14. Lectotype: IGPS no. 22422 (designated by Hanzawa *et al.*, 1961; Existing). Type locality: Kinshô-zan, near Akasaka-machi, prov. Mino [currently Akasakacho, Ogaki City, Gifu Prefecture]. Horizon: *Kuro* zone [Akasaka Limestone]. Geologic age: Permian [Middle Permian].

***Myophoria subelegans* var. *tobai* Hayasaka, 1924**

Plate 17, Figures 4–7

Japan. Jour. Geol. Geogr., vol. 2, no. 4, p. 109, pl. 15, figs. 4–8. Syntypes: IGPS nos. 8403–8407 (Existing). Type locality: Yahagi-mura, Kesen-gun, prov. Rikuzen [currently Yahagicho, Rikuzentakata City, Iwate Prefecture]. Stratigraphic unit: Upper *Productus*-limestone [Lower part of Kanokura Formation]. Geologic age: Lower Permian [Middle Permian]. Remarks: The species name was originally spelled as *sub-elegans*.

***Mytilus haboroensis* Noda, 1992**

Plate 17, Figure 8

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 62, nos. 1–2, p. 61, pl. 3, figs. 12a–13. Holotype: IGPS no. 100727 (Existing). Type locality: Loc. no. SS2 (Noda, 1992), upper stream of the Mosetakinai River, Haboro-machi [*sic*, Sakae, Shosanbetsu-mura], Tomamae-gun, Rumoi Province, Hokkaido. Stratigraphic unit: Lower part of Sankebetsu Formation. Geologic age: Miocene [Late Eocene].

***Mytilus ogawaensis* Hatai and Nisiyama, 1949**

Plate 17, Figure 9

Jour. Paleont., vol. 23, no. 1, p. 89, pl. 24, fig. 17. Holotype: IGPS no. 72503 (Existing). Ogasawara (2001)

erroneously cited IGPS no. 722503 as the holotype. Type locality: Stream exposure slightly W of Ogawa, Kawabemura, Ishiki-gun [*sic*, Iwaki-gun] [currently Kawabemachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Iwaki Formation. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene].

***Nemocardium (Keenaea) yoshidai* Masuda and Miyasaka, 1994**

Plate 17, Figure 10

Saito Ho-on Kai Mus. Nat. Hist., Res. Bull., no. 62, p. 1, pl. 1, figs. 1a–3b. Holotype: IGPS no. 102544 (Existing). Type locality: Cliff along a small stream at Takinosawa, Osawagoshuku, Nishisenboku-machi, Senboku-gun [currently Osawagoshuku, Daisen City], Akita Prefecture. Stratigraphic unit: Tentokuji Formation. Geologic age: Pliocene.

***Neoburmesia iwakiensis* Yabe and Sato, 1942**

Plate 17, Figure 11

Proc. Imp. Acad., vol. 18, no. 5, p. 251, text-figs. 1–3. Holotype: IGPS no. 65274 (Existing). Type locality: 1.5 km W Koike, Kami-mano-mura, Soma-gun [currently Koike, Kashima-ku, Minamisoma City], Fukushima [Fukushima] Prefecture. Stratigraphic unit: Torinosu limestone [Nakanosawa Formation in Soma area]. Geologic age: Upper Jurassic [Kimmeridgian (Upper Jurassic–Lower Cretaceous)].

***Nicaniella (Trautscholdia) nagaoi* Matsubara, 2016**

Plate 17, Figures 12a–b

Bull. Tohoku Univ. Mus., no. 15, p. 107. Holotype: IGPS no. 66425 (Existing). Type locality: Southern coast of Hiraiga Inlet, Tanohata-mura, Shimohei-gun, Iwate Prefecture. Stratigraphic unit: Hiraiga Formation. Geologic age: Early Cretaceous.

***Nipponopagia ommaensis* Ogasawara, 1977**

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 47, no. 2, p. 126, pl. 15, figs. 4, 6, 8, pl. 16, fig. 3. Holotype: IGPS no. 95072 (Missing). Type locality: Loc. no. KO-22 (Ogasawara, 1977); cliff, distant from the road, 300 m W of Kaminakamachi, Kanazawa City, Ishikawa Prefecture. Stratigraphic unit: Omma Formation. Geologic age: Pliocene [Early Pleistocene]. Remarks: The present species is a type species of *Nipponopagia* Ogasawara, 1977 (by original designation). However, it is thought to be a junior synonym of *Macoma (Macoma) middendorffi* Dall, 1884 (Petrov, 1982; Amano, 1996).

***Noetia nagaoi* MacNeil, 1938**

Plate 17, Figure 13

U.S. Geol. Surv., Prof. Pap., 189-A, p. 30, pl. 4, figs. 19–21. Holotype: IGPS no. 36012 (Existing). Type locality: The

Hoshuyama Mine (about 200 m S of the bridge at E of Kawamagari, and about 600 m W of the village office) at Daigyoji, Hoshuyama-mura [currently Toho-mura], Asakura-gun, Fukuoka Prefecture. Stratigraphic unit: Doshi Formation. Geologic age: Upper Eocene. Remarks: Proposed as nom. nov. for *Arca (Noetia) pondaungensis* var. *transversa* Nagao, 1928b, non *Arca transversa* Say, 1822.

***Nucula fukasawaensis* Akutsu, 1964**

Plate 17, Figure 14

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 282, pl. 59, fig. 1. Holotype: IGPS no. 85500 (Existing). Type locality: Fukasawa, about 1.8 km upstream from Kanezawa, Shiobara-machi, Shioya-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene].

***Nucula hizenensis* Nagao, 1928b**

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 19, pl. 7, figs. 18, 18a. Holotype: IGPS no. 35985 (Missing). Type locality: Okino-shima, Iôjima-mura, Nishisonogi-gun [currently Iojimamachi, Nagasaki City], Province of Hizen [Nagasaki Prefecture]. Stratigraphic unit: Okino-shima Beds [Okinoshima Formation]. Geologic age: Eocene [late Middle Eocene].

***Nucula (Acila) hokkaidoensis* Nagao, 1932**

Jour. Fac. Sci., Hokkaido Imp. Univ., Ser. 4, vol. 2, no. 1, p. 28, pl. 5, figs. 17–18. Holotype: IGPS no. 6421 (Missing). Type locality: A point about 100 m S of the junction of the Abeshinai with its tributary Sakai River [currently Nakagawa-cho, Nakagawa-gun], Teshio Province, Hokkaido. Stratigraphic unit: Upper Ammonite Beds [Middle Yezo Group and Upper Yezo Group in Teshio area]. Geologic age: Upper Cretaceous [Turonian–Campanian [Santonian], Cretaceous].

***Nucula ishidoensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 17, Figures 15a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 41, pl. 13, figs. 46, 47. Syntypes: IGPS no. 7125 (Existing). Type locality: Ishidô, near Ôhinata [currently Ishidô, Ôhinata, Sakuho-machi, Minamisaku-gun, Province of Shinano [Nagano Prefecture]. Stratigraphic unit: Ishidô Group [Ishidô Formation]. Geologic age: Cretaceous [Early Cretaceous (late Neocomian)].

***Nucula karatsuensis* Nagao, 1928b**

Plate 17, Figure 16

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 20, pl. 7, fig. 17. Holotype: IGPS no. 35988 (Existing).

Type locality: Obô near Arita-machi, Nishimatsura-gun [*sic*, Nishimatsuura-gun], Province of Hizen [Saga Prefecture]. Stratigraphic unit: Kishima Beds [Kishima Formation]. Geologic age: Oligocene [latest Eocene–earliest Oligocene].

***Nucula kokozuraensis* Hatai and Nisiyama, 1949**

Plate 17, Figures 17a–b

Jour. Paleont., vol. 23, no. 1, p. 87, pl. 25, figs. 1–5. Holotype: IGPS no. 72507 (Existing). Type locality: A small cliff in front of the grocery store at the northern entrance of Kokozura, Nakoso-machi, Ishiki-gun [*sic*, Iwaki-gun] [currently Nakosomachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Kokozura Formation. Geologic age: Miocene [latest Early Miocene].

***Nucula (Acila) mirabilis* var. *ashiyaensis* Nagao, 1928b**

Plate 17, Figures 18a–c

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 21, pl. 7, figs. 6–7, 10 [non figs. 8, 9; =*Acila (Truncacila) nagaoi* Oyama and Mizuno, 1958]. Holotype: IGPS no. 35981 (Existing). Type locality: Taya, Ashiya-machi, Onga-gun, Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Yamaga Beds [Yamaga Formation]. Geologic age: Oligocene.

***Nucula (Ennucula) omagariensis* Honda, 1989**

Plate 17, Figure 19

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 60, no. 1, p. 58, pl. 1, figs. 5, 7–9, 11, 12. Holotype: IGPS no. 95576-1 (Existing). Type locality: OM-6 (Honda, 1989), roadside cliff along the Taron-no-sawa, a tributary of the Rushin-gawa, Urahoro-machi [*sic*, Urahoro-cho], Tokachi-gun, Hokkaido. Stratigraphic unit: Omagari Formation. Geologic age: Oligocene.

***Nucula (Nucula) shiroyamaensis* Noda, 1962b**

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 34, no. 3, p. 226, pl. 16, fig. 7. Holotype: IGPS no. 79061 (Missing). Type locality: Loc. No. 480 (Noda, 1962b), upstream of the Shirono-sawa, a tributary from the Shibumi River, facing the northern slope of the Urugawara-mura [*sic*, Matsudai-machi], Higashikubiki-gun [currently Murono, Tokamachi City], Niigata Prefecture. Stratigraphic unit: Nitta Formation. Geologic age: Early Pliocene.

***Nuculana (Nuculana) karihaensis* Hatai and Nisiyama, 1949**

Plate 17, Figures 20a–c

Jour. Paleont., vol. 23, no. 1, p. 87, pl. 24, figs. 3, 4. Holotype: IGPS no. 72633 (Existing). Type locality: Bridge leading to Takayanagi, Ishiguro-mura, Kariha-gun [*sic*, Kariwa-gun] [currently Ishiguro, Takayanagicho, Kashiwa zaki City], Niigata Prefecture. Stratigraphic unit: Ishiguro

Formation. Geologic age: Miocene [Late Miocene].

***Nuculana (Nuculana) matsukuchiensis* Noda, 1962b**

Plate 17, Figure 21

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 34, no. 3, p. 227, pl. 16, figs. 4a–5. Holotype: IGPS no. 79059 (Existing). Type locality: Loc. No. 80 (Noda, 1962b), Bed of the Esudo River, about 400 m N of the bridge between Mioke and Matsukuchi, Matsunoyama-machi, Higashikubiki-gun [currently Matsunoyama, Tokamachi City], Niigata Prefecture. Stratigraphic unit: Nitta Formation. Geologic age: Early Pliocene.

***Nuculana sanchuensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 17, Figures 22–24

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 42, pl. 12, figs. 21–23. Syntypes: IGPS no. 7115 (Existing). Type locality: Ishidō, near Ōhinata [currently Ishidō, Ōhinata, Sakuho-machi, Minamisaku-gun], Province of Shinano [Nagano Prefecture]. Stratigraphic unit: Ishidō Group [Ishidō Formation]. Geologic age: Cretaceous [Early Cretaceous].

***Nuculites kimurai* Hayasaka, 1925a**

Plate 17, Figures 25a–c

Japan. Jour. Geol. Geogr., vol. 3, no. 2, p. 49, pl. 6, figs. 4–7. Holotype: IGPS no. 22418 (Existing). Type locality: Myōjin-yama, Ogachi, Jyūgohama-mura, Monō-gun, prov. Rikuzen [currently Ogatsucho, Ishinomaki City, Miyagi Prefecture]. Stratigraphic unit: Ogachi slate [Toyoma Formation]. Geologic age: Upper Paleozoic [Upper Permian].

***Nuttallia uchigoensis* Kamada, 1962**

Plate 17, Figures 26a–b

Palaeont. Soc. Japan Spec. Pap., no. 8, p. 127, pl. 14, fig. 4a, b. Holotype: IGPS no. 79387 (Existing). Type locality: Goten, Uchigo City [currently Uchigo, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Asagai Formation. Geologic age: Oligocene [Early Oligocene].

***Ostrea cassis* Nagao, 1928b**

Plate 18, Figure 1

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 32, pl. 5, figs. 6, 6a, b. Holotype: IGPS no. 36031 (Existing). Type locality: Kōyagi-jima, [Kōyagi-mura, Nishisonogi-gun] [currently Koyagimachi, Nagasaki City], Province of Hizen [Nagasaki Prefecture]. Stratigraphic unit: Okinoshima Beds [Okinoshima Formation]. Geologic age: Eocene [Middle Eocene].

***Ostrea kahoensis* Nagao, 1928b**

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 33, pl. 6, fig. 2. Holotype: IGPS unregistered (Missing). Type locality: The Tadakuma Mine near Iizuka-machi, Province of Chikuzen [currently Iizuka City, Fukuoka Prefecture]. Stratigraphic unit: Namazuta Fossil Beds [=Honso Formation]. Geologic age: Eocene [Middle Eocene].

***Ostrea lunaeformis* Nagao, 1928b**

Plate 18, Figure 2

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 35, pl. 4, fig. 28. Holotype: IGPS no. 36039 (Existing). Type locality: Yanagi, Taira-mura, Nishisonogi-gun [currently Taira, Oosetocho, Saikai City], Province of Hizen [Nagasaki Prefecture]. Stratigraphic unit: Kakinoura Beds [Kakinoura Formation]. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene].

***Ostrea sakitoensis* Nagao, 1928b**

Plate 18, Figures 3a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 34, pl. 5, figs. 17, 17a. Holotype: IGPS no. 36053 (Existing). Type locality: Kaminoura-jima [sic, Kakinoura-shima], Province of Hizen [currently Kakinourago, Sakitocho, Saikai City, Nagasaki Prefecture]. Stratigraphic unit: Itanoura Beds [Itanoura Formation]. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene].

***Ostrea (Ostrea) yokoyamai* Kamada, 1962**

Plate 18, Figure 4

Palaeont. Soc. Japan Spec. Pap., no. 8, p. 68, pl. 4, fig. 1. Holotype: IGPS no. 79378 (Existing). Type locality: In the Yumoto-Gokō, Joban Coal-mine, Yumotomachi, Joban City [currently Joban-Yumotomachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Iwaki Formation. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene]. Remarks: This species is considered as a junior synonym of *Ostrea eorivularis* Oyama and Mizuno, 1958 (Honda, 1989).

***Oxyperas okinawaensis* Masuda and Sato, 1988**

Saito Ho-on Kai Spec. Pub., no. 2 (Prof. T. Kotaka Commem. Vol.), p. 446, pl. 4, figs. 6–14. Holotype: IGPS no. 99715 (Missing). Type locality: Sea cliff at Nishizaki, about 1 km NW of Nakano, Taketomi-cho, [Yaeyama-gun], Iriomote-jima, Okinawa Prefecture. Stratigraphic unit: Iriomote Formation. Geologic age: early Middle Miocene [latest Early –early Middle Miocene].

***Palaeoneilo ogachiensis* Hayasaka, 1925a**

Japan. Jour. Geol. Geogr., vol. 3, no. 2, p. 51, pl. 6, figs. 8–12. Syntypes: IGPS unregistered (Missing). Type

locality: Myōjin-yama, Ogachi, Jyūgohama-mura, Monō-gun, prov. Rikuzen [currently Ogatsucho, Ishinomaki City, Miyagi Prefecture]. Stratigraphic unit: Ogachi slate [Toyoma Formation]. Geologic age: Upper Paleozoic [Upper Permian].

***Panomya izumo* Nomura and Hatai, 1939 [“1938”]**

Plate 18, Figures 5a–b

Japan. Jour. Geol. Geogr., vol. 16, nos. 1–2, p. 6, pl. 1, fig. 2a, b. Holotype: IGPS no. 51884 (Existing). Type locality: Husina [*sic*, Fujina], Tamanoyu-mura [*sic*, Tamayumura], Yatuka-gun [=Yatsuka-gun], Izumo [currently Fujina, Tamayumachi, Matsue City, Shimane Prefecture]. Stratigraphic unit: Izumo Neogene [=Fujina Formation]. Geologic age: Middle Miocene.

***Panope kanomatazawaensis* Akutsu, 1964**

Plate 18, Figure 6

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 288, pl. 60, figs. 3a–5. Holotype: IGPS no. 85513 (Existing). Type locality: A tributary of the Kanomatazawa valley, cliff of the Hoki River, opposite side of the Hokigawa Electric Power Station, Sekiya, Shiobara-machi, Shioka-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene].

***Panope kanomatazawaensis fudozawaensis* Akutsu, 1964**

Plate 18, Figure 7

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 288, pl. 60, fig. 7. Holotype: IGPS no. 85514 (Existing). Type locality: Fudozawa, about 2 km upstream from the entrance of the valley, Fukuwata, Shiobara-machi, Shioka-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene].

***Panopea nomurae* Kamada, 1962**

Plate 18, Figure 8

Palaeont. Soc. Japan Spec. Pap., no. 8, p. 135, pl. 16, figs. 9a–12. Holotype: IGPS no. 79395 (Existing). Type locality: Numanouchi Harbor, Toyoma-machi, Taira City [currently Numanouchi, Taira, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Numanouchi Formation. Geologic age: Miocene [latest Early–earliest Middle Miocene]. Remarks: The present species is a junior synonym of *Panopea tyugokuensis* (Otuka, 1941) (Matsubara, 2011).

***Paphia (Paphia) euglypta ohiroi* Masuda, 1966b**

Plate 18, Figure 9

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 64, p. 326,

pl. 35, figs. 22, 23. Holotype: IGPS no. 90735 (formerly DGS no. 4527; Existing). Ogasawara (2001) erroneously cited IGPS no. 90736 as the holotype. Type locality: Loc. no. 38 (Masuda, 1966a), small exposure near the stream, about 300 m S of Sotonoyama [currently Sotoyama, Otanimachi], Suzu City, Ishikawa Prefecture. Stratigraphic unit: Higashi-innai Formation. Geologic age: Early Miocene [latest Early Miocene].

***Paphia shimotsukensis* Akutsu, 1964**

Plate 18, Figure 10

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 286, pl. 59, fig. 3. Holotype: IGPS no. 85508 (Existing). Type locality: Cliff of the Hoki River, Sekiya, Shiobara-machi, Shioka-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene].

***Paphia (Paphia) suzuensis* Masuda, 1966b**

Plate 18, Figure 11

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 64, p. 327, pl. 35, figs. 24, 25. Holotype: IGPS no. 90086 (formerly DGS no. 4530; Existing). Type locality: Loc. no. 30 (Masuda, 1966a), road side cutting near Koeiji Temple, Otani[machi], Suzu City, Ishikawa Prefecture. Stratigraphic unit: Higashi-innai Formation. Geologic age: Early Miocene [latest Early Miocene].

***Parallelodon obsoletiformis* Hayasaka, 1925b**

Plate 18, Figures 12a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 8, no. 2, p. 18, pl. 8, figs. 15, 16, 16a. Lectotype: IGPS no. 22392 (designated by Hanzawa *et al.*, 1961; Existing). Type locality: Kinshō-zan, Akasaka-machi, prov. Mino [currently Akasakacho, Ogaki City, Gifu Prefecture]. Stratigraphic unit: Kuro zone [Akasaka Limestone]. Geologic age: Permian [Middle Permian].

***Parapholas satoi* Nagao, 1928b**

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 88, pl. 6, figs. 6, 6a, 7. Holotype: IGPS unregistered (Missing). Type locality: Meinohama, Meinohama-machi, Sawara-gun [currently Nishi-ku, Fukuoka City], Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Meinohama Beds [Meinohama Formation]. Geologic age: Oligocene.

***Patinopecten ibaragiensis* Masuda, 1953b**

Plate 19, Figure 1

Short Pap. Inst. Geol. Paleont. Tohōku Univ., no. 5, p. 44, pl. 5, figs. 1–5, pl. 6, figs. 1–5. Holotype: IGPS no. 90698 (formerly DGS no. 1031; Existing). Type locality:

Cliff below the Sukegawa Gas Company, [Higashicho], Hitachi City, Ibaraki Prefecture. Stratigraphic unit: Hitachi Formation. Geologic age: Late Miocene [Early Pliocene]. Remarks: This species is synonymous with *Mizuhopecten planicostulatus* (Nomura and Niino, 1932) (Tanaka and Amano, 1997).

***Patinopecten kagamianus moniwaensis* Masuda, 1958b**

Plate 19, Figure 2

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 32, p. 276, pl. 41, figs. 3–6b. Holotype: IGPS no. 90700 (formerly DGS no. 3506; Existing). Type locality: Moniwa, [Taihaku-ku], Sendai City, Miyagi Prefecture. Stratigraphic unit: Moniwa Formation. Geologic age: Early Miocene [early Middle Miocene].

***Patinopecten kimurai nakosoensis* Masuda, 1960**

Plate 19, Figure 3

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 38, p. 256, pl. 29, figs. 2, 3. Holotype: IGPS no. 90581 (formerly DGS no. 1930; Existing). Type locality: Road-side cliff at Kokozura, Nakoso City [currently Nakosomachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Kokozura Formation. Geologic age: Middle Miocene [latest Early Miocene].

***Patinopecten kimurai yudaensis* Masuda, 1960**

Plate 19, Figure 4

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 38, p. 256, pl. 30, figs. 1, 2. Holotype: IGPS no. 90661 (formerly DGS no. 1936; Existing). Type locality: Right river side of Mabechi-gawa at Yuda, Kintaichi-mura, Ninohe-gun [currently Kintaichi, Ninohe City], Iwate Prefecture. Stratigraphic unit: Shiratori Formation [=Tate Sandstone Member of Kadonosawa Formation]. Geologic age: Early Miocene [latest Early Miocene].

***Patinopecten kobyamai* Kamada, 1954**

Plate 19, Figures 5a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 15, p. 174, pl. 23, figs. 1a–3b. Holotype: IGPS no. 72963 (Existing). Type locality: IGPS loc. no. Fs-23, about 500 m E of Nakayama, Ono-mura, Iwaki-gun [currently Yotsukuramachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Kabeya Formation [=Honya Formation]. Geologic age: Miocene [late Early Miocene].

***Patinopecten (Kotorapecten) naganoensis* Masuda, 1962a**

Plate 19, Figure 6; Plate 20, Figure 1

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 2, p. 219, pl. 25, fig. 1a, b. Holotype: IGPS no. 90547 (formerly DGS no. 3888; Existing). Type locality: Floor of a small tributary of the Dojiri River, Shiroshita [*sic*, Joshita],

Nakajo-mura, Kamiminouchi-gun [currently Nakajo, Nagano City], Nagano Prefecture. Stratigraphic unit: Shigarami Formation. Geologic age: Late Miocene [Early Pliocene].

***Patinopecten nakajimai* Masuda, 1954b**

Plate 20, Figures 2a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 15, p. 159, pl. 21, figs. 1a–5. Holotype: IGPS no. 90580 (formerly DGS no. 1063; Existing). Ogasawara (2001) erroneously cited the holotype as IGPS no. 95080. Type locality: River cliff of Natori-gawa near the Akiu Car-line Station at Kita-Akaishi, Oide-mura, Natori-gun [currently Moniwa, Taihaku-ku, Sendai City], Miyagi Prefecture. Stratigraphic unit: Moniwa Formation. Geologic age: Early Miocene [early Middle Miocene]. Remarks: This species is a junior synonym of *Nipponopecten akihoensis* Saga, in Matsumoto, 1930 (Sato, 1991; Matsubara *et al.*, 2014).

***Patinopecten poculum tsudae* Noda, 1962b**

Plate 20, Figures 3a–b

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 34, no. 3, p. 228, pl. 16, figs. 1–3. Holotype: IGPS no. 79062 (Existing). Type locality: Loc. No. 1061-c (Noda, 1962b), cliff of the Higashi River, about 250 m S of a junction with Etsudo and Higashi Rivers, Matsunoyama-machi, Higashikubiki-gun [Matsunoyama, Tokamachi City], Niigata Prefecture. Stratigraphic unit: Higashigawa Formation. Geologic age: Middle Pliocene.

***Patinopecten (Patinopecten) tokyoensis hokurikuensis* Masuda, 1962a**

Plate 20, Figure 4

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 2, p. 211, pl. 25, fig. 6, pl. 27, figs. 6, 7. Holotype: IGPS no. 13430 (Existing). Type locality: Road-side cliff near the Sai River, about 400 m SE of the contact point of the two roads at Onma-machi [currently Okuwamachi], Kanazawa City, Ishikawa Prefecture. Stratigraphic unit: Onma [Omma] Formation. Geologic age: Pliocene [early Pleistocene]. Remarks: This subspecies is a junior synonym of *Patinopecten (Patinopecten) tokyoensis hokurikuensis* Akiyama, 1962, as noted by Masuda (1962a: p. 238).

***Patinopecten yamasakii kintaichiensis* Masuda, 1958c**

Plate 20, Figure 5

Saito Ho-on Kai Mus. Res. Bull., no. 27, p. 47, pl. 4, figs. 3a–4. Holotype: IGPS no. 90715 (formerly DGS no. 3610; Existing). Type locality: Entrance to the eastern valley running parallel with the Kamiyama-zawa, Kintaichi-mura, Ninohe-gun [currently Kintaichi, Ninohe City], Iwate Prefecture. Stratigraphic unit: Suenomatsuyama Formation [Tomesaki Formation]. Geologic age:

Late Miocene [early Middle Miocene]. Remarks: The present species is a junior synonym of *Masudapecten iwasakiensis* (Nomura, 1935) (Masuda *et al.*, 1994).

***Patinopecten yamasakii ninohensis* Masuda, 1954a**

Plate 20, Figure 6

Saito Ho-on Kai Mus. Res. Bull., no. 23, p. 13, figs. 1a–3. Holotype: IGPS no. 90684 (formerly DGS no. 2532; Existing). Type locality: River floor of Shiratorizawa [*sic*, Shiratorigawa] in Fukuoka-machi, Ninohe-gun [currently Fukuoka, Ninohe City], Iwate Prefecture. Stratigraphic unit: Suenomatsuyama Formation. Geologic age: Late Miocene [earliest Middle Miocene]. Remarks: IGPS no. 90683 given by Ogasawara (2001) is incorrect.

***Patinopecten (Patinopecten) yessoensis nakatonbetsuensis* Masuda, 1962a**

Plate 20, Figure 7

Sci. Rep. Tohoku Univ., 2nd. Ser. (Geol.), vol. 33, no. 2, p. 214, pl. 24, fig. 4. Holotype: IGPS no. 90662 (formerly DGS no. 3899; Existing). Type locality: Asahidai, Nakatonbetsu-machi [*sic*, Nakatonbetsu-cho], Esashi-gun, Kitami Province, Hokkaido. Stratigraphic unit: Nakatonbetsu Formation. Geologic age: Late Miocene [Middle Miocene]. Remarks: This taxon is a junior synonym of *Patinopecten (Patinopecten) nakatombetsuensis* Akiyama, 1962 *ex* Masuda (MS), as noted by Masuda (1962a: p. 238).

***Patinopecten (Patinopecten) yessoensis yokoyamae* Masuda, 1962a**

Plate 21, Figure 1

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 2, p. 215, pl. 25, figs. 2, 3, pl. 26, fig. 7, pl. 27, fig. 12. Holotype: IGPS no. 90543 (formerly DGS 3836; Existing). Type locality: Left cliff of the Chikagawa River, about 200 m from the sea shore at Chikagawa [*sic*, Nakachikagawa, Nakanosawa], Mutsu City, Aomori Prefecture. Stratigraphic unit: Hamada Formation. Geologic age: Pliocene [Early Pleistocene].

***Pecten (Pseudamusium) akihoensis* Saga, in Matsumoto, 1930**

Plate 21, Figures 2a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 13, no. 3, p. 106, pl. 40, figs. 7, 8. Neotype: IGPS no. 90586 (formerly DGS 1001, designated by Masuda, 1952; Existing). Matsumoto's (1930) syntypes are missing (Masuda, 1952). Type locality: 100 m W of the Kumanodo-shrine, Takadate-mura [currently Takadate-Kumanodo, Natori City], Miyagi Prefecture. Stratigraphic unit: Moniwa Formation. Geologic age: Late Miocene [early Middle Miocene]. Remarks: Originally spelled as *akihoënsis*

(Matsumoto, 1930).

***Pecten (Chlamys) ashiyaensis* Nagao, 1928b**

Plate 21, Figure 3

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 39, pl. 9, figs. 2, 2a. Holotype: IGPS no. 36448 (Existing). Type locality: Yamaga, Ashiya-machi, Onga-gun, Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Yamaga Formation. Geologic age: Oligocene [latest Early–earliest Late Oligocene].

***Pecten (Chlamys) ashiyaensis var. denselineatus* Nagao, 1928b**

Plate 21, Figure 4

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 40, pl. 8, fig. 9. Holotype: IGPS no. 36437 (Existing). Type locality: Kaminoura-jima, [Sakito-mura, Nishisonogigun], Province of Hizen [currently Kakinourago, Sakitocho, Saikai City, Nagasaki Prefecture]. Stratigraphic unit: Itanoura Beds [Itanoura Formation]. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene].

***Pecten (Vola) byoritsuensis* Nomura, 1933**

Plate 21, Figure 5

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 57, pl. 1, figs. 4a–5b. Holotype: IGPS no. 45001 (Existing). Type locality: The upper course of Sairyōkyō, Sanchin-shō, Tainan-shu [currently Yseiliao Bridge, Yseiliao, Ronghe Village, Tsuochen District, Tainan City], Taiwan. Lithostratigraphic unit: Byōritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Pecten (Propeamusium) cowperi var. yubarensis* Yabe and Nagao, 1928**

Plate 21, Figure 6

Sci. Rep. Tōhoku Imp. Univ., vol. 9, no. 3, p. 88, pl. 16, figs. 17–19. Holotype: IGPS no. 22599 (Existing). Type locality: Pankemo-yubari, Oyubari, Yubari-gun [currently Pankemoyuparo River, Kashima-shirogane, Yubari City], Hokkaido. Stratigraphic unit: Middle Yezo Group and Upper Yezo Group in various areas of Hokkaido. Geologic age: Cenomanian–Campanian, Cretaceous.

***Pecten (Aequipecten) gabusogaensis* Nomura and Zinbō, 1936**

Plate 21, Figure 7

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 18, no. 3, p. 236, pl. 11, figs. 3a–4b. Holotype: IGPS no. 51321 (Existing). Type locality: Gabusoga, Haneji-mura, Kunigami-gun [currently Nago City], Okinawa-jima, Okinawa Prefecture. Stratigraphic unit: Simaziri Beds [=Haneji Formation]. Geologic age: Early Pliocene [Early Pleistocene].

***Pecten (Decadopecten) izuensis* Nomura and Niino, 1932**

Plate 21, Figures 8–12

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 15, no. 3, p. 179, pl. 11, figs. 9–13. Syntypes: IGPS no. 44583 (Existing). Type locality: Nagata, Shirahama-mura, Kamo-gun, Province of Izu [currently Shirahama, Shimoda City, Shizuoka Prefecture]. Stratigraphic unit: Shirahama Shell-Beds of Shirahama Group [Shirahama Formation]. Geologic age: Miocene [Pliocene].

***Pecten (Chlamys) kagamianus miyagiensis* Nakamura, 1940a**

Plate 21, Figure 13

Japan. Jour. Geol. Geogr., vol. 17, nos. 1–2, p. 10, pl. 2, fig. 4. Holotype: IGPS no. 61336 (Existing). Type locality: Ōtutumi [=Otsutsumi], Miyatoko-mura [currently Miyatoko, Taiwa-cho], Kurokawa-gun, Miyagi Prefecture. Stratigraphic unit: Ōtutumi Beds [=Otsutsumi Formation]. Geologic age: Miocene [early Late Miocene]. Remarks: The present subspecies is a junior synonym of *Nanaochlamys notoensis otutumiensis* (Nomura and Hatai, 1937) (e.g. Masuda, 1962a; Sato, 1991).

***Pecten (Pecten) kakisakiensis* Nomura and Niino, 1932**

Plate 21, Figures 14–15

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 15, no. 3, p. 177, pl. 12, figs. 3, 4. Syntypes: IGPS no. 44582 (Existing). Type locality: Kakisaki, Hamasaki-mura [sic, Hamazaki-mura], Kamo-gun, Province of Izu [currently Kakisaki, Shimoda City, Shizuoka Prefecture]. Stratigraphic unit: Shirahama Shell-Beds of Shirahama Group [Shirahama Formation]. Geologic age: Miocene [Pliocene]. Remarks: The present species is synonymous with *Mimachlamys satoi* (Yokoyama, 1928) (e.g. Masuda, 1962a).

***Pecten (Aequipecten) kikaiensis* Nomura and Zinbō, 1934**

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 2, p. 153 (45), pl. 5 (1), fig. 9a, b. Holotype: IGPS no. 50357? (Missing). Type locality: Plateaux area near Kamikatetu, Kikai-zima, [Kikai-cho, Oshima-gun], Kagoshima Prefecture. Lithostratigraphic unit: "Ryūkyū Limestone". Geologic age: Pleistocene.

***Pecten (Patinopecten) kimurai matumoriensis* Nakamura, 1940a**

Plate 22, Figures 1a–b

Japan. Jour. Geol. Geogr., vol. 17, nos. 1–2, p. 13, pl. 1, figs. 1, 2, pl. 2, figs. 1–3. Syntypes: IGPS no. 61335 (Existing). Type locality: Matumori [=Matsumori], Nanakita-mura, Miyagi-gun [currently Matsumori, Izumi-ku, Sendai City], Miyagi Prefecture. Stratigraphic unit: Nanakita Beds [Nanakita Formation]. Geologic age: Miocene [late Late

Miocene].

***Pecten kyushuensis* Nagao, 1928b**

Plate 22, Figure 2

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 37, pl. 8, figs. 1, 1a. Holotype: IGPS no. 36459 (Existing). IGPS no. 36450 cited by Ogasawara (2001) is incorrect. Type locality: Wakita, Shimagō-mura, Onga-gun [currently Wakamatsu-ku, Kitakyushu City], Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Wakita Beds [=Waita Formation]. Geologic age: Oligocene.

***Pecten (Swiftopecten) nanakitaensis* Nakamura, 1940b**

Plate 22, Figure 3

Jour. Geol. Soc. Japan, vol. 47, no. 561, p. 264, text-fig. 1. Holotype: IGPS 61334 (Existing). Type locality: Southern slope of Dōniwayama, Nenoshiroishi-mura [=Nenoshiroishimura], Miyagi-gun [currently Nenoshiroishi, Izumi-ku, Sendai City], Miyagi Prefecture. Stratigraphic unit: Nanakita Beds [=Nanakita Formation]. Geologic age: Miocene [late Late Miocene]. Remarks: This species is a junior synonym of "*Gloripallium*" *crassivenium* (Yokoyama, 1929) (Masuda, 1958a).

***Pecten (Patinopecten) planicostulatus* Nomura and Niino, 1932**

Plate 22, Figure 4

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 15, no. 3, p. 177, pl. 11, figs. 2–5. Syntypes: IGPS no. 44584 (Existing). Type locality: Ichiyama, Yugashima-mura [sic, Kamikano-mura], Tagata-gun, Province of Izu [currently Izu City, Shizuoka Prefecture]. Stratigraphic unit: Shirahama Shell-Beds of Shirahama Group [Shirahama Formation]. Geologic age: Miocene [Pliocene].

***Pecten (Chlamys) sakitoensis* Nagao, 1928b**

Plate 22, Figure 5

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 37, pl. 17, figs. 37, 38. Holotype: IGPS no. 36438 (Existing). Ogasawara (2001) erroneously cited IGPS no. 3638 as the holotype. Type locality: Itanoura, Seto-mura, Nishisonogi-gun [currently Itanourago, Seto, Osetomachi, Saikai City], Province of Chikuzen [Nagasaki Prefecture]. Stratigraphic unit: Itanoura Formation. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene].

***Pecten (Pecten) shirahamaensis* Nomura and Niino, 1932**

Plate 22, Figures 6a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 15, no. 3, p. 175, pl. 12, figs. 5, 5a. Holotype: IGPS no. 44587

(Existing). Type locality: Nagata, Shirahama-mura, Kamo-gun, Province of Izu [currently Shirahama, Shimoda City, Shizuoka Prefecture]. Stratigraphic unit: Shirahama Shell-Beds of Shirahama Group [Shirahama Formation]. Geologic age: Miocene [Pliocene].

***Pecten (Pecten) subsquamatus* Nomura, 1933**

Plate 22, Figures 7a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 53, pl. 1, fig. 11a, b. Holotype: IGPS no. 44702 (Existing). Type locality: Station no. 57 (Nomura, 1933), 550 m E of Jô-tsûsho-wan, Tsûshô-shô, Byôritsu-gun, Shinchiku-shû [currently Shangtongsiaowan, Tongwan Village, Tongshao Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byôritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Pecten (Patinopecten) taiwanus* Nomura, 1933**

Plate 22, Figure 8

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 56, pl. 2, fig. 5a, b. Holotype: IGPS no. 45007 (Existing). Type locality: Station no. 35 (Nomura, 1933), Wangwa, Kôryû-shô, Chikunan-gun, Shinchiku-shû [currently Wanwa, Jhonghe Village, Houlong Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byôritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene]. Remarks: The present species is synonymous with *Mizuhopecten tokyoensis* (Tokunaga, 1906) (e.g. Masuda and Huang, 1994).

***Pecten (Decadopecten) tayamai* Nomura and Niino, 1932**

Plate 22, Figures 9–11

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 15, no. 3, p. 178, pl. 11, figs. 6–8. Syntypes: IGPS no. 44581 (Existing). Type locality: Nagata, Shirahama-mura, Kamo-gun, Province of Izu [currently Shirahama, Shimoda City, Shizuoka Prefecture]. Stratigraphic unit: Shirahama Shell-Beds of Shirahama Group [Shirahama Formation]. Geologic age: Miocene [Pliocene].

***Pecten (?Amussiopecten) yabei* Nomura, 1933**

Plate 23, Figure 1

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 59, pl. 2, figs. 3, 4. Holotype: IGPS no. 25265 (Existing). Type locality: Near Rahau, Banchi, Kagi-gun, Tainan-shû [currently Arishan Township, Chiayi County], Taiwan. Stratigraphic unit: Kaizan Beds. Geologic age: Miocene [Late Oligocene].

***Pectunculus hokkaidoensis* Yabe and Nagao, 1928**

Plate 23, Figure 2

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9,

no. 3, p. 82, pl. 17, fig. 22. Holotype: IGPS no. 22613 (Existing). Type locality: Ponhorokabetsu [Ponporokabetsu River], Yubari-machi, Yubari-gun [currently Yubari City], Hokkaido. Stratigraphic unit: Mikasa Group in Yubari area. Geologic age: Cenomanian–Turonian, Cretaceous.

***Pectunculus sachalinensis* Yabe and Nagao, 1925**

Plate 23, Figures 3a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 7, no. 4, p. 112, pl. 29, figs. 7, 8. Syntypes: IGPS no. 8554 (Existing). Type locality: Sea cliff 1 km S of Cape Khoi [near Alexandrovsk, north Saghalin] [currently Alexandrovsk-Sakhalinsky District, Sakhalin Oblast, Russia]. Lithostratigraphic unit: Cape Khoi bed. Geologic age: Cretaceous [Cenomanian–Turonian, Cretaceous].

***Pedalion tomiyasui* Nagao, 1928a**

Plate 23, Figure 4

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 103, pl. 20, figs. 5, 5a. Lectotype: IGPS no. 35686 (designated by Hatai and Nisiyama, 1952; Existing). Type locality: Kôyagi-jima, [Kôyagi-mura], Nishisonogi-gun, Province of Hizen [currently Koyagimachi, Nagasaki City], Nagasaki Prefecture. Stratigraphic unit: Lower *Orthis japonicus* Zone [=Futagojima Formation]. Geologic age: Lower Eocene [Middle Eocene].

***Periploma fujikuraense* Noda, 1962b**

Plate 23, Figure 5

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 34, no. 3, p. 229, pl. 16, fig. 6. Holotype: IGPS no. 79056 (Existing). Type locality: Loc. no. 1300 (Noda, 1962b), upstream of the Higashi River, about 400 m S of Fujikura, Matsunoyama-machi, Higashikubiki-gun [currently Matsunoyama, Tokamachi City], Niigata Prefecture. Stratigraphic unit: Nitta Formation. Geologic age: Early Pliocene. Remarks: Although the name of species was originally spelled as *fujikuraensis*, it is corrected herein as *fukuraense* because *Peliploma* is a neuter.

***Periploma pulchellum* Hatai and Nisiyama, 1949**

Plate 23, Figures 6a–b

Jour. Paleont., vol. 23, no. 1, p. 90, pl. 23, figs. 17, 18. Holotype: IGPS no. 72508 (Existing). IGPS no. 72507 given by original description as the holotype is incorrect. Type locality: A small cliff in front of the grocery store at the northern entrance to Kokozura, Nakoso-machi, Ishiki-gun [sic, Iwaki-gun] [currently Nakosomachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Kokozura Formation. Geologic age: Miocene [latest Early Miocene].

***Perna sanchuensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 23, Figures 7a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 57, pl. 12, figs. 1–4. Lectotype: IGPS no. 22457 (designated by Hayami, 1965a; Existing). Type locality: Hachimanzawa [currently Kagahara, Kanna-machi], Tano-gun, Province of Kōzuke [Gumma Prefecture]. Stratigraphic unit: Shiroy Group [Sebayashi Formation]. Geologic age: Cretaceous [late Early Cretaceous (Aptian–Albian)].

***Peronidia ochii* Kamada, 1962**

Plate 23, Figure 8

Palaeont. Soc. Japan Spec. Pap., no. 8, p. 133, pl. 16, figs. 6–8. Holotype: IGPS no. 79388 (Existing). Type locality: Yumoto colliery, Joban Coal-mine, Yumotomachi, Joban City [currently Joban-Yumotomachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Iwaki Formation. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene].

***Pholadomya brevtesta* Nagao, 1943**

Plate 23, Figures 9a–c

Jour. Geol. Soc. Japan, vol. 50, no. 596, p. 157, pl. 13 (10), fig. 3. Holotype: IGPS no. 72710 (Existing). Type locality: Koikorobe, Tanohata-mura, Shimohei-gun, Province of Rikutyū, [Iwate Prefecture]. Stratigraphic unit: precise horizon uncertain [Miyako Group in Tanohata area]. Geologic age: Early Cretaceous.

***Pholadomya kazusaensis* Nagao, 1943**

Plate 23, Figures 10a–c

Jour. Geol. Soc. Japan, vol. 50, no. 596, p. 154, pl. 12 (9), figs. 2, 2a, 3, 3a. Holotype: IGPS no. 19534 (Existing). Type locality: A point between Seki and Minato, Province of Kazusa [currently Futtsu City, Chiba Prefecture]. Stratigraphic unit: Nokogiri Bed [=Nokogiriyama Formation]. Geologic age: Miocene [late Late Miocene–earliest Early Pliocene].

***Pholadomya? miyamotoi* Nagao, 1943**

Plate 23, Figure 11

Jour. Geol. Soc. Japan, vol. 50, no. 596, p. 158, pl. 12 (9), figs. 8, 9. Lectotype: IGPS no. 72737 (designated by Hayami, 1966; Existing). Type locality: Haibe, Tanohata-mura, Shimohei-gun, Iwate Prefecture. Stratigraphic unit: Hiraiga Sandstone [=Hiraiga Formation] in Tanohata area. Geologic age: Early Cretaceous (Aptian).

***Pholadomya takasimensis* Nagao, 1943**

Plate 23, Figures 12a–c

Jour. Geol. Soc. Japan, vol. 50, no. 596, p. 156, pl. 13 (10),

fig. 1, 1a, b. Holotype: IGPS no. 72706 (Existing). Type locality: Okinoshima, in the Takashima Coal-field, Province of Hizen [currently Iojimamachi, Nagasaki City, Nagasaki Prefecture]. Stratigraphic unit: Okinoshima Bed [=Okinoshima Formation]. Geologic age: Eocene [Middle Eocene].

***Pinna asakuraensis* Nagao, 1928b**

Plate 23, Figures 13a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 31, pl. 8, figs. 20, 20a. Holotype: IGPS no. 36017 or 36018 (Both numbers are written on the same specimen; Existing). Type locality: Doshi, Hōshuyama-mura [currently Tōhō-mura], Asakura-gun, Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Kawamagari Beds [Kawamagari Formation]. Geologic age: Eocene.

***Pitar hataii* Natori, 1964**

Plate 23, Figure 14

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 55, p. 250, pl. 36, fig. 3a, b. Holotype: IGPS no. 85728 (Existing). Type locality: Motomiya, Motomiya-cho [sic, Hongu, Hongu-cho], Higashimuro-gun [currently Hongucho, Tanabe City], Wakayama Prefecture. Stratigraphic unit: Ukekawa-Muro Formation. Geologic age: Oligocene or Early Miocene.

***Pitar hokkaidoensis* Nomura, 1935a**

Plate 24, Figures 1a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 18, no. 1, p. 35, pl. 4, figs. 1, 2. Holotype: IGPS no. 56371 (Existing). Type locality: At the junction of the Ponrurumoppe-gawa and the Rumoi-gawa, Rumoi-gun, Teshio [River cliff about 650 m NW of Owaga Station at the junction of the Ponrurumoppe-gawa and the Rumoi-gawa, Rumoi-machi, Rumoi-gun, Teshio Province] [currently Togeshita, Rumoimura, Rumoi City], Hokkaido. Stratigraphic unit: Takikawa Formation [correctly Togeshita Formation: Hayasaka and Uozumi, 1954]. Geologic age: Pliocene [late Middle or Late Miocene].

***Pitar kotoi* Natori, 1964**

Plate 24, Figure 2

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 55, p. 252, pl. 36, fig. 4a, b. Holotype: IGPS no. 85729 (Existing). Type locality: Motomiya, Motomiya-cho [sic, Hongu, Hongu-cho], Higashimuro-gun [currently Hongucho, Tanabe City], Wakayama Prefecture. Stratigraphic unit: Ukekawa-Muro Formation. Geologic age: Oligocene or Early Miocene.

***Pitar sendaica monstrosa* Nomura, 1938**

Plate 24, Figures 3a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 19, p. 259, pl. 35, figs. 8a–9b. Holotype: IGPS no. 16131A

(Existing). Type locality: Gôroku cliff along the right bank of the Hirosegawa-River, western border of Sendai [Gôroku, Hirose-mura, Miyagi-gun] [currently Gôroku, Aoba-ku, Sendai City], Miyagi Prefecture. Stratigraphic unit: Tatunokuti Shell Bed [=Tatsunokuchi Formation]. Geologic age: Early Pliocene [latest Late Miocene—earliest Early Pliocene].

"Pitar" shiobarensis Akutsu, 1964

Plate 24, Figure 4

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 284, pl. 59, fig. 13 Holotype: IGPS no. 85505 (Existing). Type locality: Along the Hoki River, opposite the Electric Power Station at Sekiya, Shiobara-machi, Shioyagun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene].

Pitar sunakozakaensis Ogasawara, 1976

Plate 24, Figure 5

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 46, no. 2, p. 50, pl. 12, figs. 17, 18, 22. Holotype: IGPS no. 95028 (Existing). Type locality: Loc. no. Su-01 (Ogasawara, 1976), river side cliff of Asano-gawa at Higashi-Ichise [*sic*, Higashi-Ichinosemachi], Kanazawa City, Ishikawa Prefecture. Stratigraphic unit: Sunakozaka Formation [=Sunagozaka Formation]. Geologic age: Miocene [latest Early Miocene].

Pitaria? altoumbonata Nagao, 1928b

Plate 24, Figure 6

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 75, pl. 11, fig. 15. Holotype: IGPS no. 36445 (Existing). Type locality: Shinyama, Ômachi-mura, Kishima-gun, Province of Hizen [currently Omachi, Omachi-cho, Kishima-gun, Saga Prefecture]. Stratigraphic unit: Kishima Beds [Kishima Formation]. Geologic age: Oligocene [latest Late Eocene—earliest Early Oligocene].

Pitaria ashiyaensis Nagao, 1928b

Plate 24, Figure 7

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 72, pl. 13, fig. 1a, b. Holotype: IGPS no. 36434 (Existing). Type locality: Iwaya, Shimagô-mura, Onga-gun [currently Wakamatsu-ku, Kitakyushu City], Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Yamaga Beds [Yamaga Formation]. Geologic age: Oligocene. Remarks: Original spelling *ashiyaensis* is corrected.

Pitaria kyushuensis Nagao, 1928b

Plate 24, Figures 8a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 70, pl. 12, figs. 1, 1a. Holotype: IGPS no. 36238

(Existing). Type locality: Western coast of Okinoshima, Iôjima-mura, Nishisonogi-gun [currently Iojimamachi, Nagasaki City], Province of Hizen [Nagasaki Prefecture]. Stratigraphic unit: Okinoshima Beds [Okinoshima Formation]. Geologic age: Eocene [Middle Eocene].

Pitaria matsumotoi Nagao, 1928b

Plate 25, Figure 1

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 73, pl. 13, figs. 4, 4a. Holotype: IGPS no. 36241 (Existing). Type locality: Sea cliff facing the mouth of Ongagawa, about 400 m NW of Yamaga, Ashiya-machi, Onga-gun, Fukuoka Prefecture. Stratigraphic unit: Yamaga Formation. Geologic age: Oligocene.

Pitaria takashimaensis Nagao, 1928b

Plate 25, Figure 2

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 72, pl. 12, figs. 11, 11a–b. Holotype: IGPS no. 36300 (Existing). Type locality: Abô, Koyagi-jima, Koyagimura, Nishisonogi-gun, Province of Hizen [currently Koyagimachi, Nagasaki City, Nagasaki Prefecture]. Stratigraphic unit: Okinoshima Beds [Okinoshima Formation]. Geologic age: Eocene [Middle Eocene].

Pitaria yokoyamai Nagao, 1928b

Plate 25, Figures 3a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 74, pl. 11, figs. 10, 10a. Holotype: IGPS no. 36443 (Existing). Type locality: Sea coast S of Tokuman, Ôshima, Kurose-mura, Nishisonogi-gun [currently Oshimacho, Saikai City], Province of Hizen [Nagasaki Prefecture]. Stratigraphic unit: Kakinoura Beds [Kakinoura Formation]. Geologic age: Oligocene [latest Late Eocene—earliest Early Oligocene].

Placopecten nomurai Masuda, 1953a

Plate 25, Figure 4

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 12, p. 83, pl. 8, figs. 1a–7. Holotype: IGPS no. 90553 (formerly DGS no. 1041; Existing; broken). Type locality: Stream floor of small tributary of the Natori River at Moniwa, Oide-mura, Natori-gun [currently Moniwa, Taihaku-ku, Sendai City], Miyagi Prefecture. Stratigraphic unit: Moniwa Formation. Geologic age: Early Miocene [early Middle Miocene].

Placopecten wakuyaensis Masuda, 1956

Plate 25, Figures 5a–b

Saito Ho-on Kai Mus. Res. Bull., no. 25, p. 23, pl. 3, figs. 1a–4. Holotype: IGPS no. 90596 (formerly DGS no. 3003; Existing). Type locality: Oido, Wakuya-machi [*sic*, Wakuya-cho], Tôda-gun, Miyagi Prefecture. Stratigraphic unit: Oido Formation. Geologic age: Early Miocene [Middle Miocene].

***Plicatula tuberculosa* Nomura, 1933**

Plate 25, Figures 6a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 62, pl. 1, fig. 2. Holotype: IGPS no. 45030 (Existing). Type locality: Mud-volcanoes at Konsuihei, Kyoshito, Okayama-gun, Takao-shu [currently Kunshuiping Mud Volcano, Yanchao Township, Kaohsiung County], Taiwan. Geologic age: Unknown (ejecta of mud volcano).

***Pododesmus (Monia) noharai* Noda, 1971**

Plate 25, Figure 7

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 81, p. 39, pl. 7, fig. 17. Holotype: IGPS no. 86762 (Existing). Type locality: Loc. no. 109 (Noda, 1971), W of Kogachi, Haneji-son [currently Nago City], Okinawa-jima, Okinawa Prefecture. Stratigraphic unit: Haneji Formation. Geologic age: Pliocene [Early Pleistocene].

***Polynemamussium masagoi* Kotaka and Noda, 1967**

Plate 25, Figures 8a–c

Saito Ho-on Kai Mus. Res. Bull., no. 36, p. 39, pl. 1, figs. 1–6, 8, 11. Holotype: IGPS no. 90755 (Existing). Type locality: Loc. no. 8 (Kotaka and Noda, 1967), upstream of the Moriai-zawa [*sic*, Moriya-zawa], about 800 m from the junction with the Nakano-gawa, Ogawara [*sic*, Okawara], Kuroishi City, Aomori Prefecture. Stratigraphic unit: Ogawara Formation. Geologic age: Middle Natorian [Late Miocene].

***Polynemamussium yasudae* Masuda, 1962a**

Plate 25, Figure 9

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 2, p. 156, pl. 18, figs. 9a–11. Holotype: IGPS no. 90602 (Existing). Type locality: Road-side cutting, about 500 m N of the Kogane shrine, N of Koganebasama, Motowakuya, Wakuya-machi [*sic*, Wakuya, Wakuya-cho], Toda-gun, Miyagi Prefecture. Stratigraphic unit: Oido Formation. Geologic age: Early Miocene [Middle Miocene].

***Portlandia (Portlandella) enaensis* Kamada, 1962**

Plate 25, Figures 10a–b

Palaeont. Soc. Japan, Spec. Pap., no. 8, p. 51, pl. 1, figs. 28a–30. Holotype: IGPS no. 79377 (Existing). Type locality: Hieda, Shimokajiro, Ena-machi [*sic*, Ena], Iwaki City, Fukushima Prefecture. Stratigraphic unit: Honya Formation. Geologic age: Miocene [Early Miocene].

***Protocardia ibukii* Nakazawa and Murata, 1966**

Plate 25, Figure 11

Mem. Coll. Sci. Univ. Kyoto, Ser. B, vol. 32, no. 4, p. 314, pl. 4, fig. 7a, b. Holotype: IGPS no. 85765 (Existing). Type locality: Kanayama-zawa near the Omine mine [currently Kamigocho, Tono City], Iwate Prefecture. Stratigraphic

unit: Kamihei Group in Kamihei area. Geologic age: Neocomian, Cretaceous.

***Psammocola kazusensis atsumiensis* Hayasaka, 1961**

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 33, no. 1, p. 54–55, pl. 7, figs. 1–2. Holotype: IGPS no. 78419 (Missing). Type locality: Loc. no. SC132–SC144 (Hayasaka, 1961), Takamatsu coast, Takamatsu, Akabane-cho, Atsumi-gun [currently Takamatsucho, Tahara City], Aichi Prefecture. Stratigraphic unit: “Tonna bed” in Toshima Sand, Middle Pleistocene.

***Psammocola sekiyaensis* Akutsu, 1964**

Plate 25, Figure 12

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 287, pl. 60, fig. 6. Holotype: IGPS no. 85511 (Existing). Type locality: Sekiya along the Hoki River, Shiobara-machi, Shiota-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene].

***Pseudoactinodontophora yabei* Murata, 1971**

Plate 25, Figures 13a–e

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 82, p. 112, pl. 14, figs. 1a, b, 4. Holotype: IGPS no. 86885 (Existing). Type locality: Motoiwazawa, SW of Kawaguchi, Sumita-cho, Kesen-gun, Iwate Prefecture. Stratigraphic unit: Lower part of Motoiwazawa Sandstone Member, Sakamotozawa Formation. Geologic age: Early Permian.

***Pseudogrammatodon pacificus* Nomura and Zinbō, 1934**

Plate 25, Figures 14a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 2, p. 153 (45), pl. 5 (1), figs. 6a–7b. Holotype: IGPS no. 50341 (Existing). Type locality: Plateaux area near Kamikatetu, Kikai-zima, [Kikai-cho, Oshima-gun], Kagoshima Prefecture. Lithostratigraphic unit: “Ryūkyū Limestone”. Geologic age: Pleistocene.

***Pteria sunakozakaensis* Ogasawara, 1976**

Plate 25, Figure 15

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 46, no. 2, p. 40, pl. 11, figs. 15, 16. Holotype: IGPS no. 95008 (Existing). Type locality: Loc. no. Su-01 (Ogasawara, 1976), river side cliff of Asano-gawa at Higashi-Ichise [*sic*, Higashi-Ichinosemachi], Kanazawa City, Ishikawa Prefecture. Stratigraphic unit: Sunakozaka Formation. Geologic age: Miocene [latest Early Miocene].

***Rexithaerus shiratoriensis* Matsubara, 1994**

Plate 25, Figure 16

Saito Ho-on Kai Mus. Nat. Hist. Res. Bull., no. 62, p. 24,

pl. 1, figs. 1, 2, 3a–5b, pl. 2, figs. 1a–4. Holotype: IGPS no. 102562 (Existing). Type locality: A small tributary of the Shiratorigawa River, south of Shiratori, Ninohe City, Iwate Prefecture. Stratigraphic unit: Kadonosawa Formation. Geologic age: latest Early Miocene.

***Rochefortia obsoletoradiata* Nomura and Zinbô, 1936**

Plate 26, Figures 1a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 18, no. 3, p. 242 (14), pl. 11 (1), fig. 12a, b. Holotype: IGPS no. 51351 (Existing). Type locality: Gabusoga, Haneji-mura, Kunigami-gun, Okinawa-jima [currently Nago City], Okinawa Prefecture. Stratigraphic unit: Simaziri Beds [=Haneji Formation]. Geologic age: Early Pliocene [Early Pleistocene].

***Saccella confusa toyomaensis* Kamada, 1962**

Plate 26, Figure 2

Palaeont. Soc. Japan Spec. Pap., no. 8, p. 50, pl. 2, figs. 1–5. Holotype: IGPS no. 79376 (Existing; broken). Type locality: Numanouchi Harbor, Toyoma-machi, Taira City [currently Numanouchi, Taira, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Numanouchi Formation. Geologic age: Miocene [early Middle Miocene].

***Saccella konnoi* Hatai and Masuda, 1962**

Plate 26, Figure 3

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 46, p. 259, pl. 40, figs. 3–5. Holotype: IGPS no. 90196 (formerly DGS 4235; Existing). Type locality: Loc. no. 4 (Hatai and Masuda, 1962), river cliff, about 600 m W of Gôdo, Higashimatsuyama City, Saitama Prefecture. Stratigraphic unit: Tokigawa Formation. Geologic age: Late Miocene.

***Saccella saikaiensis* Masuda, 1966b**

Plate 26, Figures 4a–c

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 64, p. 322, pl. 35, figs. 1a–3. Holotype: IGPS no. 90088 (formerly DGS no. 4494; Existing). Type locality: Loc. no. 23 (Masuda, 1966a), river cliff, about 1 km SES of Mukaiyama, [Niemachi], Suzu City, Ishikawa Prefecture. Stratigraphic unit: Higashi-innai Formation. Geologic age: Miocene [latest Early Miocene].

***Sanguinolites bisectus* Hayasaka, 1925b**

Plate 26, Figures 5a–c

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 8, no. 2, p. 13, pl. 8, fig. 10. Holotype: IGPS no. 22414 (Existing). Type locality: Hikoroichi-mura, Kesen-gôri, prov. Rikuzen [currently Hikoroichicho, Ofunato City, Iwate Prefecture]. Stratigraphic unit: Dark grayish sandy shale. Geologic age: Early Carboniferous.

***Schizothaerus nuttalli kissyuensis* Hatai, 1941**

Plate 26, Figure 6

Bull. Biogeogr. Soc. Japan, vol. 11, no. 13, p. 109, pl. 3, fig. 9. Holotype: IGPS no. 64751 (Existing). Type locality: Kinseidô, Eihoku-men, Kissyû-gun, Kankyô-hoku-dô, North Tyôsen [currently Kilju-gun, Hamgyongpuk-to, North Korea]. Stratigraphic unit: Banko Beds [Banko Sandstone]. Geologic age: Miocene [early Middle Miocene].

***Septifer sinelnikovae* Noda, 1992**

Plate 26, Figure 7

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 62, nos. 1–2, p. 62, pl. 2, figs. 4a–6. Holotype: IGPS no. 100734 (Existing). Type locality: Loc. no. CS7 (Noda, 1992), upper stream of the Shosambetsu River, Haboro-machi [*sic*, Haboro-cho] [Goryo, Shosambetsu-mura], Tomamae-gun, Rumoi Province, Hokkaido. Stratigraphic unit: Basal part of Chikubetsu Formation. Geologic age: Miocene [late Early–early Middle Miocene].

***Serripes hataii* Noda, 1962a [“1961”]**

Plate 26, Figure 8

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol., no. 5 (Prof. E. Kon’no Memorial Vol.), p. 224, pl. 37, fig. 3. Holotype: IGPS no. 74593 (Existing). Type locality: Iwaigawa [*sic*, Kubo River], Kamikurosawa, Hagihana-mura [*sic*, Hagisho-mura], Nishiiwai-gun, [currently Sakainokami, Hagisho, Ichinoseki City], Iwate Prefecture. Stratigraphic unit: Shimokurosawa Formation. Noda and Tada (1968) incorrectly cited the “Nishikurosawa Formation” as the horizon of the type locality. Geologic age: Middle Miocene.

***Serripes japonica* Noda, 1962a [“1961”]**

Plate 26, Figure 9

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol., no. 5 (Prof. E. Kon’no Memorial Vol.), p. 225, pl. 39, fig. 4. Holotype: IGPS no. 78680 (Existing). Type locality: Mukai, Sakekawa [*sic*, Sakegawa-mura], Mogami-gun, Yamagata Prefecture. Stratigraphic unit: Sakekawa Formation. Geologic age: Late Miocene [Pliocene].

***Serripes makiyamai nigamiensis* Noda, 1962a [“1961”]**

Plate 26, Figure 10

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol., no. 5 (Prof. E. Kon’no Memorial Vol.), p. 227, pl. 39, fig. 1a–c. Holotype: IGPS no. 78684 (Existing). Type locality: Nigami, Ooshima-mura, Higashikubiki-gun [currently Oshima-ku, Joetsu City], Niigata Prefecture. Stratigraphic unit: Shiya Formation. Geologic age: Late Miocene.

***Serripes muraii* Noda and Tada, 1968**

Plate 26, Figure 11

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 69, p. 202, pl. 22, fig. 22. Holotype: IGPS no. 88058 (Existing). Noda and Tada (1968) erroneously stated IGPS no. 88059 as the holotype in the text. Type locality: Loc. no. 2 (Noda and Tada, 1968), small tributary of the Kakkonda River, about 4 km NNW of the Takinoue Spa, Shizukuishimachi [*sic*, Shizukuishi-cho], Iwate-gun, Iwate Prefecture. Stratigraphic unit: Yamatsuda Formation. Geologic age: Miocene [early Late Miocene].

***Serripes shiobarensis* Noda, 1962a ["1961"]**

Plate 26, Figure 12

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol., no. 5 (Prof. E. Kon'no Memorial Vol.), p. 228, pl. 39, fig. 5. Holotype: IGPS no. 78687 (Existing). Type locality: Cliff facing the Hokigawa Electric Power Station along the Hoki River, Sekiya, Shiobara-machi, Shiota-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Middle Miocene [Late Miocene].

***Solemya (Acharax) bosoana* Hatai and Koike, 1957**

Plate 26, Figure 13; Plate 27, Figure 1

Japan. Jour. Geol. Geogr., vol. 28, nos. 1–3, p. 86, pl. 4, fig. 1. Holotype: IGPS no. 94774 (Existing). Type locality: Loc. no. 9 (Hatai and Koike, 1957), Ôkuzure, Katsuyamamachi [currently Kyonan-machi], Awa-gun, Chiba Prefecture. Stratigraphic unit: Ôkuzure Conglomerate [Ôkuzure Formation; contained in a concretion reworked from the underlying Hota Group]. Geologic age: Oligocene [latest Late Oligocene–Early Miocene].

***Solemya (Acharax) muroensis* Natori, 1964**

Plate 27, Figure 2

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 55, p. 249, pl. 36, fig. 1. Holotype: IGPS no. 85727 (Existing). Type locality: Motomiya, Motomiya-cho [*sic*, Hongu, Hongu-cho], Higashimuro-gun [currently Hongu-cho, Tanabe City], Wakayama Prefecture. Stratigraphic unit: Ukekawa-Muro Formation. Geologic age: Oligocene or Early Miocene.

***Solen connectens* Oyama, 1951a**

Plate 27, Figure 3

Miner. Geol., vol. 4, nos. 1–2, p. 56. [nom. nov. for *Solen intermedius* Nagao, 1928b, non Koch, in Philippi, 1843]. Holotype: IGPS no. 36435 (Existing). Type locality: Yamaga, Ashiya, Ashiya-machi, Onga-gun, Fukuoka Prefecture. Stratigraphic unit: Yamaga Formation. Geologic age: Oligocene [latest Early–earliest Late Oligocene].

***Solen intermedius* Nagao, 1928b**

Plate 27, Figure 3

Sci. Rep. Tôhoku Imp. Univ., 2nd. Ser. (Geol.), vol. 12,

no. 1, p. 83, pl. 4, figs. 5, 6. Holotype: IGPS no. 36435 (Existing). Type locality: Yamaga, Ashiya-machi, Onga-gun, Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Yamaga Beds [Yamaga Formation]. Geologic age: Oligocene [latest Early–earliest Late Oligocene]. Remarks: Because this species is preoccupied by *Solen intermedius* Koch in Philippi, 1843, a new replacement name ***Solen connectens*** was proposed by Oyama (1951a).

***Solen shitakaraensis* Honda, 1989**

Plate 27, Figure 4

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 60, no. 1, p. 84, pl. 8, figs. 7–10. Holotype: IGPS no. 95129-1 (Existing). Type locality: Loc. no. B-08 (Honda, 1989), uppermost stream of Yukirubeshubeno-zawa a tributary of the Tokomuro-gawa, Rushin, Urahoro-machi [*sic*, Urahoro-cho], Tokachi-gun, Hokkaido. Stratigraphic unit: Shitakara Formation. Geologic age: Oligocene [Middle–Late Eocene].

***Solenomorpha elegantissima* Hayasaka, 1925b**

Plate 27, Figures 5–7b; Plate 28, Figure 1

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 8, no. 2, p. 21, pl. 9, figs. 1, 1a, 2, 2a, 3–7. Syntypes: IGPS nos. 8203, 22228, 22229 (Existing). Type locality: Kinshô-zan, Akasaka-machi, prov. Mino [currently Akasakacho, Ogaki City, Gifu Prefecture]. Stratigraphic unit: *Kuro* zone [Akasaka Limestone] Geologic age: Permian [Middle Permian].

***Spisula (Cymbophora) ezoensis* Yabe and Nagao, 1928**

Plate 28, Figure 2

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 91, pl. 16, figs. 5–10. Holotype: IGPS no. 22614 (Existing). Type locality: The upper course of the Ponnebets, Manji [currently Nishimanji, Kurisawacho, Iwamizawa City], Ishikari Province, Hokkaido. Stratigraphic unit: *Trigonia* sandstone [Middle Yezo Group in Manji area]. Geologic age: Cretaceous [Cenomanian–Campanian, Cretaceous].

***Spisula iwatensis* Hatai, 1940**

Plate 28, Figure 3

Bull. Biogeogr. Soc. Japan, vol. 10, no. 9, p. 130, pl. 1, fig. 7. Holotype: IGPS no. 61360 (Existing). Type locality: Siratori [=Shiratori], Nisatai-mura, Ninohe-gun [currently Shiratori, Ninohe City], Iwate Prefecture. Stratigraphic unit: Siratori Beds [=Tate Sandstone Member of Kadonosawa Formation]. Geologic age: Miocene [latest Early Miocene].

***Spisula (Mactromeris) polynyma nagakoensis* Hatai and Nisiyama, 1949**

Plate 28, Figure 4

Jour. Paleont., vol. 23, no. 1, p. 92, pl. 24, fig. 18. Holotype: IGPS no. 72506 (Existing). Type locality: Small

exposure in drainage W of Nagako, Nishiki-mura, Iwaki-gun [currently Nishikimachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Asagai Formation [correctly Iwaki Formation]. Geologic age: Oligocene [latest Late Eocene—earliest Early Oligocene].

***Spisula shimotsukensis* Akutsu, 1964**

Plate 28, Figure 5

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 287, pl. 59, fig. 11. Holotype: IGPS no. 85510 (Existing). Type locality: Upstream of the Shimotokurazawa valley, Sekiya, Shiobara-machi, Shioya-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene].

***Strebrochondria miyamoriensis* Murata, 1964**

Plate 28, Figure 6

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 54, p. 229, pl. 35, fig. 14a, b. Holotype: IGPS no. 85733 (Existing). Type locality: Southeastern slope of Hiryu-yama, Miyamori-mura, Kamihei-gun [currently Miyamoricho, Tono City], Iwate Prefecture. Stratigraphic unit: Hiruyuyama Formation. Geologic age: Middle Permian.

***Tapes nagahamaensis* Saito, Bando and Noda, 1970**

Plate 28, Figure 7

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 77, p. 282, pl. 31, figs. 1–4, 22. Holotype: IGPS no. 78707 (Existing). Although Ogasawara (2001) cited IGPS no. 86743 from the Teshima Formation as the holotype, the specimens with this reg. no. are figured specimens by Saito *et al.* (1970). Type locality: Nagahama, Tonoshō-cho, Shodo-gun [*sic*, Shōzu-gun], Kagawa Prefecture. Stratigraphic unit: Shikai Formation. Geologic age: Miocene [Late Eocene].

***Taras millepustulata* Nomura, 1933**

Plate 28, Figure 8

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 75, pl. 3, fig. 16. Holotype: IGPS no. 45096 (Existing). Type locality: Hanpeizan, Okayama-gun, Takao-shū [currently Ban Pin Shan, Kaohsiung City], Taiwan. Lithostratigraphic unit: "Riukiu Limestone" [correlative of the Ryukyu Limestone]. Geologic age: Pleistocene.

***Tellina (Pharaonella) akiana* Nomura, 1937**

Plate 28, Figure 9

Japan. Jour. Geol. Geogr., vol. 14, nos. 3–4, p. 83, pl. 6, fig. 4. Holotype: IGPS no. 54691 (Existing). Type locality: Tōnohama, Yasuda-mura [*sic*, Yasuda-cho], Aki-gun, Kōti [=Kochi] Prefecture. Stratigraphic unit: Tosa Pliocene [=Ananai Formation]. Geologic age: Pliocene [latest Late

Pliocene—early Early Pleistocene].

***Tellina equideclivis* Nagao, 1928b**

Plate 28, Figure 10

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 79, pl. 4, fig. 29. Holotype: IGPS no. 36457 (Existing). Type locality: Abō, Kōyagi-jima, Kōyagi-mura, Nishisonogigun, Province of Hizen [currently Koyagimachi, Nagasaki City, Nagasaki Prefecture]. Stratigraphic unit: Okinoshima Beds [Okinoshima Formation]. Geologic age: Eocene [Middle Eocene].

***Tellina hamadai* Masuda, 1955**

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 20, p. 122, pl. 19, figs. 10, 11. Holotype: IGPS no. 90415 (formerly DGS no. 1657; Missing). Type locality: Tokunari, Machinomachi, Fugeshi-gun [currently Wajima City], Ishikawa Prefecture. Stratigraphic unit: Higashi-innai Formation. Geologic age: Early Miocene [latest Early Miocene].

***Tellina kikaizimana* Nomura and Zinbō, 1934**

Plate 28, Figures 11a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 2, p. 157 (49), pl. 5 (1), fig. 19a, b. Holotype: IGPS no. 50398 (Existing). Type locality: Plateaux area near Kamikatetu, Kikai-zima, [Kikai-cho, Oshima-gun], Kagoshima Prefecture. Lithostratigraphic unit: "Ryūkyū Limestone". Geologic age: Pleistocene.

***Tellina kuntsuipinensis* Nomura, 1933**

Plate 28, Figures 12a–b

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 99, pl. 4, fig. 10a, b. Holotype: IGPS no. 48595 (Existing). Type Locality: Ejecta of mud-volcanoes at Konsuihei [currently Kunshuiping Mud Volcano, Yanchao Township, Kaohsiung City], Taiwan. Geologic age: Unknown (ejecta of mud volcano)

***Tellina maxima* Nagao, 1928b**

Plate 28, Figure 13

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 80, pl. 4, figs. 8–11. Holotype: IGPS no. 36412 (Existing; broken). Type locality: Shinyama, Ōmachi-mura [currently Omachi-cho], Kishima-gun, Province of Hizen [Saga Prefecture]. Stratigraphic unit: Kishima Beds [Kishima Formation]. Geologic age: Oligocene [latest Late Eocene—earliest Early Oligocene]. Remarks: See also *Angulus maximus submaximus* Mizuno, 1964.

***Tellina notoensis* Masuda, 1955**

Plate 28, Figure 14

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 20, p. 122,

pl. 19, fig. 12. Holotype: IGPS no. 90451 (formerly DGS no. 2502; Existing). Type locality: Tokunari, Machinomachi, Fugeshi-gun [currently Wajima City], Ishikawa Prefecture. Stratigraphic unit: Higashi-innai Formation. Geologic age: Early Miocene [latest Early Miocene].

***Tellina prototenuilirata* Nomura, 1933**

Plate 28, Figure 15

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 100, pl. 4, figs. 7a–9b. Holotype: IGPS no. 48192 (Existing; broken). Type locality: Futoko (?), Bôshiho, Shiko-shô, Byôritsu-gun, Shinchiku-shû [currently Maozihbu, Wuhwu Village, Shihwu Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byôritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Tellina scabricostulata* Nomura and Zinbô, 1936**

Plate 28, Figures 16a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 18, no. 3, p. 246, pl. 11, figs. 16a–17b. Holotype: IGPS no. 51333 (Existing). Type locality: Gabusoga, Haneji-mura, Kunigami-gun [currently Nago City], Okinawa Prefecture. Stratigraphic unit: Simaziri Beds [=Haneji Formation]. Geologic age: Early Pliocene [Early Pleistocene].

***Tellina tricarinata* Nagao, 1928b**

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 78, pl. 3, fig. 17. Holotype: IGPS no. unknown (Missing). Type locality: Chôgiri, Kiuragi-mura, Higashimatsuura-gun [currently Ouchicho, Karatsu City], Province of Hizen [Saga Prefecture]. Stratigraphic unit: Kiuragi Beds [Kiuragi Formation]. Geologic age: Eocene [Late Eocene].

***Tellina umedairensis* Shikama, 1951**

Plate 28, Figures 17a–b

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 1, p. 15, text-figs. 1, 2. Holotype: IGPS no. 90404 (Existing). Type locality: Umedaira, Yaegôchi-mura [*sic*, Yaekawachimura], Shimoina-gun [currently Yaegochi, Minamishinano, Iida City], Nagano Prefecture. Stratigraphic unit: Wada Formation. Geologic age: Oligocene [Early Miocene].

***Tellina venulosa zyonoensis* Hatai and Nisiyama, 1939 [“1938”]**

Plate 28, Figure 18

Japan. Jour. Geol. Geogr. vol. 16, nos. 1–2, p. 150, pl. 9, fig. 3. Holotype: IGPS no. 62424 (Existing). Type locality: A cliff of the Zintu-gawa [=Jintu-gawa] at Zyônô [=Jônô], Sugihara-mura, Nehi-gun [*sic*, Nei-gun], Ettyû [=Etchû] Province [currently Jônô, Yatsuomachi, Toyama City, Toyama Prefecture]. Stratigraphic unit: Zyônô Beds [=Otogawa Formation]. Geologic age: Pliocene [Late Miocene].

***Teredo matsushimaensis* Hatai, 1951**

Plate 28, Figure 19

Short Pap. Inst. Geol. Paleont., Tôhoku Univ., no. 3, p. 30, pl. 5, figs. 1–5. Lectotype: IGPS no. 73697 (designated by Hayami, 1966; Existing). Type locality: IGPS loc. no. It-4 (Hatai, 1951), Matsushima, Taro-mura [*sic*, Taro-cho], Shimohei-gun [currently Taro, Miyako City], Iwate Prefecture. Stratigraphic unit: Hiraiga Sandstone Formation [Hiraiga Formation]. Geologic age: Early Cretaceous [Aptian].

***Thetironia affinis* var. *japonica* Yabe and Nagao, 1928**

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 89, pl. 17, figs. 14, 15. Holotype: IGPS no. 22605 (Missing). Type locality: Ponbets [*sic*, Pombetsu River], a tributary of the Ikushumbets [*sic*, Ikushumbetsu River], [currently Mikasa City, Hokkaido]. Stratigraphic unit: Mikasa Formation. Geologic age: Cenomanian–Turonian, Cretaceous.

***Thracia hataii* Kamada, 1955**

Plate 28, Figures 20a–b

Sci. Rep., Fac. Arts and Liter., Nagasaki Univ., no. 4, p. 10, pl. 1, figs. 5, 6. Holotype: IGPS no. 72960 (Existing). Type locality: IGPS loc. no. Fs-37 (Kamada, 1955), about 600 m N of Ena-machi water-reservoir, Igamesaku, Nagasaki, Ena-machi [currently Ena, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Nakayama Formation. Geologic age: Miocene [latest Early Miocene].

***Thracia kamayasikiensis* Hatai, 1940**

Plate 28, Figures 21a–b

Bull. Biogeogr. Soc. Japan, vol. 10, no. 9, p. 123, pl. 1, fig. 2. Holotype: IGPS no. 61349 (Existing). Type locality: Kamayasiki [=Kamayashiki], Tomai-mura, Ninohe-gun [currently Shimotomai, Ninohe City], Iwate Prefecture. Stratigraphic unit: Suenomatuyama Beds [=Tomesaki Formation]. Geologic age: Pliocene [Middle Miocene].

***Thracia kidoensis* Kamada, 1955**

Plate 28, Figures 22a–b

Sci. Rep., Fac. Arts and Liter., Nagasaki Univ., no. 4, p. 11, pl. 1, figs. 1–2b. Holotype: IGPS no. 72958 (Existing). Type locality: IGPS loc. no. Fs-38, in the tunnel, W of the Iriumi mineral spring, Kobansaku, Kido-mura [currently Naraha-machi], Futaba-gun, Fukushima Prefecture. Stratigraphic unit: Asagai Formation. Geologic age: Oligocene [Early Oligocene].

***Thracia kurosawaensis* Hayasaka, 1957**

Plate 28, Figures 23a–b

Saito Ho-on Kai Mus. Res. Bull., no. 26, p. 28, text-fig. 1a–c. Holotype: IGPS no. 77497 (Existing). Type locality:

Loc. no. 6 (Hayasaka, 1957), river side cliff at the western entrance of the railway tunnel between the Iwateyuda and Kawajiri Stations, Yuda-mura [currently Nishiwaga-machi], Waga-gun, Iwate Prefecture. Stratigraphic unit: Kurosawa Formation. Geologic age: Miocene [Middle–Late Miocene].

***Thracia (Thracia) shitakaraensis* Honda, 1989**

Plate 28, Figure 24; Plate 29, Figure 1

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 60, no. 1, p. 89, pl. 6, figs. 2, 5, pl. 7, figs. 1–3, 5–7. Holotype: IGPS no. 95428-4 (Existing). Type locality: Loc. no. B-03 (Honda, 1989), tributary of Rushin River, Rushin, Urahoro-machi [*sic*, Urahoro-cho], Tokachi-gun, Hokkaido. Stratigraphic unit: Shitakara Formation. Geologic age: Oligocene [Middle–Late Eocene].

***Thracidora nishizawaensis* Akutsu, 1964**

Plate 29, Figure 2

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 283, pl. 59, fig. 4. Holotype: IGPS no. 85502 (Existing). Ogasawara (2001) erroneously cited IGPS no. 85504 as the holotype. Type locality: Nishizawa, Uzuno [*sic*, Utsuno], Shiobara-machi, Shiota-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene].

***Thyasira bisecta* var. *nipponica* Yabe and Nomura, 1925**

Plate 29, Figures 3a–c

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 7, no. 4, p. 84, pl. 23, figs. 3a–b, pl. 24, figs. 2a–4b. Lectotype: IGPS no. 7485 (designated by Hatai and Nisiyama, 1952; Existing). Type locality: Mōrai, Atsuta-mura, Atsuta-gun [currently Atsuta-ku, Ishikari City], Ishikari Province, Hokkaido. Stratigraphic unit: Kawabata Series [=Morai Formation]. Geologic age: Tertiary [Late Miocene].

***Thyasira inflata* Yabe and Nomura, 1925**

Plate 29, Figure 4

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 7, no. 4, p. 93, pl. 23, fig. 5a–b. Holotype: IGPS no. 17251 (Existing). Type locality: Sea cliff S of Tsurushizaki, Hitachi-mura, Taga-gōri, province of Hitachi [currently Higashicho, Hitachi City, Ibaraki Prefecture]. Stratigraphic unit: not cited [Hitachi Formation]. Geologic age: Tertiary [Early Pliocene].

***Thyasira quadrata* Yabe and Nomura, 1925**

Plate 29, Figures 5a–c

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 7, no. 4, p. 92, pl. 23, figs. 1a–b. Holotype: IGPS no. 8188 (Existing). Type locality: “Japan” (exact locality unknown). Stratigraphic unit: unknown. Geologic age: Tertiary [precise age unknown].

***Thyasira subexcavata* Yabe and Endō, in Yabe and Nomura, 1925**

Plate 29, Figure 6

Sci. Rep. Tōhoku Imp. Univ., 2nd Ser. (Geol.), vol. 7, no. 4, p. 93, pl. 24, figs. 1a–b. Holotype: IGPS no. 6973 (Existing). Type locality: Near Takai, Sekimoto-mura, Taga-gōri [currently Sekimotomachi, Kitaibaraki City], Ibaraki Prefecture. Stratigraphic unit: not cited [Kokozura Formation or Taga Group]. Geologic age: Tertiary [Miocene].

***Thyasira tokunagai* Kuroda and Habe, 1951**

Plate 29, Figures 7a–b

Illust. Cat. Jpn. Shells, no. 13, p. 86 [“nom. nov.” for *Thyasira gouldii* (Philippi) *sensu* Yabe and Nomura, 1925, p. 94, pl. 23, figs. 6a–b (not of Philippi, 1845)]. Lectotype: IGPS no. 13786 (designated herein) (Existing). Type locality: Shinagawa, near Tōkyō [=Shinagawa-machi, Ebara-gun, Tokyo Prefecture] [currently Shinagawa-ku, Tokyo; precise locality unknown]. Stratigraphic unit: Tōkyō Beds [Tokyo Formation]. Geologic age: Pliocene [Late Pleistocene].

***Trapezium (Neotrapezium) ichinoheense* Matsubara, 1995**

Plate 29, Figures 8a–b

Trans. Proc. Palaeont. Soc. Japan, N. S., no. 180, p. 328, figs. 4-1, 4-7a, b, 4-8a–c. Holotype: IGPS no. 102605 (Existing). Type locality: Loc. no. 18 (Matsubara, 1995), upper reaches of the Nesori River about 3 km E of Nosokei [*sic*, Nosoke], Ichinohe-machi, Ninohe-gun, Iwate Prefecture. Stratigraphic unit: Yotsuyaku Formation. Geologic age: late Early Miocene.

***Trapezium (Neotrapezium) isohareense* Kamada, 1962**

Plate 29, Figure 9

Palaeont. Soc. Japan Spec. Pap., no. 8, p. 91, pl. 8, figs. 4–6. Holotype: IGPS no. 79382 (Existing). Type locality: 100 m upstream from the Futatsujima mineral-spring, Isoharamachi, Kitaibaraki City, Ibaraki Prefecture. Stratigraphic unit: Kunugidaira Formation. Geologic age: Miocene [Early Miocene].

***Trapezium isomatsuense* Kotaka, 1955**

Plate 29, Figure 10

Saito Ho-on Kai Mus. Res. Bull., no. 24, p. 28, pl. 2, fig. 1. Holotype: IGPS no. 74006 (Existing). Type locality: IGPS loc. no. Ao-15 (Kotaka, 1955), upper course of the Isomatsu-gawa, Wakimoto-mura, Kitatsugaru-gun [currently Wakimoto, Goshogawara City], Aomori Prefecture. Stratigraphic unit: Isomatsu Formation. Geologic age: Oligocene [Early Miocene].

***Trapezium jobanicum* Hatai and Nisiyama, 1949**

Plate 29, Figure 11

Jour. Paleont., vol. 23, no. 1, p. 90, pl. 24, figs. 8, 9. Holotype: IGPS no. 72505 (Existing). IGPS no. 72506 given by original description is incorrect. Reg. no. of the holotype by Ogasawara (2001) is identical that in the original description. Type locality: A small cliff in front of the dormitory of Nippon Coal Mining Company, Nakosomachi, Ishiki-gun [*sic*, Iwaki-gun] [currently Nakosomachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Iwaki Formation. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene].

***Trifaricardium nomurai* Kuroda and Habe, 1951**

Plate 29, Figures 12a–b

Illust. Cat. Jpn. Shells, no. 13, p. 86. [nom. nov. for *Cardium* (*Acanthocardia*) *cancellatum* Nomura, 1933 non Gmelin, 1791] Holotype: IGPS no. 46500 (Existing). Type locality: Station no. 14 (Nomura, 1933), exposure, 550 m SE of Jô-tsûsho-wan, Tsûshô-shô, Byôritsu-gun, Shinchiku-shû [currently Shangtongsiaowan, Tongwan Village, Tongshao Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byôritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene]. Remarks: This species is a type species of *Trifaricardium* Kuroda and Habe, 1951 (by monotypy). See *Cardium* (*Acanthocardia*) *cancellatum* Nomura, 1933 [non Gmelin, 1791] also.

***Trigonarca? obsoleta* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926**

Plate 29, Figure 13

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 2, p. 43, pl. 12, fig. 24. Holotype: IGPS no. 22538 (Existing). Type locality: Ishidô, near Ôhinata[-mura] [currently Ishidô, Ôhinata, Sakuho-machi], Minamisaku-gun, Province of Shinano [Nagano Prefecture]. Stratigraphic unit: Ishidô Group [Ishidô Formation]. Geologic age: Cretaceous [late Early–early Late Cretaceous (late Neocomian or Aptian)].

***Trigonia ainuana* Yabe and Nagao, 1928**

Plate 30, Figure 1

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 9, no. 3, p. 84, pl. 16, fig. 20. Holotype: IGPS no. 22591 (Existing). Type locality: Ponbets [=Pombetsu River] (near the Ikushumbets [=Ikushumbetsu] coal-mines), Sorachi-gun [currently Mikasa City], Hokkaido. Stratigraphic unit: *Trigonia* sandstone [Mikasa Formation]. Geologic age: Cretaceous [early Late Cretaceous (Cenomanian–Turonian)].

***Trigonia brevicula* Yehara, 1915**

Plate 30, Figure 2

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 2, no.

2, p. 42, pl. 2, figs. 18, 19. Lectotype: IGPS no. 4329 (designated by Nakano and Numano, 1961; Existing). Type locality: Ikushumbets [=Ikushumbetsu], some 3 km above the Ikushumbets [=Ikushumbetsu] coal mines [currently Mikasa City], Hokkaido. Stratigraphic unit: *Thetis* aff. *affinis* zone [Middle Yezo Group (Mikasa sandstone)]. Geologic age: Cretaceous [early Late Cretaceous (Cenomanian–Turonian)].

***Trigonia datemasamunei* Yehara, 1915**

Plate 30, Figures 3–4

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 2, no. 2, p. 38, pl. 2, figs. 13, 14. Syntypes: IGPS no. 4331 (Existing). Type locality: Raga II, Miyako District [Southern coast of Hiraname, northeast of Raga, Tanohata-mura, Shimohei-gun, Iwate Prefecture]. Stratigraphic unit: *Orbitolina* sandstone [=Miyako Group]. Geologic age: Cretaceous [late Early Cretaceous (Aptian–Lower Albian)].

***Trigonia hokkaidoana* Yehara, 1915**

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 2, no. 2, p. 39, pl. 1, figs. 1–8. Lectotype: IGPS no. 4224 (designated by Kobayashi and Nakano, 1957; Missing). Type locality: Tokuzo, southern coast of Hiraiga inlet, Tanohata-mura, Shimohei-gun, Iwate Prefecture. Stratigraphic unit: Miyako Group (Hiraiga Formation). Geologic age: late Early Cretaceous (Aptian–Lower Albian).

***Trigonia pustulosa* Nagao, 1930**

Plate 30, Figures 5a–8

Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4, vol. 1, no. 1, p. 17, pl. 3, figs. 9–12. Syntypes: IGPS nos. 35603, 35608, 35609, 35610, 35612, 35613 (Existing). Type locality: Goshonoura-jima [*sic*, Goshoura-jima], Amakusa-gun, Province of Higo [At the seashore of Enokuchi, Goshonoura [currently Goshoura, Goshouramachi], Amakusa City, Kumamoto Prefecture]; Shishi-jima, Nagashima-mura, Province of Satsuma [currently Nagashima-cho, Izumi-gun, Kagoshima Prefecture]. Stratigraphic unit: Goshonoura Group. Geologic age: Cretaceous [Albian(?)–Cenomanian, Cretaceous].

***Trigonia yokoyamai* Yehara, 1915**

Plate 30, Figures 9–10

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 2, no. 2, p. 41, pl. 2, figs. 15–17. Syntypes: IGPS nos. 4366, 4367 (Existing). Type locality: Tokuzo, southern coast of Hiraiga inlet, Tanohata-mura, Shimohei-gun, Iwate Prefecture. Stratigraphic unit: Miyako Group (Hiraiga Formation). Geologic age: Upper Neocomian(?)–Aptian, Cretaceous.

***Vasticardium arenicoloides* Akutsu, 1964**

Plate 30, Figure 11

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 284, pl. 59, figs. 6, 7. Syntypes: IGPS no. 85504 (Existing). Type locality: Upstream of the Shimotokurazawa valley, Sekiya, Shiobara-machi, Shioya-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene].

***Vasticardium shimotokuraense* Akutsu, 1964**

Plate 30, Figure 12

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 35, no. 3, p. 283, pl. 59, figs. 9, 10. Syntype: IGPS no. 85503 (Existing). Type locality: Shimotokurazawa, Sekiya, Shiobara-machi, Shioya-gun [currently Nasushiobara City], Tochigi Prefecture. Stratigraphic unit: Kanomatazawa Formation. Geologic age: Miocene [Late Miocene]. Remarks: Although the name of species was originally spelled as *shimotokuraensis*, it is corrected as *shimotokuraense* because *Vasticardium* is a neuter.

***Vasticardium teshimaense* Saito, Bando and Noda, 1970**

Plate 30, Figure 13

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 77, p. 283, pl. 31, figs. 5–7. Holotype: IGPS no. 86745 (Existing). Type locality: Loc. no. 1 (Saito *et al.*, 1970), (about 500 m SW of Abuzaki), Teshima Island, Tonosho-cho, Shôdo-gun [*sic*, Shôzu-gun], Kagawa Prefecture. Stratigraphic unit: Teshima Formation. Geologic age: Miocene [Late Eocene].

***Venericardia crenulicostata* Nomura, 1933**

Plate 30, Figures 14a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 69, pl. 2, figs. 12a–16b. Holotype: IGPS no. 46221 (Existing). Type locality: Station no. 18 (Nomura, 1933), 650 m SE of Jô-tsûshô-wan, Tsûshô-shô, Byôritsu-gun, Shinchiku-shu [currently Shangtongsiaowan, Tongwan Village, Tongsiao Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byôritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Venericardia (Cyclocardia) enaensis* Kamada, 1962**

Plate 30, Figure 15

Palaeont. Soc. Japan Spec. Pap., no. 8, p. 87, pl. 7, figs. 7, 8. Holotype: IGPS no. 79381 (Existing). Type locality: Igamesaku, Nagasaki, Ena-machi [currently Ena, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Honya Formation. Geologic age: Miocene [late Early Miocene].

***Venericardia (Cyclocardia) ferruginea complexa* Ogasawara, 1977**

Plate 30, Figures 16a–b

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 47, no. 2, p. 107, pl. 11, fig. 3a, b, pl. 12, fig. 4. Holotype: IGPS no. 95127 (Existing). Type locality: Loc. no. KO-22 (Ogasawara, 1977), cliff, distant from the road, 300 m W of Kaminakamachi, Kanazawa City, Ishikawa Prefecture. Stratigraphic unit: Omma Formation. Geologic age: Pliocene [Early Pleistocene].

***Venericardia granulicostata* Nomura, 1933**

Plate 30, Figures 17a–e

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 70, pl. 2, fig. 7a–d. Holotype: IGPS no. 46136 (Existing). Type locality: 1,450 W of Hokkô, Ôbokô, Station 14, Shiko-shô, Byôritsu-gun, Shinchiku-shû [currently Yamukeng, Jinshih Village, Hsihu Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byôritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Venericardia millegrana* Nomura and Zinbô, 1934**

Plate 30, Figures 18a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 2, p. 154 (46), pl. 5 (1), figs. 13a–14b. Holotype: IGPS no. 50375 (Existing). Type locality: Plateaux area near Kamikatetu, Kikai-zima, [Kikai-cho, Oshima-gun], Kagoshima Prefecture. Lithostratigraphic unit: “Ryûkyû Limestone”. Geologic age: Pleistocene.

***Venericardia nagaoi* Mizuno, 1964**

Plate 30, Figure 19

Rep., Geol. Surv. Japan, no. 204, p. 57. Holotype: IGPS no. 36314 (Existing). [= *Venericardia nipponica* Yokoyama, *sensu* Nagao 1928b, pl. 13, fig. 11]. Type locality: Nakayama Pass, Hôshuyama-mura, Asakura-gun, Fukuoka Prefecture [currently Tôhō-mura, Asakura-gun, Fukuoka Prefecture]. Stratigraphic unit: Kawamagari Formation. Geologic age: Eocene.

***Venericardia okinoshimaensis* Mizuno, 1964**

Plate 30, Figure 20

Rep., Geol. Surv. Japan, no. 204, p. 57. Holotype: IGPS no. 36371 (Existing) [= *Venericardia nipponica* Yokoyama, *sensu* Nagao, 1928b, pl. 13, figs. 15, 15a]. Type locality: Abo, Kôyagi-jima, Kôyagi-mura, Nishi-Sonogi-gun, Nagasaki Prefecture [currently Abo, Kôyagi-machi, Nagasaki City, Nagasaki Prefecture]. Stratigraphic unit: Okinoshima Formation. Geologic age: Eocene [Middle Eocene].

***Venericardia (Megacardita) ommaensis* Ogasawara, 1977**

Sci. Rep. Tohoku Univ., 2nd Ser. (Geol.), vol. 47, no. 2, p. 106, pl. 10, figs. 2, 5, pl. 13, fig. 3. Holotype: IGPS 95122 (Missing). Type locality: Loc. no. KO-15 (Ogasawara, 1977), river-side cliff of Asano-gawa, 400

m W of Tagamihonmachi, Kanazawa City, Ishikawa Prefecture. Stratigraphic unit: Omma Formation. Geologic age: Pliocene [Early Pleistocene]. Remarks: *Trominina japonica* (Takeda) from the Oligocene Charo Formation is registered in the same number as the holotype.

***Venericardia onukii* Masuda and Takegawa, 1965**

Plate 31, Figures 1a–b

Saito Ho-on Kai Mus. Res. Bull., no. 34, p. 12, pl. 1, figs. 15–22. Holotype: IGPS no. 90828 (formerly DGS no. 4683; Existing). Type locality: Loc. no. 13 (Masuda and Takegawa, 1965), river cliff about 200 m downstream of Dam, Taniyama, NW of Ashitate, Murata-machi, Shibata-gun, Miyagi Prefecture. Stratigraphic unit: Fukuda Member of Kanagase Formation. Geologic age: Middle Miocene [late Late Miocene].

***Venericardia quadriangulata* Nomura and Zinbô, 1934**

Plate 31, Figures 2a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 2, p. 155 (47), pl. 5 (1), figs. 15a–16b. Holotype: IGPS no. 50385 (Existing). Type locality: Plateaux area near Kamikatetu, Kikai-zima, [Kikai-cho, Oshima-gun], Kagoshima Prefecture. Lithostratigraphic unit: “Ryûkyû Limestone”. Geologic age: Pleistocene.

***Venericardia ryukyuensis* Nomura and Zinbô, 1936**

Plate 31, Figures 3a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 18, no. 3, p. 240 (12), pl. 11 (1), figs. 7a–8b. Holotype: IGPS no. 51344 (Existing). Type locality: Gabusoga, Haneji-mura, Kunigami-gun [currently Nago City], Okinawa Prefecture. Stratigraphic unit: Simaziri Beds [=Haneji Formation]. Geologic age: Early Pliocene [Early Pleistocene].

***Venericardia subnipponica* Nagao, 1928b**

Plate 31, Figures 4a–c

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 55, pl. 14, fig. 19, 19a. Holotype: IGPS no. 36405 (Existing). Type locality: Taya, Ashiya-machi, [Onga-gun], Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Yamaga Beds [Yamaga Formation]. Geologic age: Oligocene.

***Venericardia yoshidai* Nagao, 1928b**

Plate 31, Figure 5

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 57, pl. 12, fig. 14. Holotype: IGPS no. 36327 (Existing). Type locality: Ôbô, near Arita-machi [currently Arita-cho], Nishimatsuura-gun, Province of Hizen [Saga Prefecture]. Stratigraphic unit: Kishima Beds [Kishima Formation]. Geologic age: Oligocene [latest Late Eocene–

earliest Early Oligocene].

***Veniella? japonica* Nagao, 1930**

Plate 31, Figures 6–7

Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4, vol. 1, no. 1, p. 21, pl. 2, figs. 1, 3a–c. Syntypes: IGPS nos. 35578, 44306, 44307 (Existing). Type locality: Goshonoura-jima [*sic*, Goshoura-jima], Province of Higo [currently Goshoura, Goshouramachi, Amakusa City, Kumamoto Prefecture]. Stratigraphic unit: Goshonoura Group in Goshonoura area. Geologic age: Cretaceous [Albian(?)-Cenomanian, Cretaceous].

***Venus (Chione) byoritsuensis* Nomura, 1933**

Plate 31, Figure 8

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 84, pl. 3, fig. 7a, b. Holotype: IGPS no. 48061 (Existing). Type locality: Station no. 48 (Nomura, 1933), Chû-tsushô-wan, Tsûshô-shô, Byôritsu-gun, Shinchiku-shû [currently Shangtongsiaowan, Tongwan Village, Tongsiao Township, Miaoli County], Taiwan. Lithostratigraphic unit: Byôritsu Beds [Miaoli Formation]. Geologic age: Pliocene [Pleistocene].

***Venus (Chione) taiwanensis* Nomura, 1933**

Plate 31, Figure 9

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 1, p. 86, pl. 1, figs. 12a–13b. Holotype: IGPS no. 47771 (Existing). Type locality: Hanpeizan, Okayama-gun, Takao-shû [currently Ban Pin Shan, Kaohsiung City], Taiwan. Lithostratigraphic unit: “Riukiu Limestone” [correlative of the Ryukyu Limestone]. Geologic age: Pleistocene.

***Venus (Chione) yabei* Nomura and Zinbô, 1934**

Plate 31, Figures 10a–b

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 16, no. 2, p. 156 (48), pl. 5 (1), fig. 18a, b. Holotype: IGPS no. 50651 (Existing). Type locality: Plateaux area near Kamikatetu [=Kamikatsutsu], Kikai-zima, [Kikai-cho, Oshima-gun], Kagoshima Prefecture. Lithostratigraphic unit: “Ryûkyû Limestone”. Geologic age: Pleistocene.

***VolSELLa yokoyamai* Hatai and Nisiyama, 1949**

Plate 31, Figures 11a–b

Jour. Paleont., vol. 23, no. 1, p. 90, pl. 23, figs. 13, 14. Holotype: IGPS no. 72504 (Existing). Type locality: Near the Mimatsu Colliery, Ogawa, Kawabe-mura, Ishiki-gun [*sic*, Iwaki-gun] [currently Kawabemachi, Iwaki City], Fukushima Prefecture. Stratigraphic unit: Iwaki Formation. Geologic age: Oligocene [latest Late Eocene–earliest Early Oligocene].

***Waagenoperna elongata* Nakazawa and Murata, 1966**

Plate 31, Figure 12

Mem. Coll. Sci. Univ. Kyoto, Ser. B, vol. 32, no. 4, p. 312, pl. 4, fig. 1a, b. Holotype: IGPS no. 85764 (Existing). Type locality: Kanayama-zawa, near the Omine mine, Tono City, Iwate Prefecture. Stratigraphic unit: Kamihei Group in Kamihei area. Geologic age: Neocomian, Cretaceous.

***Yabepecten ogasawarai* Matsubara, 2003**

Plate 31, Figures 13a–b

Paleontol. Res., vol. 7, no. 2, p. 169, Figs. 2, 3, 4.2, 4.4, 4.6a, b. Holotype: IGPS no. 98911 (Existing). Type locality: Bed of the Sagae River, about 250 m downstream of "Uwano-o-hashii" (Uwano big bridge) over the Sagae River and about 500 m S-SE of the hamlet of Uwano, [Shiraiwa], Sagae City, Yamagata Prefecture. Stratigraphic unit: Oya Tuffaceous Sandstone Member of the Hongô Formation. Geologic age: Late Miocene.

***Yoldia iwatensis* Hatai, 1940**

Plate 31, Figures 14a–b

Bull. Biogeogr. Soc. Japan, vol. 10, no. 9, p. 121, pl. 1, figs. 5, 6. Holotype: IGPS no. 61348 (Existing). Type locality: Kadonosawa, Nisatai-mura, Ninohe-gun [currently Fukuoka, Ninohe City], Iwate Prefecture. Stratigraphic unit: Kadonosawa Beds [=Kadonosawa Formation]. Geologic age: Miocene [latest Early–earliest Middle Miocene].

***Yoldia scaphoides* Nagao, 1928b**

Plate 31, Figures 15a–c

Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geol.), vol. 12, no. 1, p. 23, pl. 2, figs. 29, 29a. Holotype: IGPS no. 35987 (Existing). Type locality: Taya, Ashiya-machi, Onga-gun, Province of Chikuzen [Fukuoka Prefecture]. Stratigraphic unit: Yamaga Beds [Yamaga Formation]. Geologic age: Oligocene.

***Zirfaea hataii* Masuda and Noda, 1969**

Plate 31, Figure 16

Trans. Proc. Palaeont. Soc. Japan, N.S., no. 75, p. 133, pl. 14, figs. 3, 4. Holotype: IGPS no. 86742 (Existing). Type locality: Gôroku cliff along the right bank of the Hirosegawa, near the waterway tunnel of the Sankyozawa Electric Plant, in the western border of Sendai City [sic, Gôroku, Miyagi-machi, Miyagi-gun][currently Aoba-ku, Sendai City], Miyagi Prefecture. Stratigraphic unit: Tatsunokuchi Formation. Geologic age: Early Pliocene [latest Late Miocene–earliest Early Pliocene].

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Note: Bibliography with asterisk (*) behind the date of publication includes the original description(s) of listed taxa.

Explanation of Plates

All figures in natural size, unless otherwise stated

Plate 1

1. *Acanthopecten onukii* Murata, 1964. IGPS no. 85745 (Holotype). 2. *Acanthopecten spinosus* Hayasaka, 1925b. IGPS no. 22388 (Lectotype). 3. *Acila divaricata chitosensis* Noda, 1962b. IGPS no. 79060 (Holotype). 4a–b. *Acila (Acila) kiiensis* Masuda and Katto, in Katto and Masuda, 1978. IGPS no. 96071 (Holotype). 5. *Aequipecten matsunagiensis* Masuda, 1966b. IGPS no. 90089 (Holotype). 6. *Amussiopecten akiyamae* Masuda, 1962a. IGPS no. 90658 (Holotype). 7a–d. *Anadara (Scapharca) akitaensis* Noda, 1966a. IGPS no. 16330 (Holotype). 8a–b. *Anadara (Anadara) amacula elongata* Noda, 1966a. IGPS no. 85907 (Holotype). 9a–b. *Anadara (Anadara) arasawaensis* Noda, 1966a. IGPS no. 90046 (Holotype). 10. *Anadara (Anadara) gentaroensis* Noda, 1966a. IGPS no. 86411 (Holotype). 11a–c. *Anadara (Anadara) hataii* Noda, 1966a. IGPS no. 73210 (Holotype).

Plate 2

1a–b. *Anadara (Anadara) hataii* Noda, 1966a. IGPS no. 73210 (Holotype). 2a–c. *Anadara (Anadara) hokkaidoensis* Noda, 1966a. IGPS no. 86408 (Holotype). 3. *Anadara (Scapharca?) iwashibaraensis* Noda, 1965. IGPS no. 29050 (Holotype). 4a–b. *Anadara (Anadara) iwatusensis* Noda, 1966a. IGPS no. 90048 (Holotype). 5a–b. *Anadara (Anadara) iwatoensis* Noda, 1966a. IGPS no. 63342 (Holotype). 6a–d. *Anadara (Anadara) kakehataensis* Hatai and Nisiyama, 1949. IGPS no. 72510 (Holotype). 7a–c. *Anadara (Hataiarca) kogachiensis* Noda, 1971. IGPS no. 86757 (Holotype).

Plate 3

1a–b. *Anadara (Hataiarca) kogachiensis* Noda, 1971. IGPS no. 86757 (Holotype). 2a–b. *Anadara (Anadara) kurosedaniensis* Hatai and Nisiyama, 1949. IGPS no. 72511 (Holotype). 3a–b. *Anadara (Scapharca) masudai* Noda, 1966a. IGPS no. 51550 (Holotype). 4. *Anadara (Anadara) naganoensis* Noda, 1966a. IGPS no. 86410 (Holotype). 5a–b. *Anadara (Tegillarca) obessa* Kotaka, 1953. IGPS no. 66536 (Holotype). 6a–b. *Anadara (Scapharca) omaruensis* Sasaki, 1991. IGPS no. 101325 (Holotype). 7a–b. *Anadara (Hataiarca) pseudosubcrenata* Ogasawara, 1977. IGPS no. 95070 (Holotype). 8a–b. *Anadara (Scapharca?) shizuokaensis* Noda, 1965. IGPS no. 78919 (Holotype). 9. *Anadara (Scapharca) taiwanica* Noda, 1966a. IGPS no. 42357 (Holotype).

Plate 4

1a–c. *Anadara (Scapharca) taiwanica* Noda, 1966a.

IGPS no. 42357 (Holotype). 2a–b. *Anadara (Scapharca) takanabensis* Sasaki, 1991. IGPS no. 101327 (Holotype). 3a–b. *Anadara (Hataiarca) takayamai* Noda, 1966a. IGPS no. 86403 (Holotype). 4a–b. *Anadara (Anadara) tanakuraensis* Noda, 1966a. IGPS no. 28404 (Holotype). 5. *Anadara (Tosarca) tosaensis* Noda, 1965. IGPS no. 54609 (Holotype). 6a–c. *Anadara (Anadara) tsudai* Noda, 1966a. IGPS no. 86396 (Holotype). 7a–c. *Anadara (Hataiarca) yatsuoensis* Noda, 1966a. IGPS no. 86402 (Holotype).

Plate 5

1a–b. *Angulus maximus submaximus* Mizuno, 1964. IGPS no. 36452 (Syntype). 2a–c. *Anisocorbula ohiroi* Masuda, 1966b. IGPS no. 90734 (Holotype). 3. *Annuliconcha kitakamiensis* Murata, 1964. IGPS no. 22389 (Holotype). 4–5. *Anomia pseudotruncata* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22522 (Syntypes). 6a–b. *Arca (Arca) kikaizimana* Nomura and Zinbô, 1934. IGPS no. 50198 (Holotype). 7a–b. *Arca (Arca) miurensis* Noda, 1966a. IGPS no. 23846 (Holotype). 8. *Arca sakamizuensis* Hatai and Nisiyama, 1952. IGPS no. 35996 (Holotype). 9–11. *Arca shinanoensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22521 (Syntypes). 12. *Arca (Arca) sokeishiensis* Nomura, 1933. IGPS no. 47770 (Holotype external mold). 13. *Arca (Arca) takaoensis* Nomura, 1933. IGPS no. 37444 (Holotype). 14a–e. *Arca (Barbatia) yokoyamai* Nomura, 1933. IGPS no. 42588 (Holotype). 15. *Astarte shinanoensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22544 (Lectotype). 16. *Astarte subomalioides* Nagao, 1934. IGPS no. 66446 (Lectotype). 17. *Astarte subsenecta* var. *costata* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22483 (Holotype). 18a–b. *Aviculopecten hataii* Murata, 1964. IGPS no. 85732 (Holotype; b. external mold). 19. *Aviculopecten minoensis* Hayasaka, 1925b. IGPS no. 22412 (Lectotype). 20a–b. *Aviculopecten? onukii* Murata, 1969. IGPS no. 91380 (Holotype). 21. *Aviculopecten reticularis* Hayasaka, 1925b. IGPS no. 22227 (Holotype). 22a–b. *Aviculopecten sasakii* Murata, 1964. IGPS no. 85730 (Holotype; b. external mold). 23. *Azorius philippianus* Kotaka and Noda, 1977. IGPS no. 95087 (Holotype). 24a–b. *Barbatia (Acar) hayasakai* Noda, 1966a. IGPS no. 76249 (Holotype). 25. *Barbatia kanezawaensis* Akutsu, 1964. IGPS no. 85501 (Holotype). 26a–b. *Barbatia (Acar) numaensis* Noda, 1966a. IGPS no. 86137 (Holotype). 27. *Barbatia (Pugilarca) tsurushizakiensis* Noda, 1966a. IGPS no. 17271 (Holotype). 28. *Barbatia (Barbatia) uetsukiensis* Hatai and Nisiyama, 1949. IGPS no. 72522 (Holotype). 29a–b. *Cyrena (Batissa) ponderosa* Nagao, 1928a. IGPS no. 35777 (Syntype) [non Prime, 1860; =*Batissa nagaoi* Suzuki, 1941. IGPS no. 35777 (Holotype)].

Plate 6

1. *Cyrena (Batissa) ponderosa* Nagao, 1928a. IGPS no. 35777 (Syntype). [non Prime, 1860; =*Batissa nagaoi* Suzuki, 1941. IGPS no. 35777 (Holotype)]. **2a–b.** *Batissa taiwanensis* Nomura, 1933. IGPS no. 45087 (Holotype). **3.** *Brachidontes takiensis* Kamada, 1962. IGPS no. 79380 (Holotype). **4.** *Callista chinensis takagii* Masuda, 1955. IGPS no. 90885 (Holotype). **5.** *Callista pseudoplana* Yabe and Nagao, 1925. IGPS no. 8553 (Lectotype). **6.** *Callista sekiyaensis* Akutsu, 1964. IGPS no. 85506 (Syntype). **7.** *Cardiomya (Cardiomya) kotakai* Honda, 1989. IGPS no. 99278 (Holotype). **8a–b.** *Cardita katsumatai* Nagao, 1928b. IGPS no. 36331 (Holotype). **9.** *Cardita kondoi* Nagao, 1928b. IGPS no. 36407 (Holotype). **10.** *Cardium (Trachycardium) hanpeizanense* Nomura, 1933. IGPS no. 37455 (Holotype). **11a–b.** *Cardium (Cerastoderma) hanzawai* Nomura, 1933. IGPS no. 46803 (Holotype). **12.** *Cardium (Cerastoderma) hizenense* Nagao, 1928b. IGPS no. 36369 (Holotype). **13a–b.** *Cardium (Trachycardium) infantile* Nomura and Zinbô, 1934. IGPS no. 50386 (Holotype). **14.** *Cardium ishidoense* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22553 (Lectotype). **15a–b.** *Cardium (Cerastoderma?) kishimaense* Nagao, 1928b. IGPS no. 36367 (Holotype). **16.** *Cardium miikense* Nagao, 1928a. IGPS no. 35733 (Lectotype). **17a–b.** *Cardium (Nemocardium) torii* Nomura, 1933. IGPS no. 49000 (Holotype). **18.** *Caryocorbula saikawai* Kotaka, 1955. IGPS no. 74010 (Holotype).

Plate 7

1. *Chlamys (Chlamys) akutsui* Masuda, 1962a. IGPS no. 28293 (Holotype). **2.** *Chlamys chinkopensis* Masuda and Sawada, 1961. IGPS no. 90595 (Holotype). **3.** *Chlamys cosibensis hanzawae* Masuda, 1959. IGPS no. 90648 (Holotype). **4.** *Chlamys daishakaensis* Masuda and Sawada, 1961. IGPS no. 90708 (Holotype). **5.** *Chlamys (Chlamys) hanaishiensis* Masuda, 1962a. IGPS no. 90565 (Holotype). **6.** *Chlamys (Chlamys) hasimotoi* Masuda, 1962a. IGPS no. 90527 (Holotype). **7.** *Chlamys hataii* Masuda and Akutsu, 1956. IGPS no. 90726 (Holotype). **8.** *Chlamys (Chlamys) hatakeyamae* Masuda, 1962a. IGPS no. 27563 (Holotype). **9a–b.** *Chlamys imanishii* Masuda and Sawada, 1961. IGPS no. 72555 (Holotype). **10.** *Chlamys (Chlamys) ishidae* Masuda, 1962a. IGPS no. 90676 (Holotype). **11.** *Chlamys (Chlamys) itoigawae* Masuda, 1962a. IGPS no. 90538 (Holotype). **12.** *Chlamys kitamurai* Kotaka, 1955. IGPS no. 74009 (Plastotype).

Plate 8

1. *Chlamys (Chlamys) kotakae* Masuda, 1962a. IGPS no. 90646 (Holotype). **2.** *Chlamys kumanodoensis* Masuda, 1953a. IGPS no. 90522 (Holotype). **3.** *Chlamys (Chlamys)*

matsunoii Masuda, 1962a. IGPS no. 90627 (Holotype). **4.** *Chlamys (Chlamys) nagaoi* Masuda, 1962a. IGPS no. 36440 (Holotype). **5.** *Chlamys (Chlamys) niikappuensis* Masuda, 1962a. IGPS no. 90536 (Holotype). **6a–b.** *Chlamys oidensis* Hatai, Masuda and Noda, 1974. IGPS no. 64419 (Holotype). **7a–b.** *Chlamys otukae* Masuda and Sawada, 1961. IGPS no. 90607 (Holotype). **8a–b.** *Chlamys (Chlamys) setsukoe* Masuda, 1962b. IGPS no. 90477 (Holotype). **9a–c.** *Chlamys shitakaraensis* Honda, 1980. IGPS no. 95439 (Holotype; **a–b.** external molds of both valves, **c.** cast from the holotype). **10.** *Chlamys tamurae* Masuda and Sawada, 1961. IGPS no. 90550 (Holotype). **11.** *Circe (Circe) triangulus* Kotaka and Noda, 1977. IGPS no. 95085 (Holotype). **12.** *Clementia japonica* Masuda, 1955. IGPS no. 90405 (Holotype). **13a–b.** *Clementia (Clementia) nakosoensis* Kamada, 1962. IGPS no. 79385 (Holotype).

Plate 9

1a–b. *Clinocardium asagaiense arakawae* Kamada, 1962. IGPS no. 79383 (Holotype). **2a–b.** *Clinocardium asagaiense makiyamae* Kamada, 1962. IGPS no. 15800 (Holotype). **3a–b.** *Clinocardium chikagawaense* Kotaka, 1950. IGPS no. 72999 (Holotype). **4.** *Clinocardium hataii* Hayasaka, 1956. IGPS no. 77375 (Holotype). **5.** "*Clinocardium*" *nomurai* Hayasaka, 1956. IGPS no. 77376 (Holotype). **6a–c.** *Clinocardium omagariense* Honda, 1981b. IGPS no. 95740-1 (Holotype). **7.** *Codakia kitamurai* Hatai and Nisiyama, 1949. IGPS no. 72526 (Holotype). **8a–b.** *Codakia (Jagonia) okinawazimana* Nomura and Zinbô, 1936. IGPS no. 51319 (Holotype). **9a–b.** *Codakia semipolita* Nomura, 1933. IGPS no. 45086 (Holotype). **10a–c.** *Conularia rectangularis* Hayasaka, 1920. IGPS no. 7320 (Lectotype). **11a–b.** *Corbicula (Corbicula) kotakai* Honda, 1981a. IGPS no. 96758 (Holotype). **12–14.** *Corbicula (Veloritina?) sanchuensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22467 (Syntypes). **15.** *Corbicula (Veloritina?) sanchuensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22449 (Syntype). **16a–b.** *Corbicula (Corbicula) sachalinensis* Suzuki, 1943. IGPS no. 8353c (Holotype). **17a–b.** *Corbicula (Corbicula) shimizui* Suzuki, 1943. IGPS no. 8353a (Holotype). **18.** *Corbicula takasago* Nomura, 1933. IGPS no. 45079 (Holotype). **19.** *Corbula (Cunaecorbula) kyushuensis* Nagao, 1928a. IGPS no. 35834 (Lectotype). **20.** *Corbula (Corbula) subtumida* Nagao, 1928a. IGPS no. 35828 (Lectotype). **21a–b.** *Corbula (Corbula) taiwanensis* Nomura, 1933. IGPS no. 48966 (Holotype). **22.** *Crassatellites asakuraensis* Nagao, 1928b. IGPS no. 36258 (Holotype). **23.** *Crassatellites formosanus* Nomura, 1933. IGPS no. 37441 (Holotype). **22a–b.** *Crassatellites inconspicuus* Nagao, 1928b. IGPS no. 36308 (Holotype). **23a–c.** *Crassatellites matsuraensis* Nagao, 1928b. IGPS no. 36310 (Holotype). **24a–b.** *Crassatellites*

tosanus Nomura, 1937. IGPS no. 54638 (Lectotype).

Plate 10

1a–b. *Crassostrea gravitesta eoilensis* Kim, Noda and Yoon, 1974. IGPS no. 92938 (Holotype). **2a–b.** *Crassostrea sunakozakaensis* Ogasawara, 1976. IGPS no. 95018 (Holotype). **3.** *Crenella (Megacrenella) nuibetsuensis* Honda, 1989. IGPS no. 97096 (Holotype). **4.** *Crenella (Megacrenella) shitakaraensis* Honda, 1989. IGPS no. 97111 (Holotype). **5.** *Crenella striatocostata* Nagao, 1928b. IGPS no. 36291 (Holotype). **6a–c.** *Crenella subformicata* Nagao, 1928b. IGPS no. 36288 (Holotype). **7.** *Crenella tomiyaensis* Hatai and Nakamura, 1940. IGPS no. 61354 (Holotype). **8.** *Crenipecten kesenensis* Hayasaka, 1925b. IGPS no. 22383 (Holotype). **9a–b.** *Ctena hataii* Masuda, 1966b. IGPS no. 90729 (Holotype). **10a–b.** *Ctenodonta manchuriensis* Endo, 1935. IGPS no. 55582 (Holotype). **11.** *Cucullaea delicatostriata* Yabe and Nagao, 1925. IGPS no. 8555 (Lectotype). **12.** *Cucullaea ezoensis* Yabe and Nagao, 1928. IGPS no. 22611 (Syntype). **13.** *Cucullaea nipponica* Nagao, 1928b. IGPS no. 35999 (Holotype).

Plate 11

1a–b. *Cucullaea nipponica* Nagao, 1928b. IGPS no. 35999 (Holotype). **2.** *Cultellus? brevis* Nagao, 1928a. IGPS no. 35788 (Holotype). **3.** *Cultellus? leguminoides* Nagao, 1928b. IGPS no. 36447 (Holotype). **4a–b.** *Cyclina (Cyclina) asagaiensis* Kamada, 1952. IGPS no. 72955 (Holotype). **5.** *Cyclina compressa* Nagao, 1928b. IGPS no. 36415 (Holotype). **6a–b.** *Cyclina (Cyclina) japonica* Kamada, 1952. IGPS no. 72952 (Holotype). **7a–b.** *Cyclina? nodai* Nagao, 1928b. IGPS no. 36442 (Holotype). **8.** *Cyclina (Cyclina) umbonata* Kotaka and Noda, 1977. IGPS no. 95090 (Holotype). **9.** *Cyclocardia fujinaensis* Ogasawara and Nomura, 1980. IGPS no. 96024 (Holotype). **10–13.** *Cyrena otsukai* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22476 (Syntypes; external and internal molds). **14–16.** *Cyrena shiroiensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22451 (Syntypes). **17–19.** *Cyrena shiroiensis* var. *alata* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22443 (Syntypes). **20.** *Daonella densisulcata* Yabe and Shimizu, 1927. IGPS no. 7571 (Holotype). **21.** *Daonella densisulcata* var. *subquadrata* Yabe and Shimizu, 1927. IGPS no. 7890 (Holotype). **22.** *Daonella kotoi* var. *alta* Yabe and Shimizu, 1927. IGPS no. 5298 (Holotype). **23.** *Daonella kotoi* var. *multistriata* Yabe and Shimizu, 1927. IGPS no. 35278 (Syntype). **24.** *Daonella kotoi* var. *multistriata* Yabe and Shimizu, 1927. IGPS no. 22998 (Syntype). **25.** *Diplodonta confusa* Nagao, 1928b. IGPS no. 36351 (Holotype). **26.** *Diplodonta? problematica* Nagao, 1928a. IGPS no. 35827 (Lectotype). **27.** *Dosinia chikuzenensis* Nagao, 1928b.

IGPS no. 36277 (Holotype). **28.** *Dosinia ettyuensis* Hatai and Nisiyama, 1939 ["1938"]. IGPS no. 62429 (Holotype).

Plate 12

1a–c. *Dosinia (Phacosoma) hataii* Masuda, 1963. IGPS no. 72476 (Holotype). **2.** *Dosinia (Kaneharaia) kaneharai fujinaensis* Masuda, 1967. IGPS no. 90888 (Holotype). **3a–b.** *Dosinia (Kaneharaia) kannoi* Masuda, 1963. IGPS no. 64682 (Holotype). **4a–b.** *Dosinia tatunokutiensis* Nomura, 1938. IGPS no. 15944 (Holotype). **5a–c.** *Ennucula praeipponica* Kamada, 1962. IGPS no. 79375 (Holotype). **6a–b.** *Ezocallista kurodae* Kamada, 1962. IGPS no. 79384 (Holotype).

Plate 13

1. *Fortipecten kuroishiensis* Kotaka and Noda, 1967. IGPS no. 90767 (Holotype). **2a–b.** *Gafrarium (Circe) hanzawai* Nomura and Zinbō, 1936. IGPS no. 51348 (Holotype). **3.** *Gari (Gari) pitogoensis* Kotaka and Noda, 1977. IGPS no. 95086 (Holotype). **4.** *Gervillia shinanoensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22507 (Syntype). **5a–b.** *Glans naomiae* Masuda, 1966b. IGPS no. 90181 (Holotype). **6.** *Gloripallium izurense* Masuda, 1958a. IGPS no. 90541 (Holotype). **7.** *Glycimeris altoumbonata* Nagao, 1928b. IGPS no. 36013 (Holotype). **8–10.** *Glycimeris amakusensis* Nagao, 1930. IGPS no. 42727 (Syntypes). **11a–b.** *Glycimeris cisshuensis* var. *compressa* Nagao, 1928b. IGPS no. 36001 (Holotype). **12a–b.** *Glycimeris hanzawai* Nomura and Zinbō, 1934. IGPS no. 50196 (Holotype). **13a–b.** *Glycimeris nakosoensis* Hatai and Nisiyama, 1949. IGPS no. 72502 (Holotype). **14.** *Glycimeris nozokiensis* Hatai and Nisiyama, 1951. IGPS no. 72883 (Holotype). **15.** *Glycimeris ogawaraensis* Kotaka and Noda, 1967. IGPS no. 90739 (Holotype). **16.** *Glycimeris oshimaensis* Noda, 1962b. IGPS no. 79057 (Holotype). **17.** *Glycimeris rhyconelloides* Nomura and Hatai, 1939 ["1938"]. IGPS no. 60022 (Holotype). **18a–b.** *Glycimeris subpectiniformis* Nomura and Zinbō, 1934. IGPS no. 50200 (Holotype). **19a–b.** *Glycimeris yamaguchii* Hayasaka, 1956. IGPS no. 77373 (Holotype). **20.** *Grammatodon yokoyamai* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22555 (Lectotype). **21a–b.** *Halicardia akitaensis* Ogasawara and Takayasu, 1982. IGPS no. 96013 (Holotype; **b.** cast from the holotype). **22a–b.** *Halicardia miyagiensis* Fujiwara, 1992. IGPS no. 101555 (Holotype).

Plate 14

1–3. *Homomya? dubia* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22505 (Syntypes). **4.** *Inoceramus balticus* var. *toyajoanus* Nagao and Matumoto, 1940. IGPS no. 4540 (Lectotype). **5.** *Inoceramus pedalionoides* Nagao and Matumoto, 1939 ex Inai (MS). IGPS no. 22720

(Syntype). **6.** *Isognomon (Isognomon) hataii* Noda and Furuichi, 1972. IGPS no. 91766 (Holotype). **7.** *Katelsysia (Nipponomarcia) endoi* Hatai and Kotaka, 1952. IGPS no. 74341 (Holotype). **8.** *Leptochondria? hataii* Murata, 1973. IGPS no. 92661 (Holotype). **9.** *Leukomoides nipponicus* Ogasawara, 1976. IGPS no. 95190 (Holotype). **10a–b.** *Lima amaxensis* var. *kumasoana* Nagao, 1928a. IGPS no. 35808 (Lectotype). **11.** *Lima eocenica* Nagao, 1928a. IGPS no. 35817 (Lectotype). **12.** *Lima (Limatula) ishidoensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22539 (Lectotype). **13a–b.** *Lima (Limea) limopsis* Nomura and Zinbô, 1934. IGPS no. 50368 (Holotype). **14.** *Limatula sakoi* Masuda and Katto, in Katto and Masuda, 1978. IGPS no. 96073 (Holotype). **15a–b.** *Limipecten bandoi* Murata, 1969. IGPS no. 91384 (Holotype; **a.** external mold, **b.** cast from the holotype).

Plate 15

1a–b. *Lioconcha tosana* Nomura, 1937. IGPS no. 54674 (Holotype). **2a–b.** *Loripes tonohamanus* Nomura, 1937. IGPS no. 54645 (Holotype). **3a–b.** *Lucina kunigamiensis* Nomura and Zinbô, 1936. IGPS no. 51350 (Holotype). **4a–b.** *Lucinoma otukai* Hatai and Nisiyama, 1949. IGPS no. 72501 (Holotype; external molds of both valves). **5a–b.** *Lucinopsis? boshihoensis* Nomura, 1933. IGPS no. 48007 (Holotype). **6.** *Lucinopsis kosuiensis* Nomura, 1933. IGPS no. 48001 (Holotype; broken). **7a–b.** *Macoma (Macoma) atsunaiensis* Honda, 1988. IGPS no. 97106-2 (Holotype). **8a–b.** *Macoma hakushatonensis* Nomura, 1933. IGPS no. 48589 (Holotype; broken). **9.** *Macoma hokiensis* Akutsu, 1964. IGPS no. 85512 (Holotype). **10.** *Macrocallista ariakensis* Nagao, 1928a. IGPS no. 35758 (Lectotype). **11.** *Macrocallista hanzawai* Nagao, 1928b. IGPS no. 36236 (Holotype). **12a–b.** *Macrocallista kahoensis* Nagao, 1928b. IGPS no. 36389 (Holotype). **13a–c.** *Macrocallista matsuraensis* Nagao, 1928b. IGPS no. 36209 (Holotype). **14a–b.** *Mactra (Spisula) asperaeformis* Nomura and Zinbô, 1934. IGPS no. 50396 (Holotype). **15a–b.** *Mactra nakayamaensis* Kamada, 1962. IGPS no. 79386 (Holotype). **16.** *Mactra sulcataroides* Akutsu, 1964. IGPS no. 85509 (Holotype). **17a–b.** *Margaritifera owadaensis* Noda, 1970. IGPS no. 86893 (Holotype). **18a–b.** *Meretrix deguchii* Hayasaka and Hayasaka, 1960. IGPS no. 77512 (Holotype). **19a–b.** *Meretrix meretrix ninohensis* Hatai, 1940. IGPS no. 61351 (Holotype). **20.** *Meretrix pseudomeretrix* Nagao, 1928b. IGPS no. 36361 (Holotype). **21a–b.** *Meretrix tochiensis* Akutsu, 1964. IGPS no. 85507 (Holotype).

Plate 16

1a–b. *Miyagipecten matsumoriensis* Masuda, 1952. IGPS no. 90690 (Lectotype). **2.** *Mizuhopecten kimurai kagaensis* Ogasawara, 1976. IGPS no. 95012 (Holotype).

3a–b. *Mizuhopecten paraplebejus murataensis* Masuda and Takegawa, 1965. IGPS no. 90826 (Holotype). **4.** *Modiola? ishidoensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 8570 (Holotype). **5a–b.** *Modiolus ezoensis* Yabe and Nagao, 1928. IGPS no. 22627 (Holotype). **6a–b.** *Modiolus wanizakiensis* Masuda, 1966b. IGPS no. 90180 (Holotype). **7a–b.** *Modiolus (Modiolatus) yasuihiroii* Kamada, 1962. IGPS no. 79379 (Holotype). **8a–d.** *Monia denselineata* Hatai, Masuda and Suzuki, 1961. IGPS no. 90505 (Holotype). **9.** *Mya arenaria kitahukuokaensis* Hatai, 1940. IGPS no. 61363 (Holotype). **10.** *Mya convexa* Noda, 1992. IGPS no. 100877 (Holotype). **11a–b.** *Myadora okadae* Hatai and Masuda, 1960. IGPS no. 90184 (Holotype).

Plate 17

1. *Myadora suzuensis* Masuda, 1966b. IGPS no. 90776 (Holotype). **2.** *Myoconcha hamadaensis* Yabe and Shimizu, 1927. IGPS no. 35286 (Holotype). **3.** *Myophoria japonica* Hayasaka, 1925b. IGPS no. 22422 (Lectotype). **4.** *Myophoria subelegans* var. *tobai* Hayasaka, 1924. IGPS no. 8405 (Syntype). **5.** *Myophoria subelegans* var. *tobai* Hayasaka, 1924. IGPS no. 8404 (Syntype). **6.** *Myophoria subelegans* var. *tobai* Hayasaka, 1924. IGPS no. 8406 (Syntype; external mold). **7.** *Myophoria subelegans* var. *tobai* Hayasaka, 1924. IGPS no. 8407 (Syntype; external mold). **8.** *Mytilus haboroensis* Noda, 1992. IGPS no. 100727 (Holotype). **9.** *Mytilus ogawaensis* Hatai and Nisiyama, 1949. IGPS no. 72503 (Holotype). **10.** *Nemocardium (Keenaea) yoshidai* Masuda and Miyasaka, 1994. IGPS no. 102544 (Holotype). **11.** *Neoburmesia iwakiensis* Yabe and Sato, 1942. IGPS no. 65274 (Holotype). **12a–b.** *Astarte minor* Nagao, 1934. IGPS no. 66425 (Lectotype) [= *Nicaniella (Trautscholdia) nagaoi* Matsubara, 2016. IGPS no. 66425 (Holotype)]. **13.** *Arca (Noetia) pondaungensis* var. *transversa* Nagao, 1928b [= *Noetia nagaoi* MacNeil, 1938]. IGPS no. 36012 (Holotype). **14.** *Nucula fukasawaensis* Akutsu, 1964. IGPS no. 85500 (Holotype). **15a–b.** *Nucula ishidoensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 7125 (Syntype). **16.** *Nucula karatsuensis* Nagao, 1928b. IGPS no. 35988 (Holotype). **17a–b.** *Nucula kokozuraensis* Hatai and Nisiyama, 1949. IGPS no. 72507 (Holotype). **18a–c.** *Nucula (Acila) mirabilis* var. *ashiyaensis* Nagao, 1928b. IGPS no. 35981 (Holotype). **19.** *Nucula (Ennucula) omagariensis* Honda, 1989. IGPS no. 95576-1 (Holotype). **20a–c.** *Nuculana (Nuculana) karihaensis* Hatai and Nisiyama, 1949. IGPS no. 72633 (Holotype). **21.** *Nuculana (Nuculana) matsukuchiensis* Noda, 1962b. IGPS no. 79059 (Holotype). **22–24.** *Nuculana sanchuensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 7115 (Syntypes). **25a–c.** *Nuculites kimurai* Hayasaka, 1925a. IGPS no. 22418 (Holotype). **26a–b.** *Nuttallia uchigoensis* Kamada, 1962. IGPS no. 79387 (Holotype).

Plate 18

1. *Ostrea cassis* Nagao, 1928b. IGPS no. 36031 (Holotype).
2. *Ostrea lunaeformis* Nagao, 1928b. IGPS no. 36039 (Holotype).
- 3a–b. *Ostrea sakitoensis* Nagao, 1928b. IGPS no. 36053 (Holotype).
4. *Ostrea (Ostrea) yokoyamai* Kamada, 1962. IGPS no. 79378 (Holotype).
- 5a–b. *Panomya izumo* Nomura and Hatai, 1939 [“1938”]. IGPS no. 51884 (Holotype).
6. *Panope kanomatazawaensis* Akutsu, 1964. IGPS no. 85513 (Holotype).
7. *Panope kanomatazawaensis fudozawaensis* Akutsu, 1964. IGPS no. 85514 (Holotype).
8. *Panopea nomurae* Kamada, 1962. IGPS no. 79395 (Holotype).
9. *Paphia (Paphia) euglypta ohiroi* Masuda, 1966b. IGPS no. 90735 (Holotype).
10. *Paphia shimotsukensis* Akutsu, 1964. IGPS no. 85508 (Holotype).
11. *Paphia (Paphia) suzuensis* Masuda, 1966b. IGPS no. 90086 (Holotype).
- 12a–b. *Parallelodon obsoletiformis* Hayasaka, 1925b. IGPS no. 22392 (Lectotype).

Plate 19

1. *Patinopecten ibaragiensis* Masuda, 1953b. IGPS no. 90698 (Holotype).
2. *Patinopecten kagamianus moniwaensis* Masuda, 1958b. IGPS no. 90700 (Holotype).
3. *Patinopecten kimurai nakosoensis* Masuda, 1960. IGPS no. 90581 (Holotype).
4. *Patinopecten kimurai yudaensis* Masuda, 1960. IGPS no. 90661 (Holotype).
- 5a–b. *Patinopecten kobyamai* Kamada, 1954. IGPS no. 72963 (Holotype).
6. *Patinopecten (Kotorapecten) naganensis* Masuda, 1962a. IGPS no. 90547 (Holotype).

Plate 20

1. *Patinopecten (Kotorapecten) naganensis* Masuda, 1962a. IGPS no. 90547 (Holotype).
- 2a–b. *Patinopecten nakajimai* Masuda, 1954b. IGPS no. 90580 (Holotype).
- 3a–b. *Patinopecten poculum tsudae* Noda, 1962b. IGPS no. 79062 (Holotype).
4. *Patinopecten (Patinopecten) tokyoensis hokurikuensis* Masuda, 1962a. IGPS no. 13430 (Holotype).
5. *Patinopecten yamasakii kintaichiensis* Masuda, 1958c. IGPS no. 90715 (Holotype).
6. *Patinopecten yamasakii ninohensis* Masuda, 1954a. IGPS no. 90684 (Holotype).
7. *Patinopecten (Patinopecten) yessoensis nakatonbetsuensis* Masuda, 1962a. IGPS no. 90662 (Holotype).

Plate 21

1. *Patinopecten (Patinopecten) yessoensis yokoyamae* Masuda, 1962a. IGPS no. 90543 (Holotype).
- 2a–b. *Pecten (Pseudamussium) akihoensis* Saga, in Matsumoto, 1930. IGPS no. 90586 (Neotype).
3. *Pecten (Chlamys) ashiyaensis* Nagao, 1928b. IGPS no. 36448 (Holotype).
4. *Pecten (Chlamys) ashiyaensis* var. *denselineatus* Nagao, 1928b. IGPS no. 36437 (Holotype).
5. *Pecten (Vola) byoritsuensis* Nomura, 1933. IGPS no. 45001 (Holotype).

6. *Pecten (Propeamussium) cowperi* var. *yubarensis* Yabe and Nagao, 1928. IGPS no. 22599 (Holotype).
7. *Pecten (Aequipecten) gabusogaensis* Nomura and Zinbō, 1936. IGPS no. 51321 (Holotype).
- 8–12. *Pecten (Decadopecten) izuensis* Nomura and Niino, 1932. IGPS no. 44583 (Syntypes).
13. *Pecten (Chlamys) kagamianus miyagiensis* Nakamura, 1940a. IGPS no. 61336 (Holotype).
- 14–15. *Pecten (Pecten) kakisakiensis* Nomura and Niino, 1932. IGPS no. 44582 (Syntypes).

Plate 22

- 1a–b. *Pecten (Patinopecten) kimurai matumoriensis* Nakamura, 1940a. IGPS no. 61335 (Syntype).
2. *Pecten kyushuensis* Nagao, 1928b. IGPS no. 36459 (Holotype).
3. *Pecten (Swiftiopecten) nanakitaensis* Nakamura, 1940b. IGPS 61334 (Holotype; external mold).
4. *Pecten (Patinopecten) planicostulatus* Nomura and Niino, 1932. IGPS no. 44584 (Syntype).
5. *Pecten (Chlamys) sakitoensis* Nagao, 1928b. IGPS no. 36438 (Holotype).
- 6a–b. *Pecten (Pecten) shirahamaensis* Nomura and Niino, 1932. IGPS no. 44587 (Holotype).
- 7a–b. *Pecten (Pecten) subsquamatus* Nomura, 1933. IGPS no. 44702 (Holotype).
8. *Pecten (Patinopecten) taiwanus* Nomura, 1933. IGPS no. 45007 (Holotype).
- 9–11. *Pecten (Decadopecten) tayamai* Nomura and Niino, 1932. IGPS no. 44581 (Syntypes).

Plate 23

1. *Pecten (?Amussiopecten) yabei* Nomura, 1933. IGPS no. 25265 (Holotype).
2. *Pectunculus hokkaidoensis* Yabe and Nagao, 1928. IGPS no. 22613 (Holotype).
- 3a–b. *Pectunculus sachalinensis* Yabe and Nagao, 1925. IGPS no. 8554 (Syntype).
4. *Pedalion tomiyasui* Nagao, 1928a. IGPS no. 35686 (Lectotype).
5. *Periploma fujikuraense* Noda, 1962b. IGPS no. 79056 (Holotype).
- 6a–b. *Periploma pulchellum* Hatai and Nisiyama, 1949. IGPS no. 72508 (Holotype).
- 7a–b. *Perna sanchuensis* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22457 (Lectotype).
8. *Peronidia ochii* Kamada, 1962. IGPS no. 79388 (Holotype).
- 9a–c. *Pholadomya brevitesta* Nagao, 1943. IGPS no. 72710 (Holotype).
- 10a–c. *Pholadomya kazusaensis* Nagao, 1943. IGPS no. 19534 (Holotype).
11. *Pholadomya? miyamotoi* Nagao, 1943. IGPS no. 72737 (Lectotype).
- 12a–c. *Pholadomya takasimensis* Nagao, 1943. IGPS no. 72706 (Holotype).
- 13a–b. *Pinna asakuraensis* Nagao, 1928b. IGPS no. 36017 or 36018 (Holotype).
14. *Pitar hataii* Natori, 1964. IGPS no. 85728 (Holotype).

Plate 24

- 1a–b. *Pitar hokkaidoensis* Nomura, 1935a. IGPS no. 56371 (Holotype).
2. *Pitar kotoi* Natori, 1964. IGPS no. 85729 (Holotype).
- 3a–b. *Pitar sendaica monstrosa* Nomura, 1938.

IGPS no. 16131A (Holotype). **4.** *"Pitar" shiobarensis* Akutsu, 1964. IGPS no. 85505 (Holotype). **5.** *Pitar sunakozakaensis* Ogasawara, 1976. IGPS no. 95028 (Holotype). **6.** *Pitaria? altoumbonata* Nagao, 1928b. IGPS no. 36445 (Holotype). **7.** *Pitaria ashiyaensis* Nagao, 1928b. IGPS no. 36434 (Holotype). **8a–b.** *Pitaria kyushuensis* Nagao, 1928b. IGPS no. 36238 (Holotype).

Plate 25

1. *Pitaria matsumotoi* Nagao, 1928b. IGPS no. 36241 (Holotype). **2.** *Pitaria takashimaensis* Nagao, 1928b. IGPS no. 36300 (Holotype). **3a–b.** *Pitaria yokoyamai* Nagao, 1928b. IGPS no. 36443 (Holotype). **4.** *Placopecten nomurai* Masuda, 1953a. IGPS no. 90553 (Holotype; broken). **5a–b.** *Placopecten wakuyaensis* Masuda, 1956. IGPS no. 90596 (Holotype). **6a–b.** *Plicatula tuberculosa* Nomura, 1933. IGPS no. 45030 (Holotype). **7.** *Pododesmus (Monia) noharai* Noda, 1971. IGPS no. 86762 (Holotype). **8a–c.** *Polynemamussium masagoi* Kotaka and Noda, 1967. IGPS no. 90755 (Holotype). **9.** *Polynemamussium yasudae* Masuda, 1962a. IGPS no. 90602 (Holotype). **10a–b.** *Portlandia (Portlandella) enaensis* Kamada, 1962. IGPS no. 79377 (Holotype). **11.** *Protocardia ibukii* Nakazawa and Murata, 1966. IGPS no. 85765 (Holotype; external mold). **12.** *Psammocola sekiyaensis* Akutsu, 1964. IGPS no. 85511 (Holotype). **13a–e.** *Pseudoactinodontophora yabei* Murata, 1971. IGPS no. 86885 (Holotype; **a.** internal mold, **b.** external mold, **c–e.** casts from the holotype). **14a–b.** *Pseudogrammatodon pacificus* Nomura and Zinbô, 1934. IGPS no. 50341 (Holotype). **15.** *Pteria sunakozakaensis* Ogasawara, 1976. IGPS no. 95008 (Holotype). **16.** *Rexithaerus shiratoriensis* Matsubara, 1994. IGPS no. 102562 (Holotype).

Plate 26

1a–b. *Rochefortia obsoletoradiata* Nomura and Zinbô, 1936. IGPS no. 51351 (Holotype). **2.** *Saccella confusa toyomaensis* Kamada, 1962. IGPS no. 79376 (Holotype; broken). **3.** *Saccella konnoi* Hatai and Masuda, 1962. IGPS no. 90196 (Holotype). **4a–c.** *Saccella saikaiensis* Masuda, 1966b. IGPS no. 90088 (Holotype). **5a–c.** *Sanguinolites bisectus* Hayasaka, 1925b. IGPS no. 22414 (Holotype). **6.** *Schizothaerus nuttalli kissyuensis* Hatai, 1941. IGPS no. 64751 (Holotype). **7.** *Septifer sinelnikovae* Noda, 1992. IGPS no. 100734 (Holotype). **8.** *Serripes hataii* Noda, 1962a ["1961"]. IGPS no. 74593 (Holotype). **9.** *Serripes japonica* Noda, 1962a ["1961"]. IGPS no. 78680 (Holotype). **10.** *Serripes makiyamai nigamiensis* Noda, 1962a ["1961"]. IGPS no. 78684 (Holotype). **11.** *Serripes muraii* Noda and Tada, 1968. IGPS no. 88058 (Holotype). **12.** *Serripes shiobarensis* Noda, 1962a ["1961"]. IGPS no. 78687 (Holotype). **13.** *Solemya (Acharax) bosoana* Hatai and

Koike, 1957. IGPS no. 94774 (Holotype).

Plate 27

1. *Solemya (Acharax) bosoana* Hatai and Koike, 1957. IGPS no. 94774 (Holotype). **2.** *Solemya (Acharax) muroensis* Natori, 1964. IGPS no. 85727 (Holotype). **3.** *Solen intermedius* Nagao, 1928b [= *Solen connectens* Oyama, 1951a]. IGPS no. 36435 (Holotype). **4.** *Solen shitakaraensis* Honda, 1989. IGPS no. 95129-1 (Holotype). **5.** *Solenomorpha elegantissima* Hayasaka, 1925b. IGPS no. 8203 (Syntype). **6a–c.** *Solenomorpha elegantissima* Hayasaka, 1925b. IGPS no. 22228 (Syntype). **7a–b.** *Solenomorpha elegantissima* Hayasaka, 1925b. IGPS no. 22229 (Syntype).

Plate 28

1. *Solenomorpha elegantissima* Hayasaka, 1925b. IGPS no. 22229 (Syntype). **2.** *Spisula (Cymbophora) ezoensis* Yabe and Nagao, 1928. IGPS no. 22614 (Holotype). **3.** *Spisula iwatensis* Hatai, 1940. IGPS no. 61360 (Holotype). **4.** *Spisula (Mactromeris) polynyma nagakoensis* Hatai and Nisiyama, 1949. IGPS no. 72506 (Holotype). **5.** *Spisula shimotsukensis* Akutsu, 1964. IGPS no. 85510 (Holotype). **6.** *Strebromchondria miyamoriensis* Murata, 1964. IGPS no. 85733 (Holotype). **7.** *Tapes nagahamaensis* Saito, Bando and Noda, 1970. IGPS no. 78707 (Holotype). **8.** *Taras millepustulata* Nomura, 1933. IGPS no. 45096 (Holotype). **9.** *Tellina (Pharaonella) akiana* Nomura, 1937. IGPS no. 54691 (Holotype). **10.** *Tellina equideclivis* Nagao, 1928b. IGPS no. 36457 (Holotype). **11a–b.** *Tellina kikaizimana* Nomura and Zinbô, 1934. IGPS no. 50398 (Holotype). **12a–b.** *Tellina kuntsuipinensis* Nomura, 1933. IGPS no. 48595 (Holotype). **13.** *Tellina maxima* Nagao, 1928b. IGPS no. 36412 (Holotype; broken). **14.** *Tellina notoensis* Masuda, 1955. IGPS no. 90451 (Holotype). **15.** *Tellina prototenuilrata* Nomura, 1933. IGPS no. 48192 (Holotype; broken). **16a–b.** *Tellina scabricostulata* Nomura and Zinbô, 1936. IGPS no. 51333 (Holotype). **17a–b.** *Tellina umedairensis* Shikama, 1951. IGPS no. 90404 (Holotype). **18.** *Tellina venulosa zyonoensis* Hatai and Nisiyama, 1939 ["1938"]. IGPS no. 62424 (Holotype). **19.** *Teredo matsushimaensis* Hatai, 1951. IGPS no. 73697 (Lectotype). **20a–b.** *Thracia hataii* Kamada, 1955. IGPS no. 72960 (Holotype). **21a–b.** *Thracia kamayasikiensis* Hatai, 1940. IGPS no. 61349 (Holotype). **22a–b.** *Thracia kidoensis* Kamada, 1955. IGPS no. 72958 (Holotype). **23a–b.** *Thracia kurosawaensis* Hayasaka, 1957. IGPS no. 77497 (Holotype). **24.** *Thracia (Thracia) shitakaraensis* Honda, 1989. IGPS no. 95428-4 (Holotype).

Plate 29

1. *Thracia (Thracia) shitakaraensis* Honda, 1989. IGPS no. 95428-4 (Holotype). **2.** *Thracidora nishizawaensis* Akutsu,

1964. IGPS no. 85502 (Holotype). **3a–c.** *Thyasira bisecta* var. *nipponica* Yabe and Nomura, 1925. IGPS no. 7485 (Lectotype). **4.** *Thyasira inflata* Yabe and Nomura, 1925. IGPS no. 17251 (Holotype). **5a–c.** *Thyasira quadrata* Yabe and Nomura, 1925. IGPS no. 8188 (Holotype). **6.** *Thyasira subexcavata* Yabe and Endô, in Yabe and Nomura, 1925. IGPS no. 6973 (Holotype). **7a–b.** *Thyasira tokunagai* Kuroda and Habe, 1951. IGPS no. 13786 (Lectotype, designated herein). **8a–b.** *Trapezium (Neotrapezium) ichinohense* Matsubara, 1995. IGPS no. 102605 (Holotype). **9.** *Trapezium (Neotrapezium) isoharensis* Kamada, 1962. IGPS no. 79382 (Holotype). **10.** *Trapezium isomatsuense* Kotaka, 1955. IGPS no. 74006 (Holotype). **11.** *Trapezium jobanicum* Hatai and Nisiyama, 1949. IGPS no. 72505 (Holotype). **12a–b.** *Cardium (Acanthocardia) cancellatum* Nomura, 1933 [= *Trifaricardium nomurai* Kuroda and Habe, 1951]. IGPS no. 46500 (Holotype). **13.** *Trigonarca? obsoleta* Yabe and Nagao, in Yabe, Nagao and Shimizu, 1926. IGPS no. 22538 (Holotype).

Plate 30

1. *Trigonia ainuana* Yabe and Nagao, 1928. IGPS no. 22591 (Holotype). **2.** *Trigonia brevicula* Yehara, 1915. IGPS no. 4329 (Lectotype). **3–4.** *Trigonia datemasamunei* Yehara, 1915. IGPS no. 4331 (Syntypes). **5a–b.** *Trigonia pustulosa* Nagao, 1930. IGPS no. 35612 (Syntype; **a.** external mold, **b.** cast from the syntype). **6a–b.** *Trigonia pustulosa* Nagao, 1930. IGPS no. 35613 (Syntype; **a.** external mold, **b.** cast from the syntype). **7–8.** *Trigonia pustulosa* Nagao, 1930. IGPS no. 35613 (Syntypes; **7a.** external mold, **7b–8.** casts from syntypes). **9.** *Trigonia yokoyamai* Yehara, 1915. IGPS no. 4367 (Syntype). **10.** *Trigonia yokoyamai* Yehara, 1915. IGPS nos. 4366 (Syntype). **11.** *Vasticardium arenicoloides* Akutsu, 1964. IGPS no. 85504 (Syntype). **12.** *Vasticardium shimotokuraense* Akutsu, 1964. IGPS no. 85503 (Syntype). **13.** *Vasticardium teshimaense* Saito,

Bando and Noda, 1970. IGPS no. 86745 (Holotype). **14a–b.** *Venericardia crenulicostata* Nomura, 1933. IGPS no. 46221 (Holotype). **15.** *Venericardia (Cyclocardia) enaensis* Kamada, 1962. IGPS no. 79381 (Holotype). **16a–b.** *Venericardia (Cyclocardia) ferruginea complexa* Ogasawara, 1977. IGPS no. 95127 (Holotype). **17a–e.** *Venericardia granulicostata* Nomura, 1933. IGPS no. 46136 (Holotype). **18a–b.** *Venericardia millegrana* Nomura and Zinbô, 1934. IGPS no. 50375 (Holotype). **19.** *Venericardia nagaoi* Mizuno, 1964. IGPS no. 36314 (Holotype). **20.** *Venericardia okinoshimaensis* Mizuno, 1964. IGPS no. 36371 (Holotype).

Plate 31

1a–b. *Venericardia onukii* Masuda and Takegawa, 1965. IGPS no. 90828 (Holotype). **2a–b.** *Venericardia quadriangulata* Nomura and Zinbô, 1934. IGPS no. 50385 (Holotype). **3a–b.** *Venericardia ryukyuensis* Nomura and Zinbô, 1936. IGPS no. 51344 (Holotype). **4a–c.** *Venericardia subnipponica* Nagao, 1928b. IGPS no. 36405 (Holotype). **5.** *Venericardia yoshidai* Nagao, 1928b. IGPS no. 36327 (Holotype). **6a–b.** *Veniella? japonica* Nagao, 1930. IGPS no. 44307 (Syntype). **7.** *Veniella? japonica* Nagao, 1930. IGPS no. 44306 (Syntype). **8.** *Venus (Chione) byoritsuensis* Nomura, 1933. IGPS no. 48061 (Holotype). **9.** *Venus (Chione) taiwanensis* Nomura, 1933. IGPS no. 47771 (Holotype). **10a–b.** *Venus (Chione) yabei* Nomura and Zinbô, 1934. IGPS no. 50651 (Holotype). **11a–b.** *VolSELLA yokoyamai* Hatai and Nisiyama, 1949. IGPS no. 72504 (Holotype). **12.** *Waagenoperna elongata* Nakazawa and Murata, 1966. IGPS no. 85764 (Holotype). **13a–b.** *Yabepecten ogasawarai* Matsubara, 2003. IGPS no. 98911 (Holotype). **14a–b.** *Yoldia iwatensis* Hatai, 1940. IGPS no. 61348 (Holotype; **b.** external mold). **15a–c.** *Yoldia scaphoides* Nagao, 1928b. IGPS no. 35987 (Holotype). **16.** *Zirfaea hataii* Masuda and Noda, 1969. IGPS no. 86742 (Holotype).

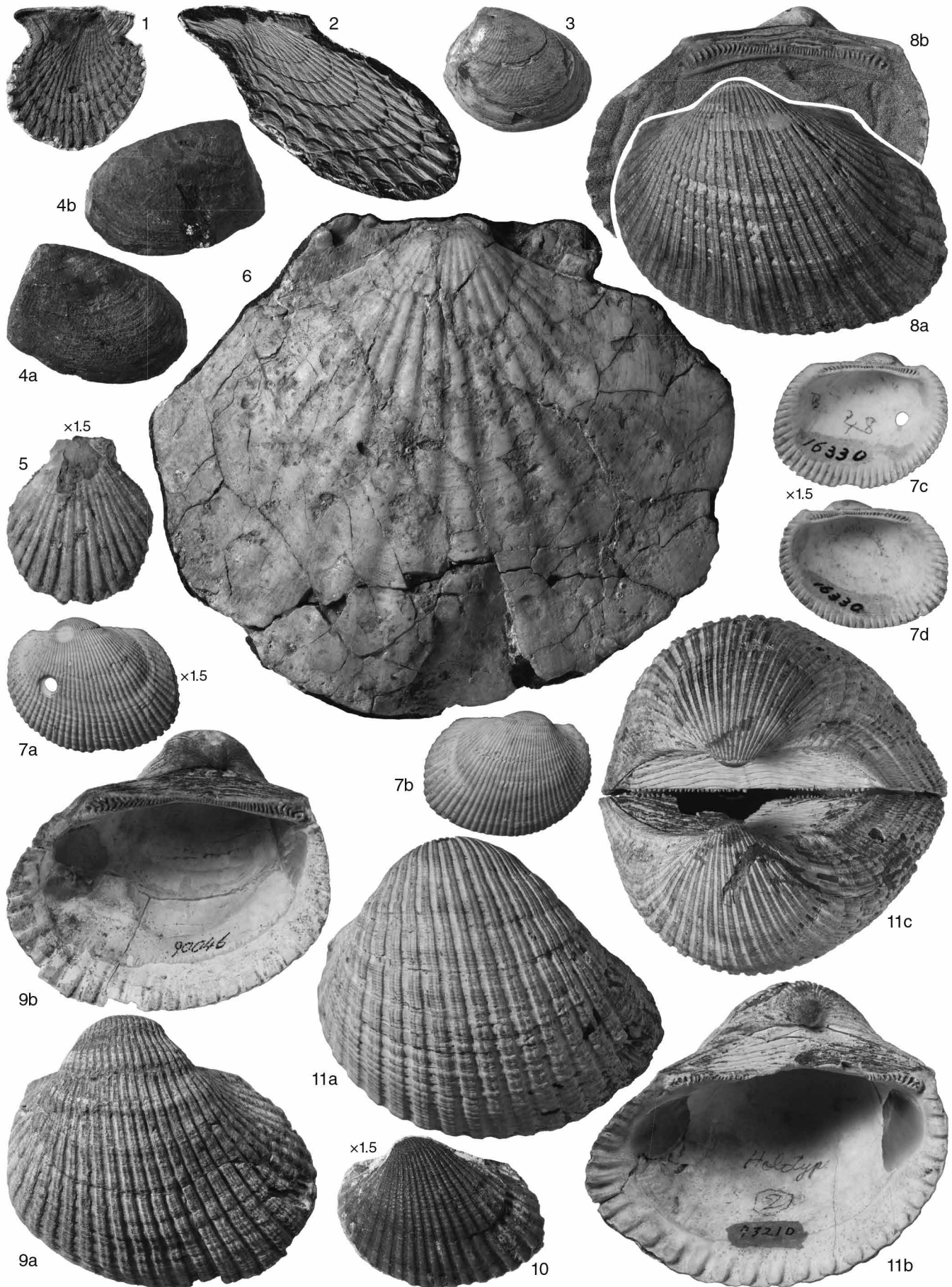


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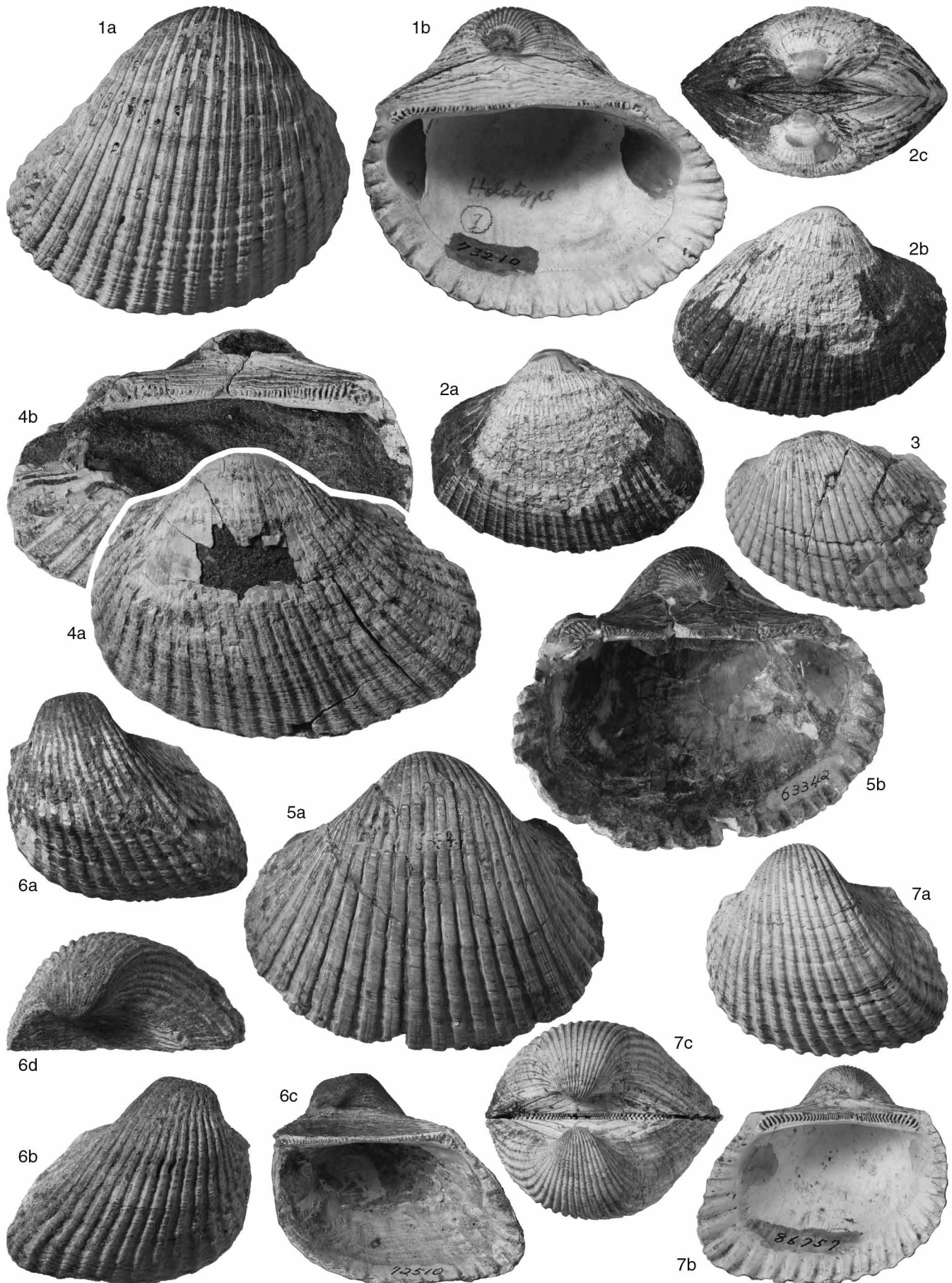
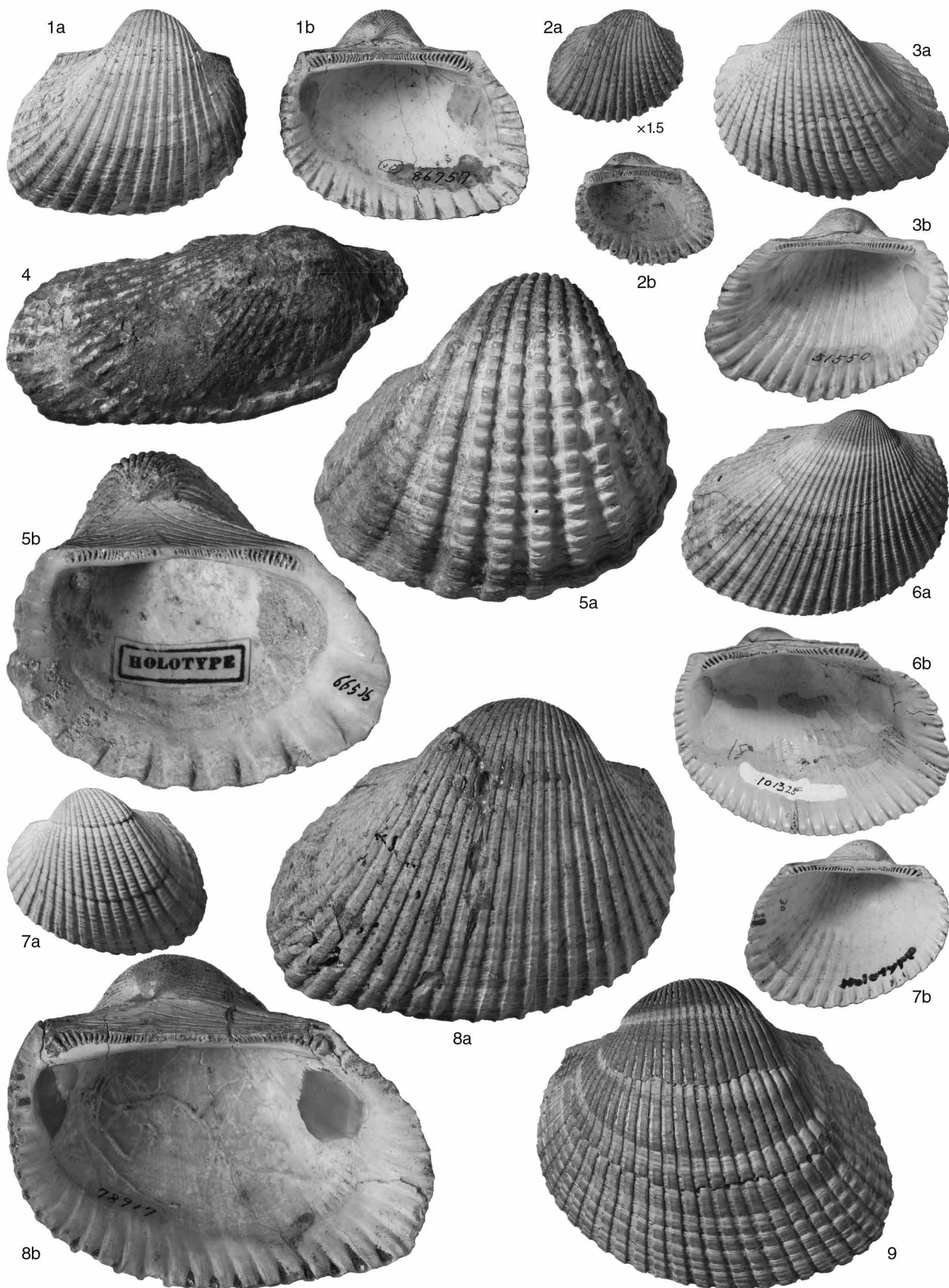


PLATE 2



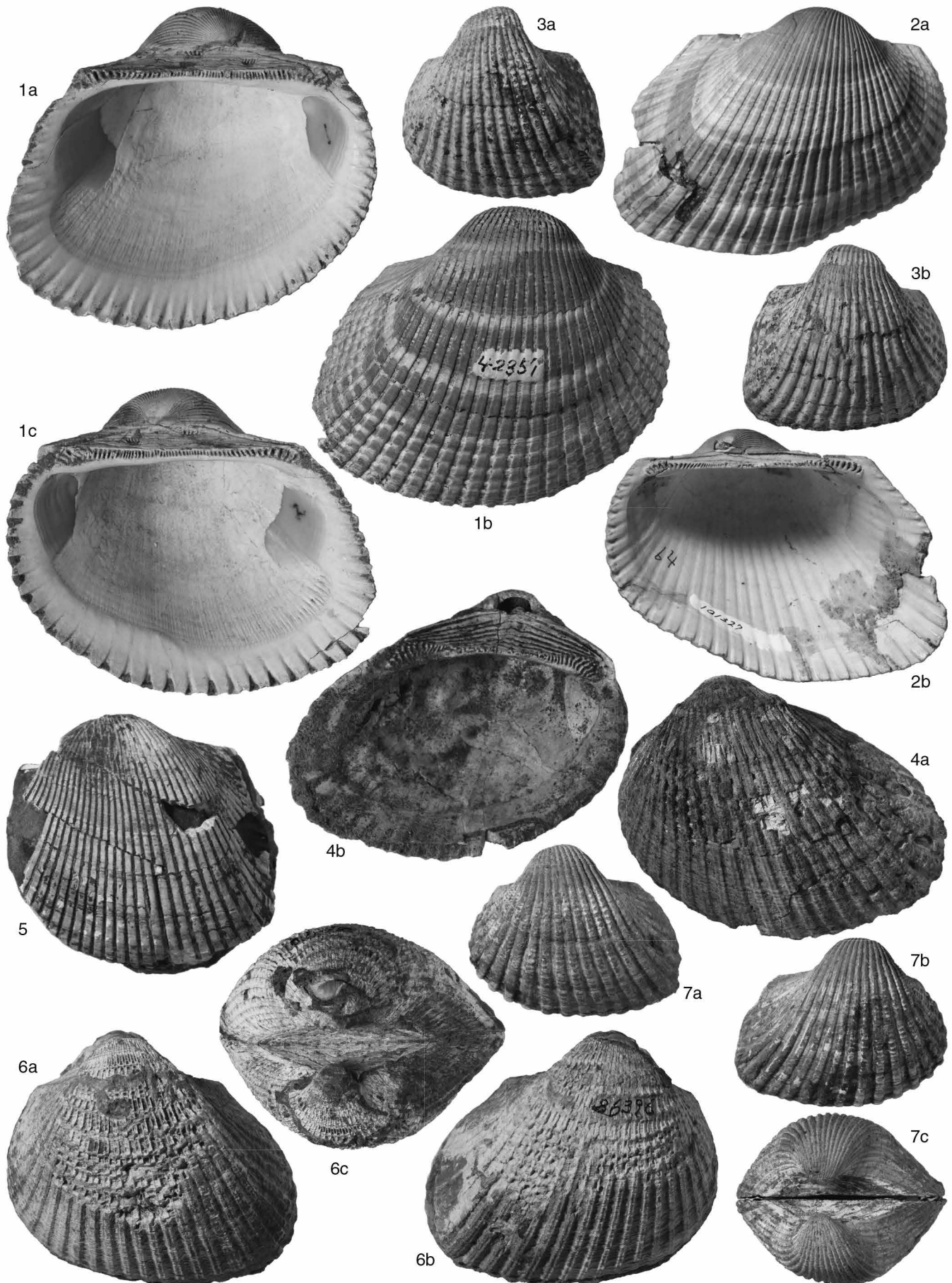
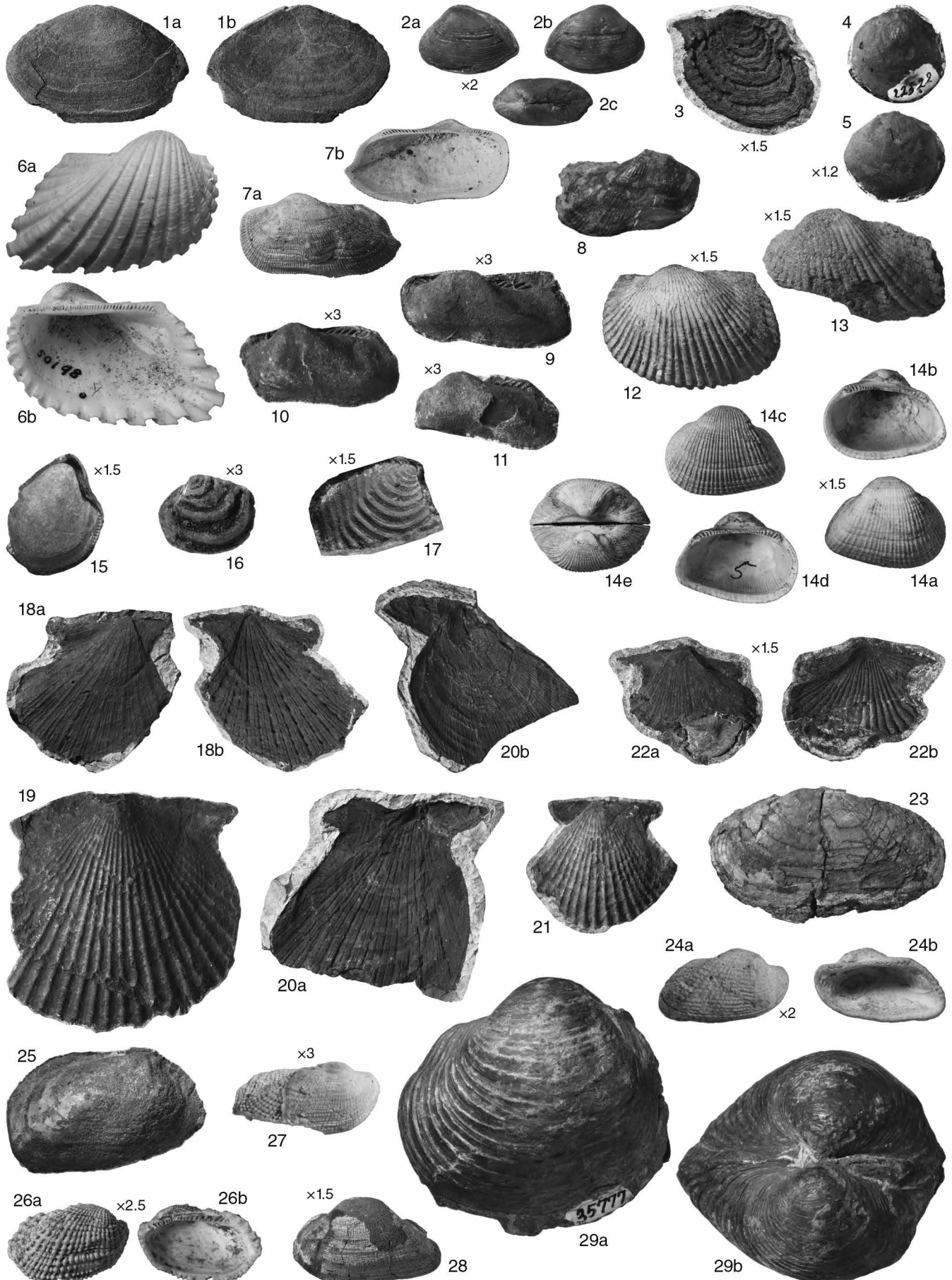


PLATE 4



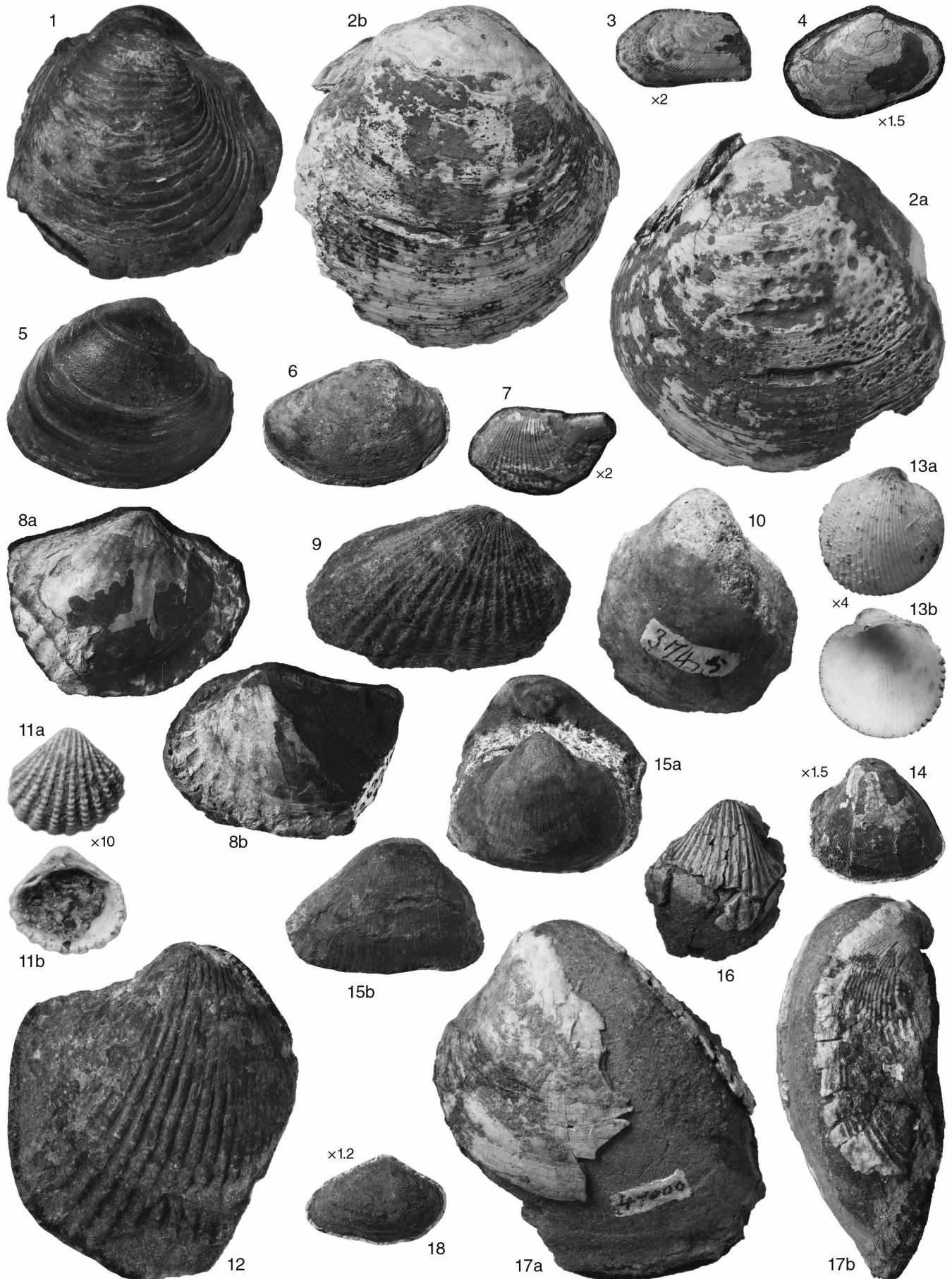
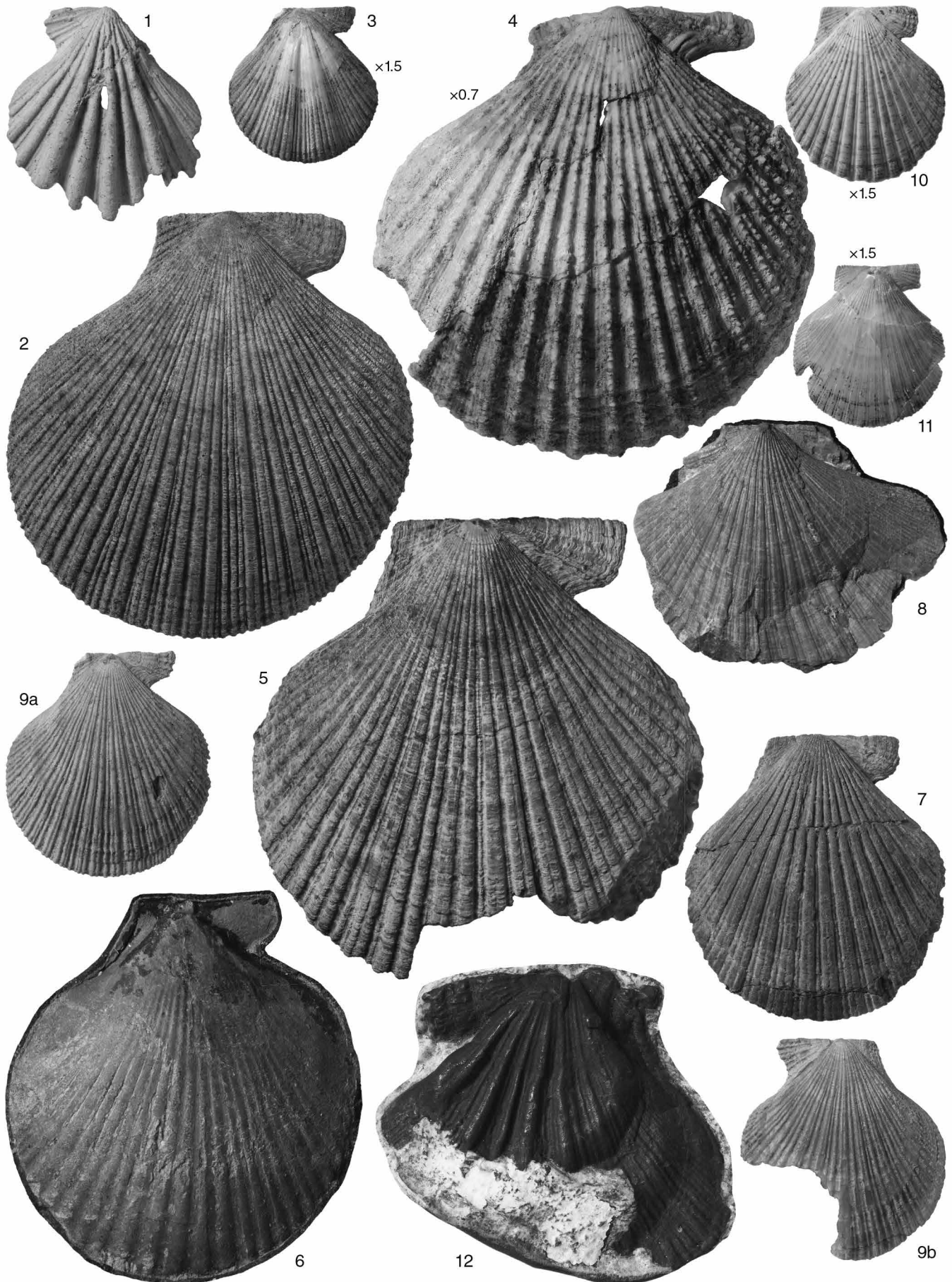


PLATE 6



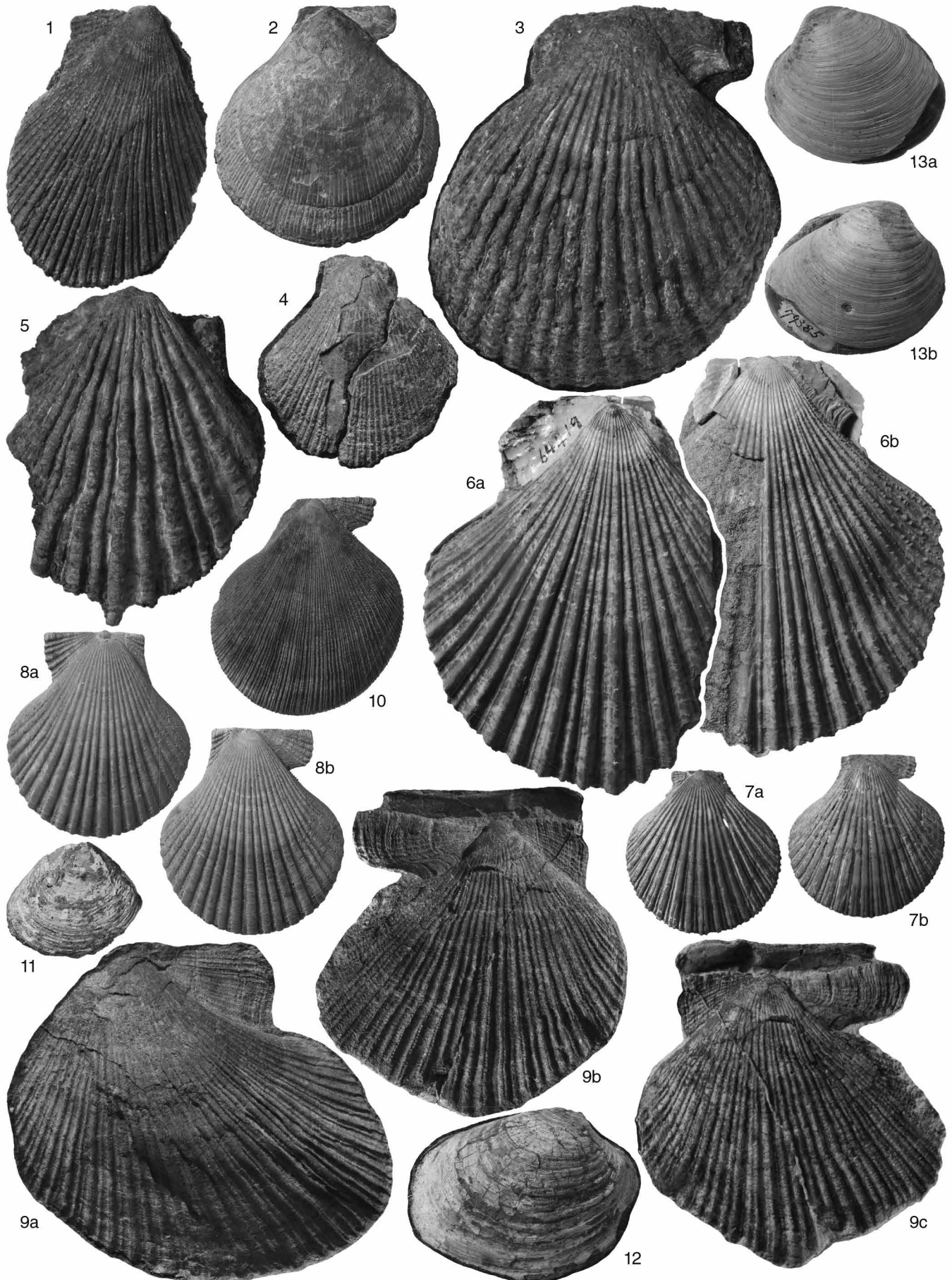


PLATE 8

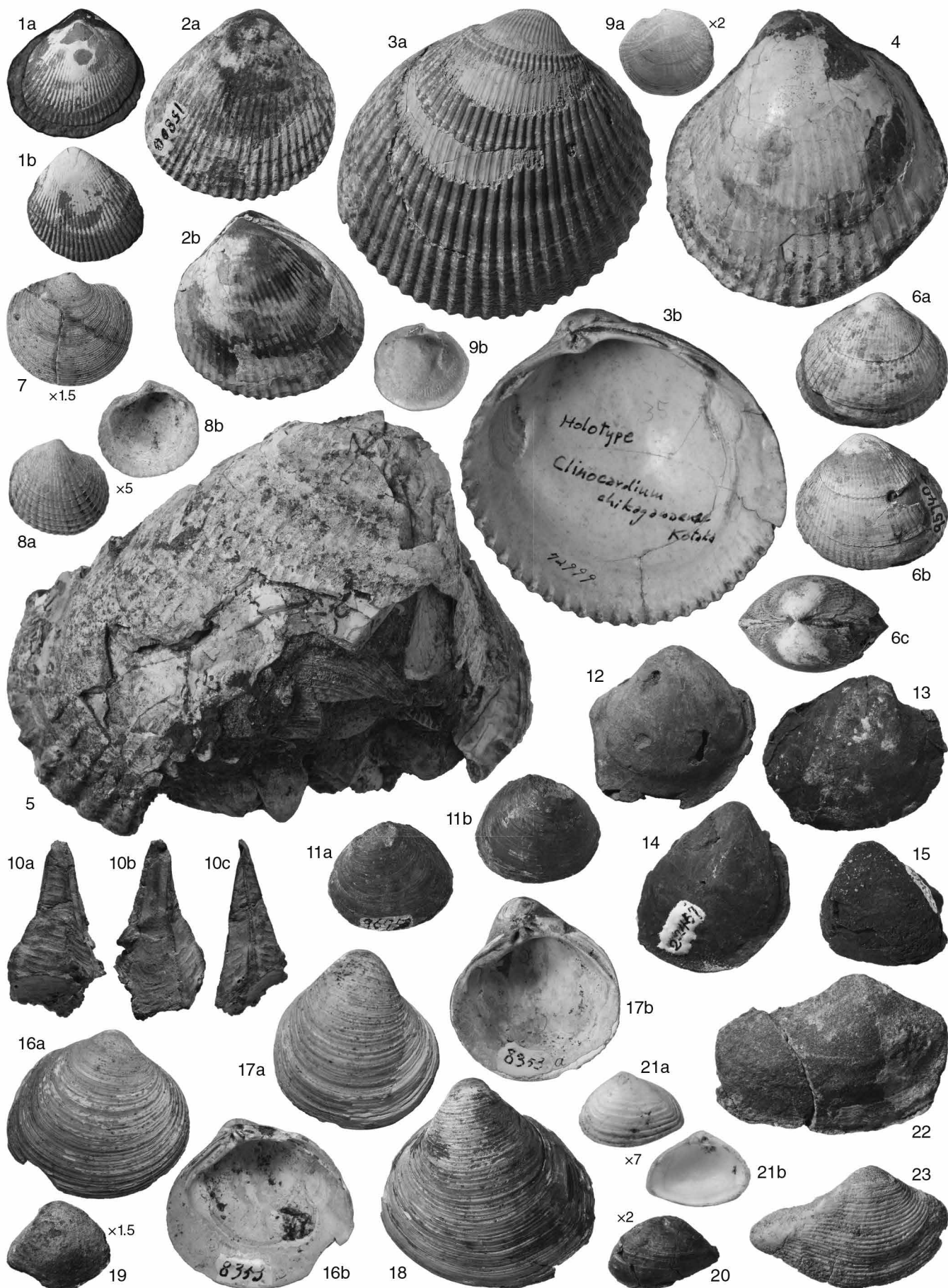
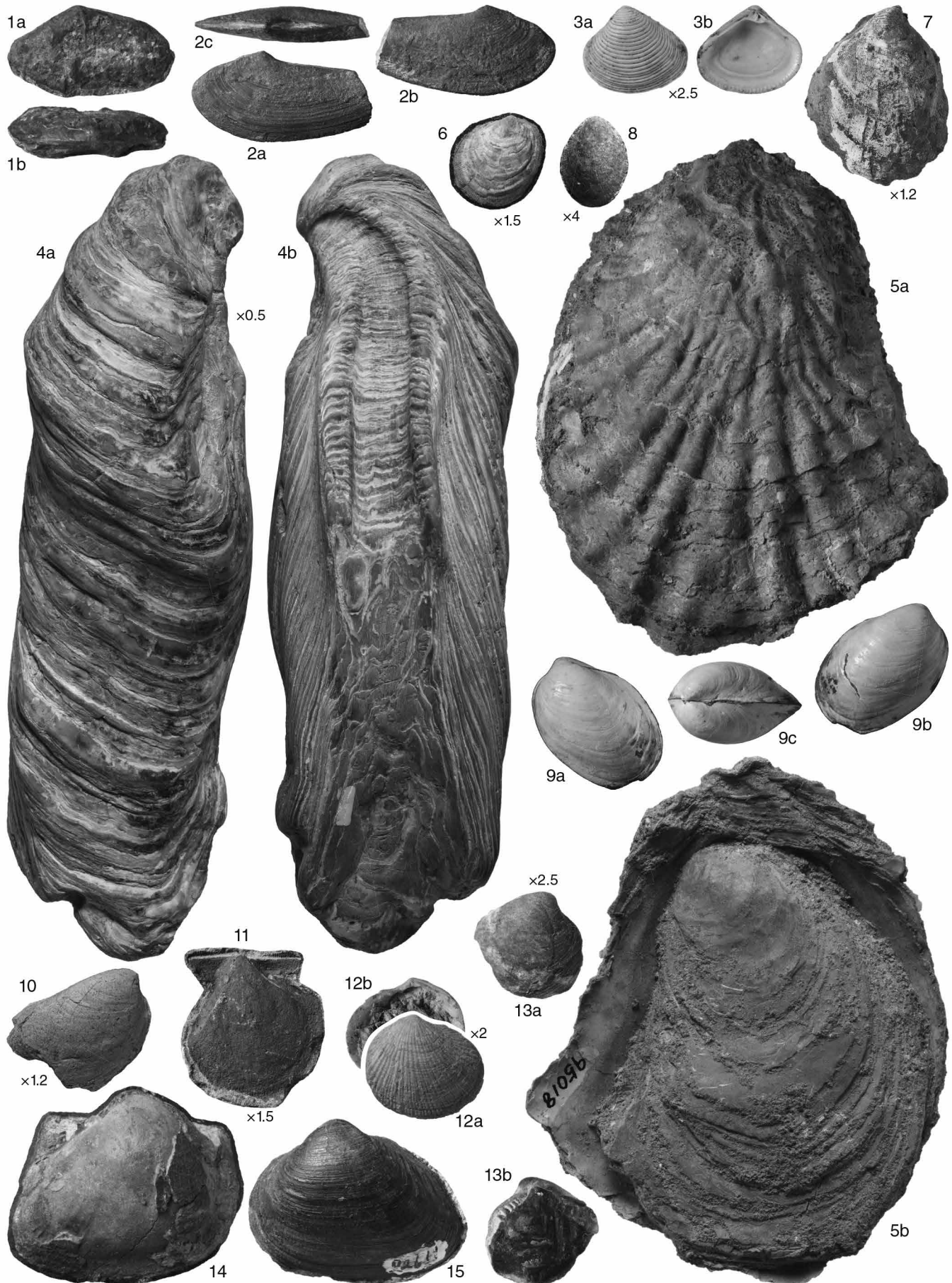
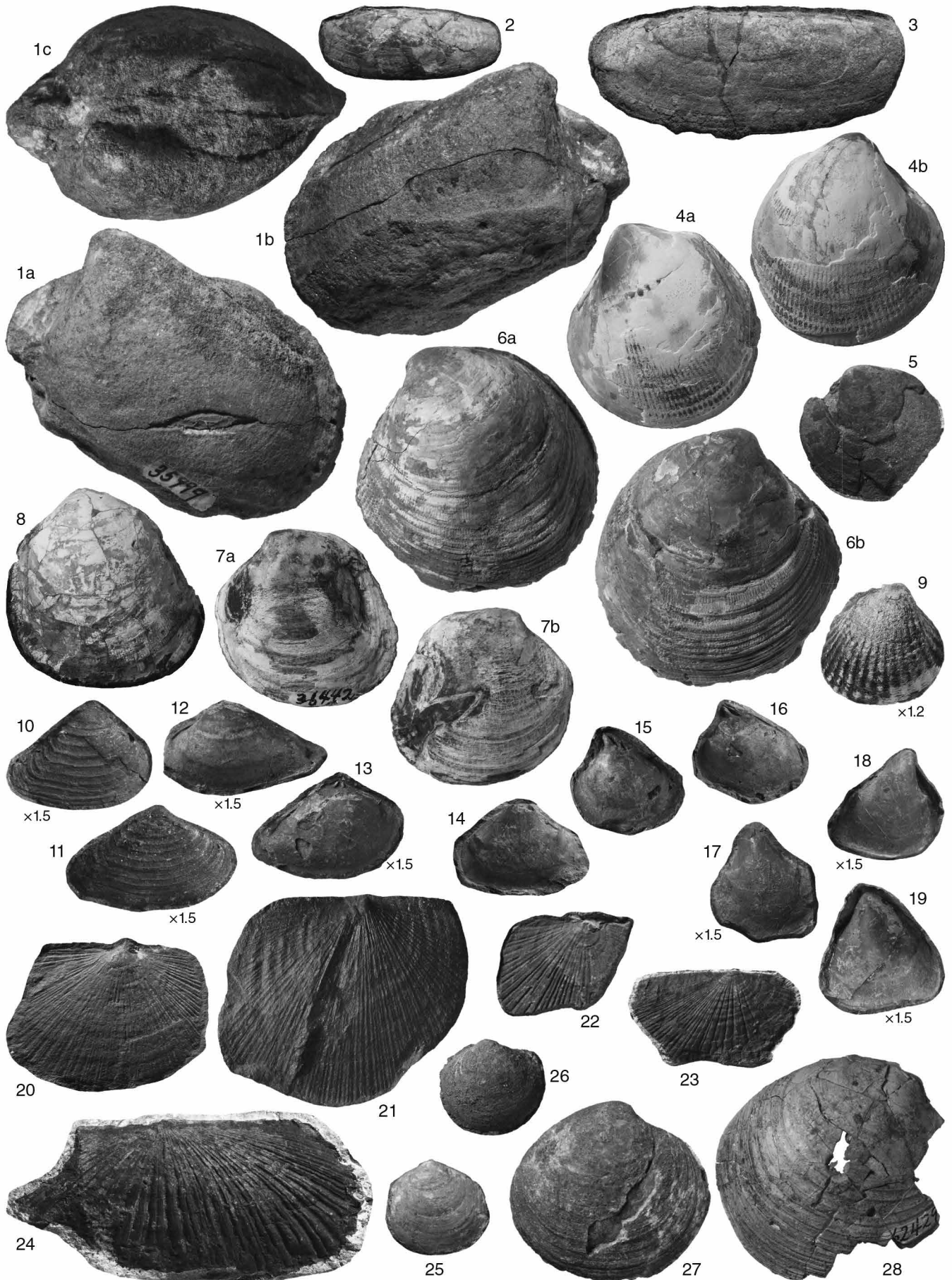
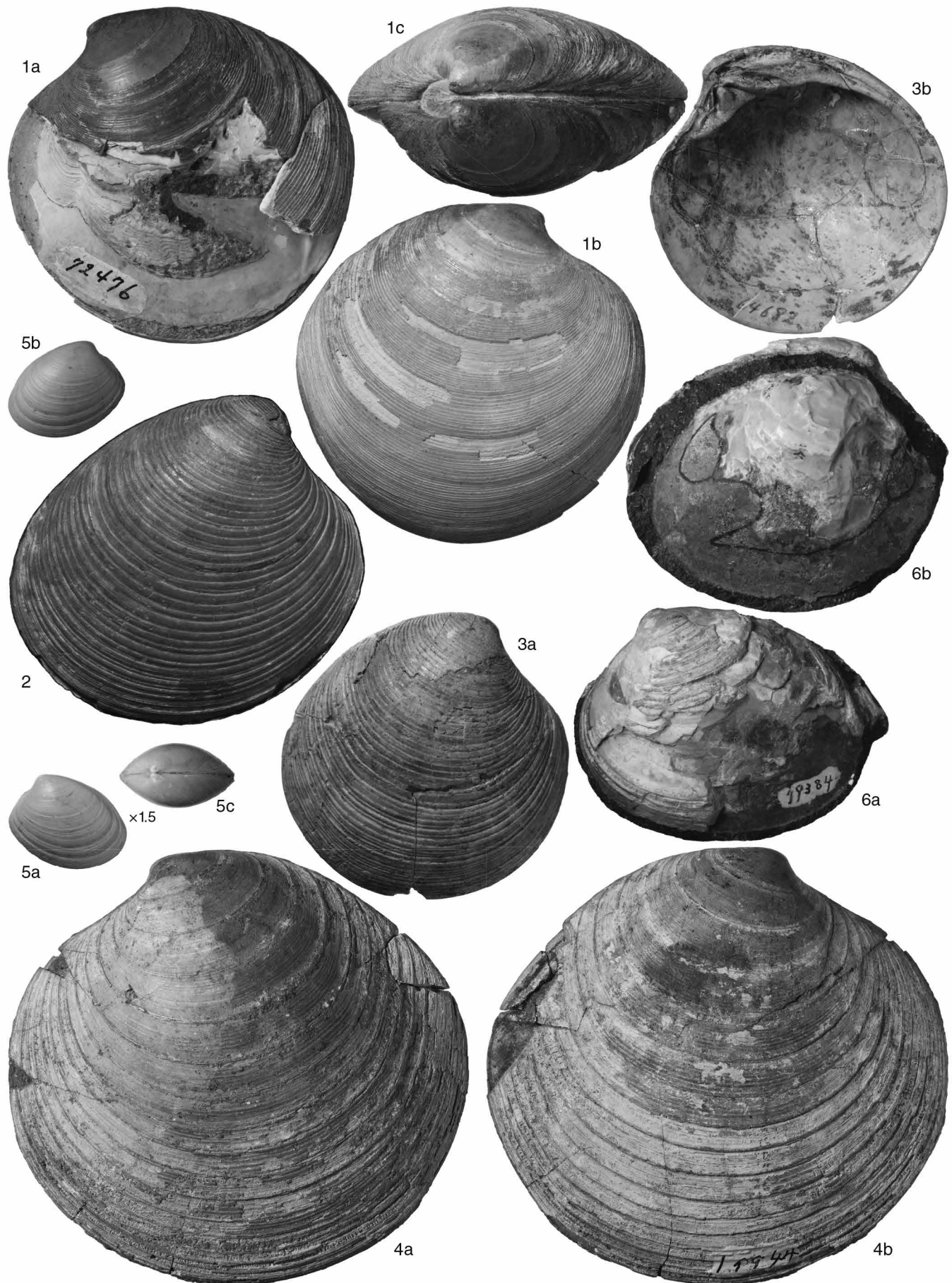


PLATE 9







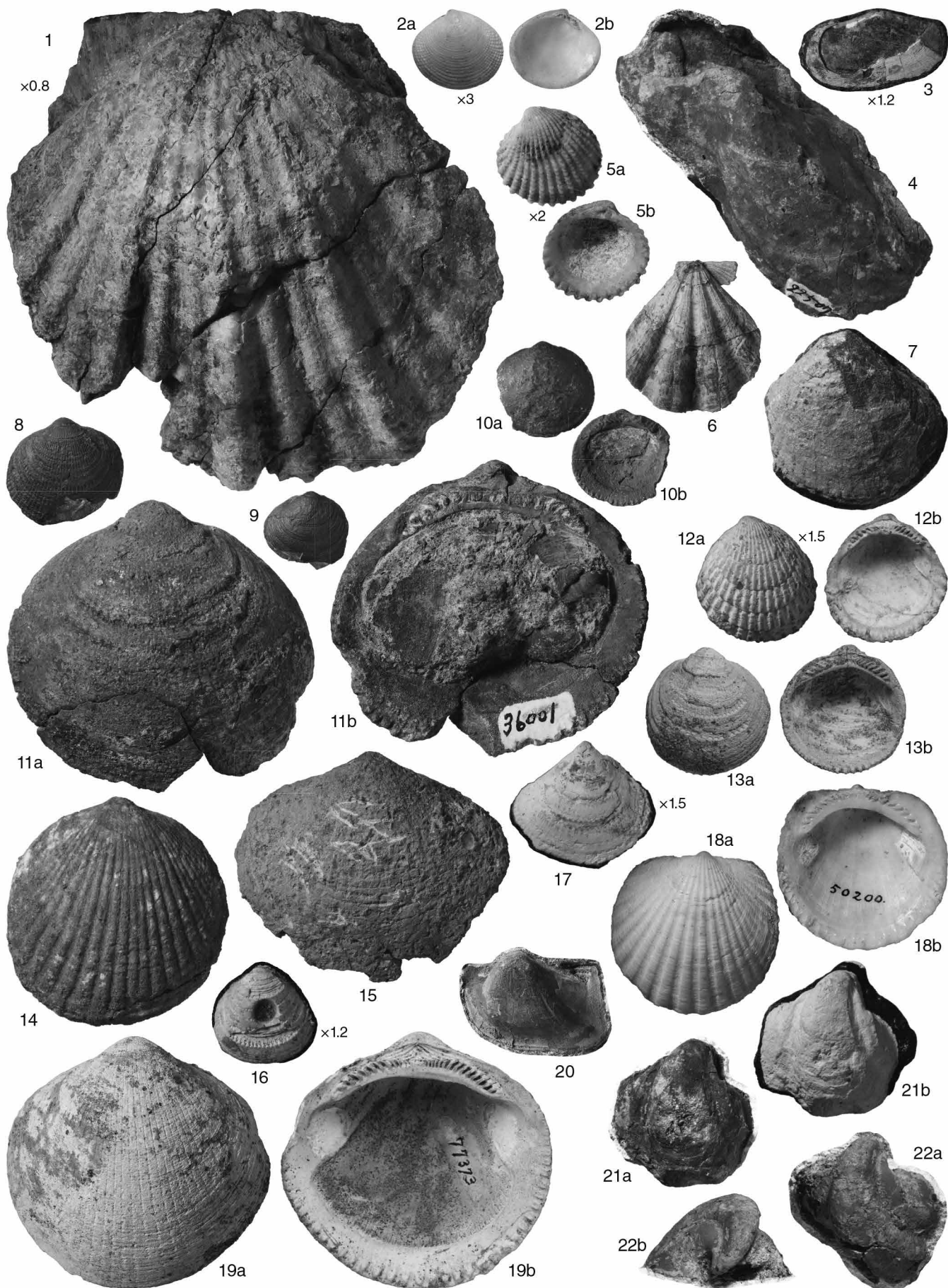


PLATE 13

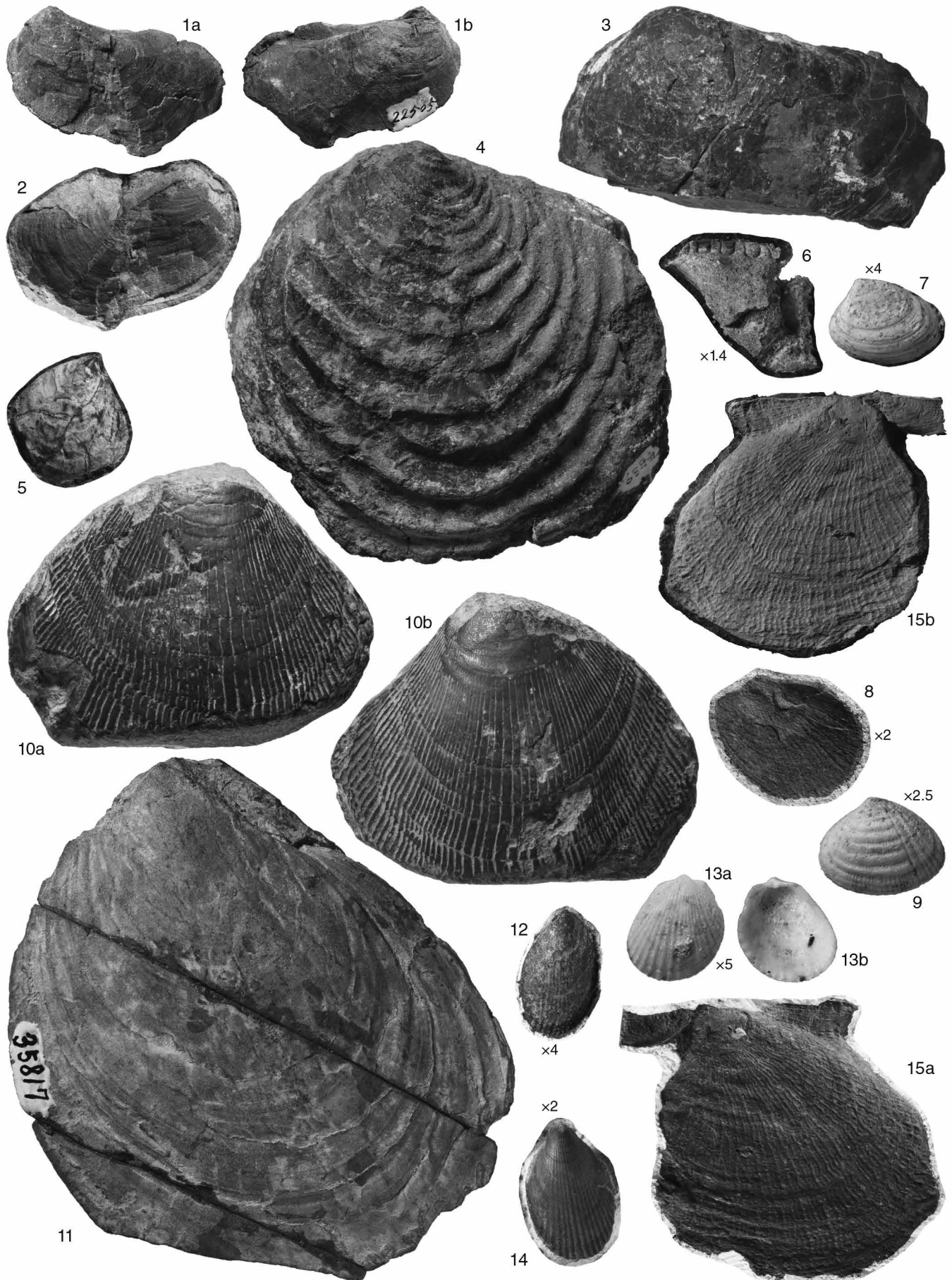
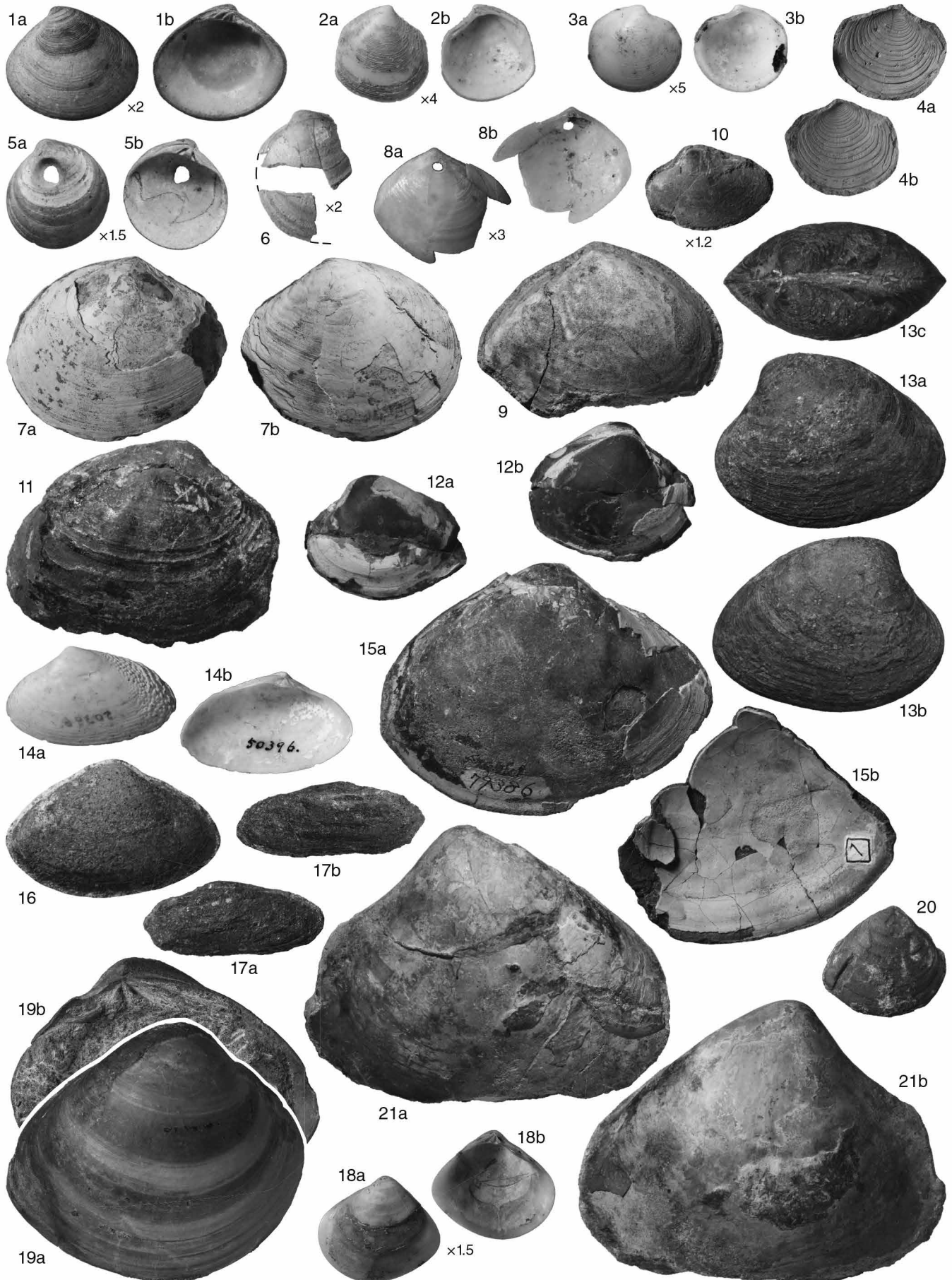


PLATE 14



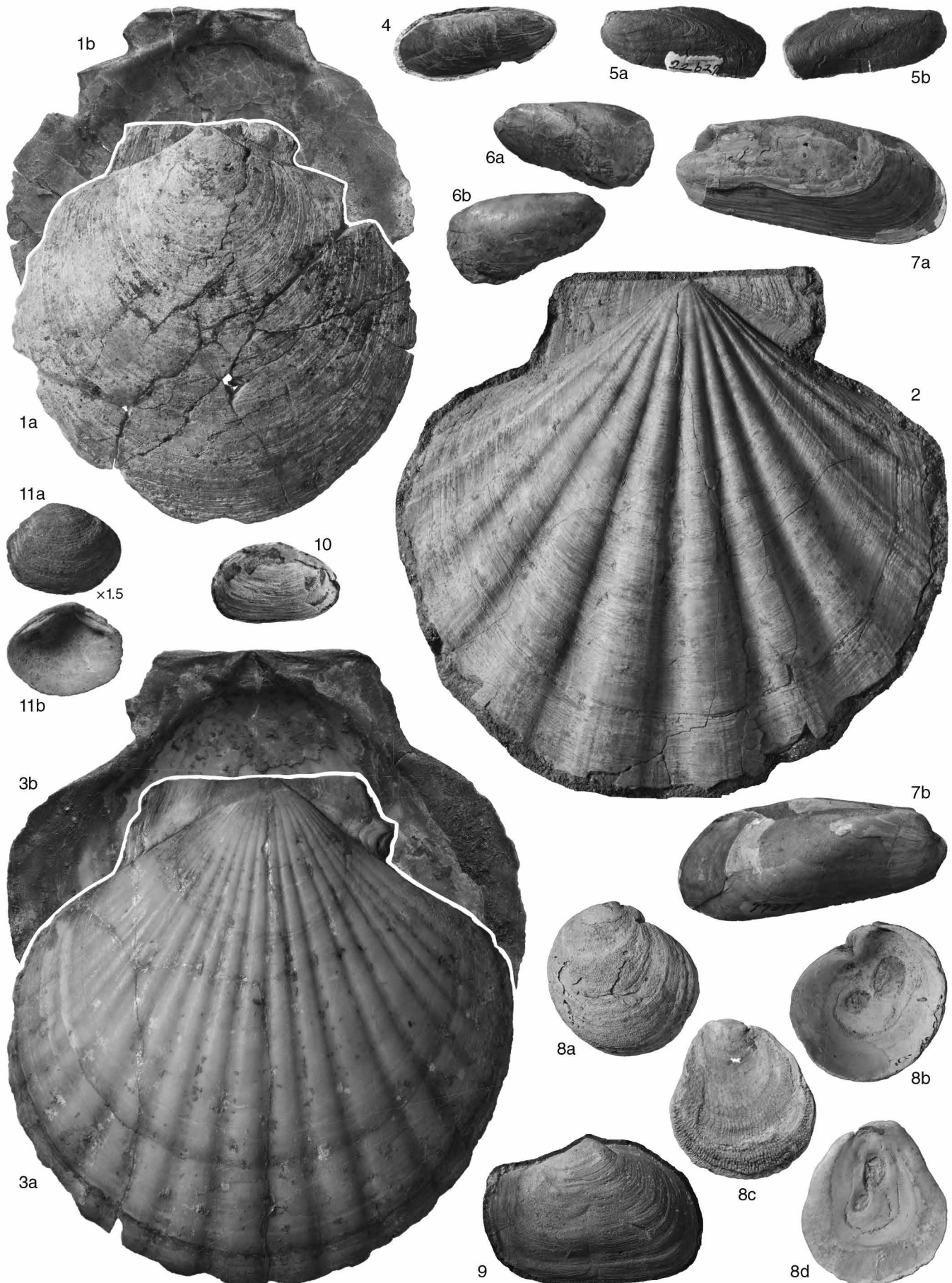
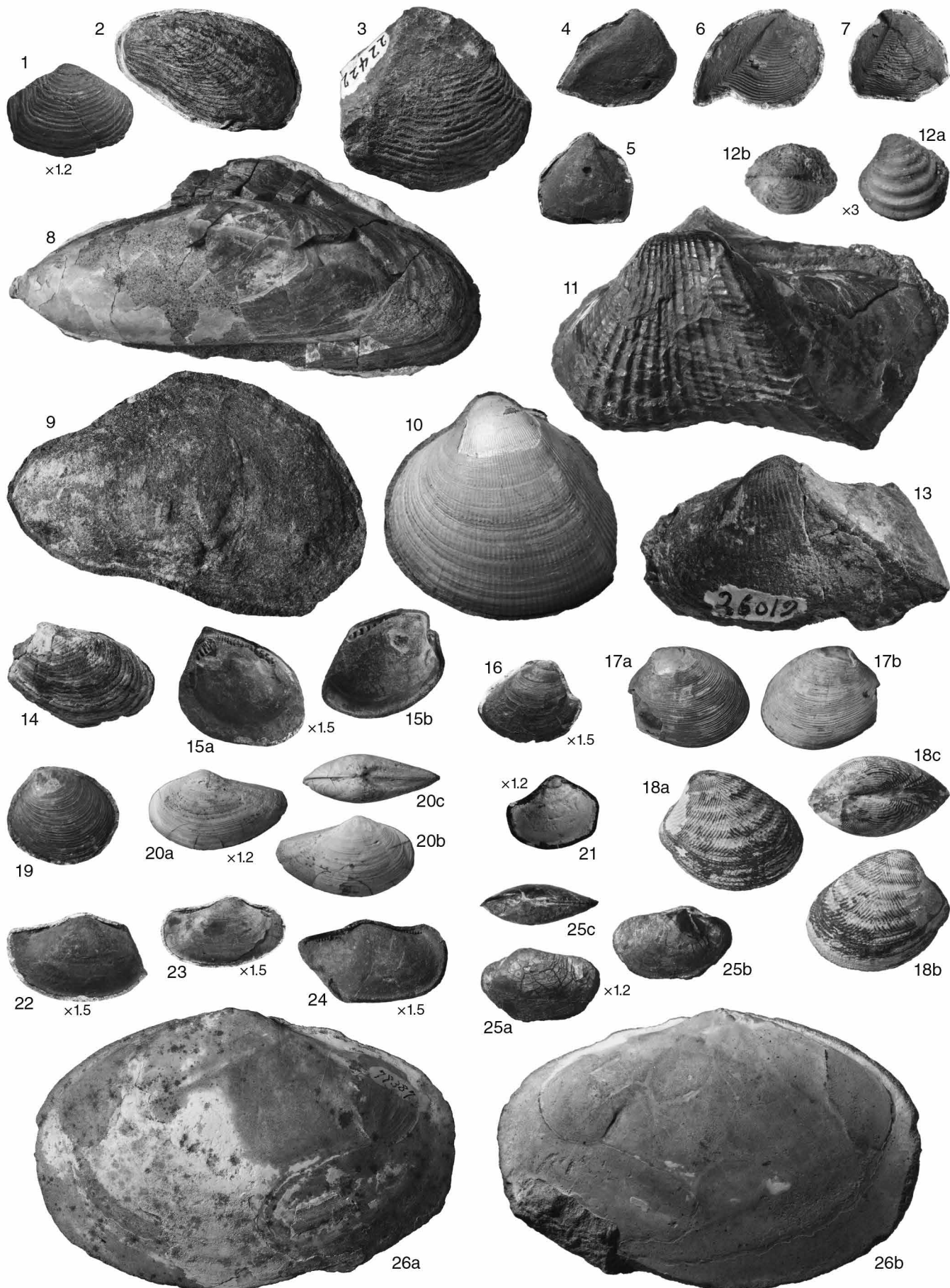
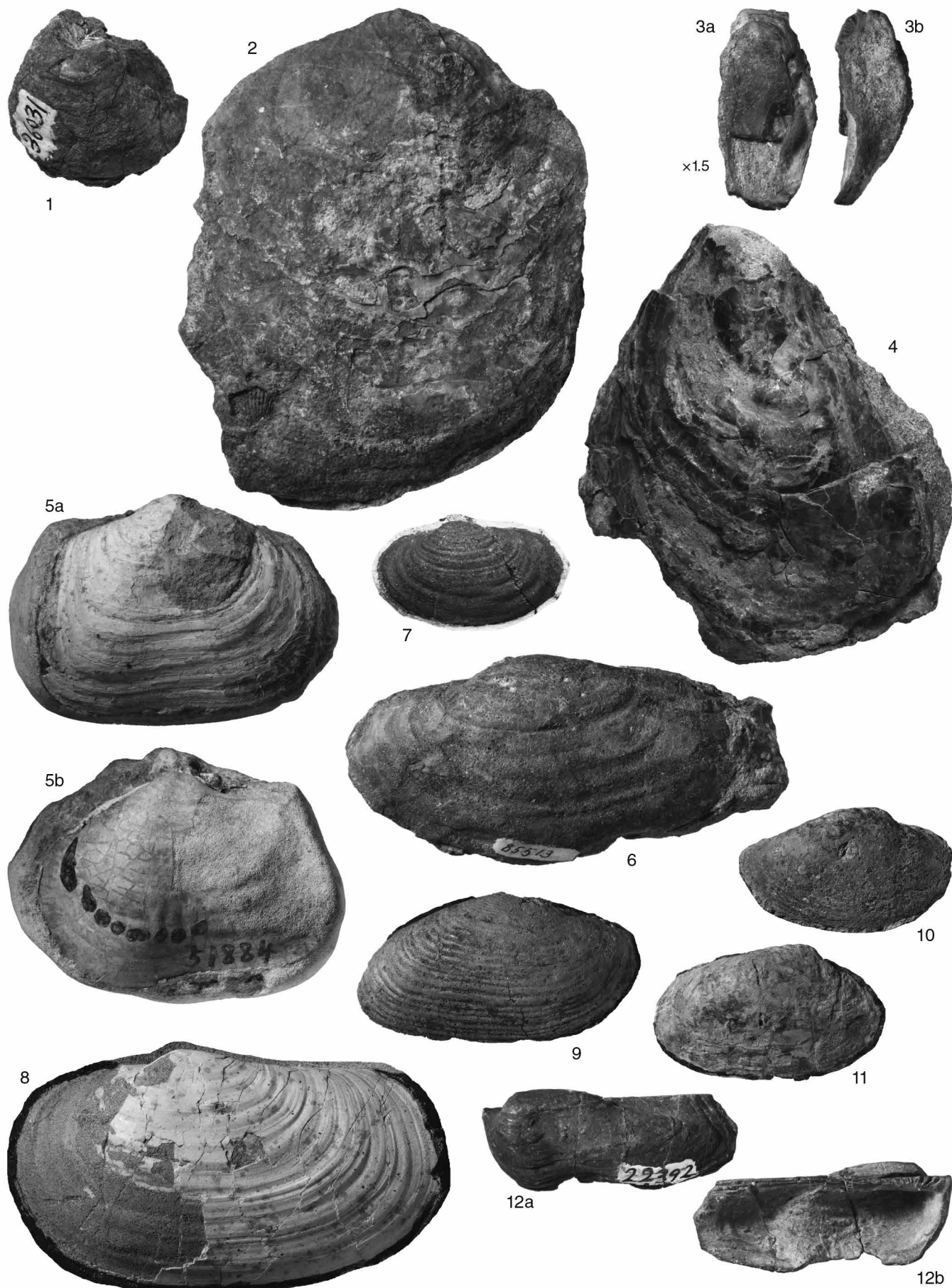


PLATE 16





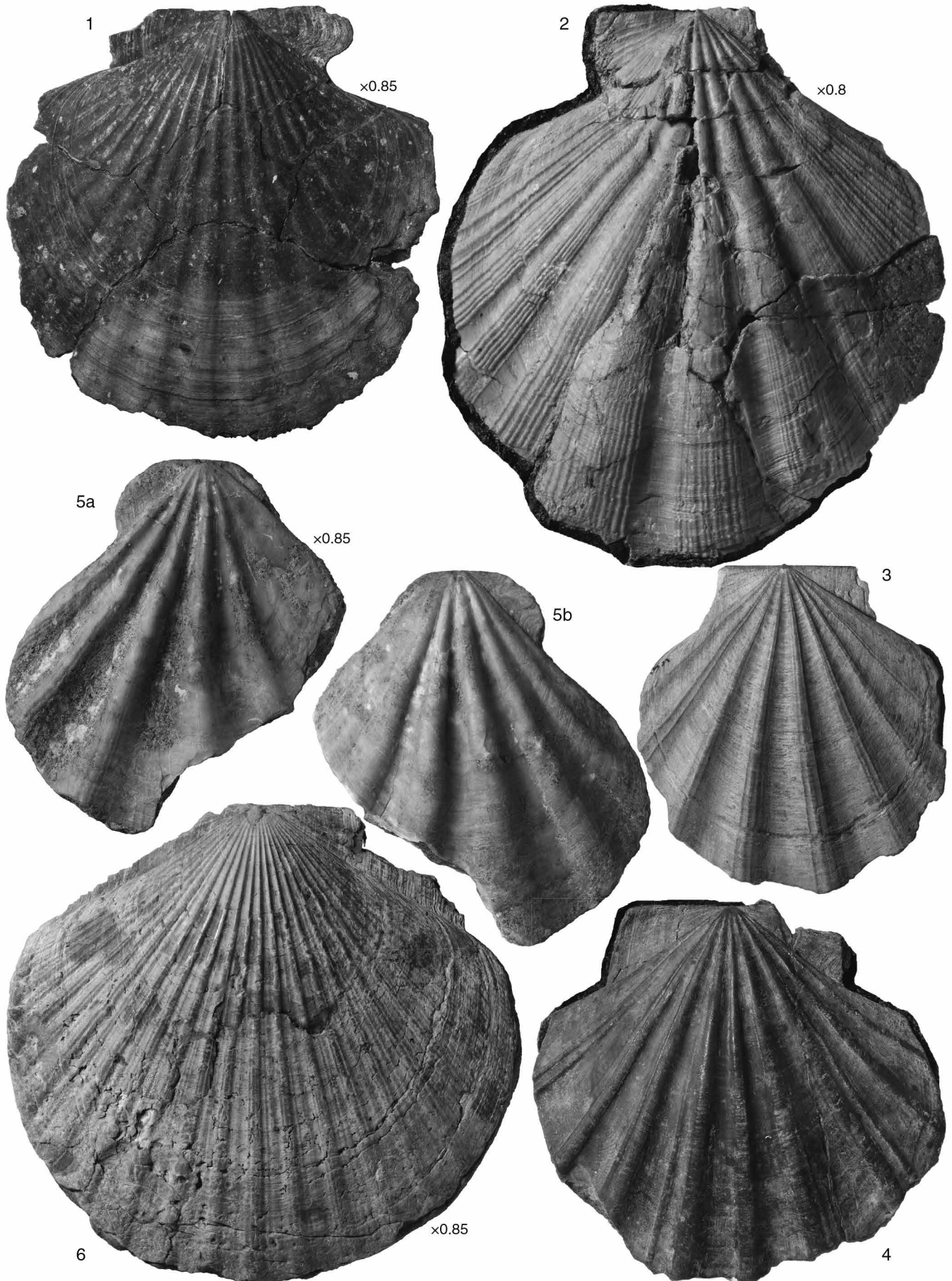
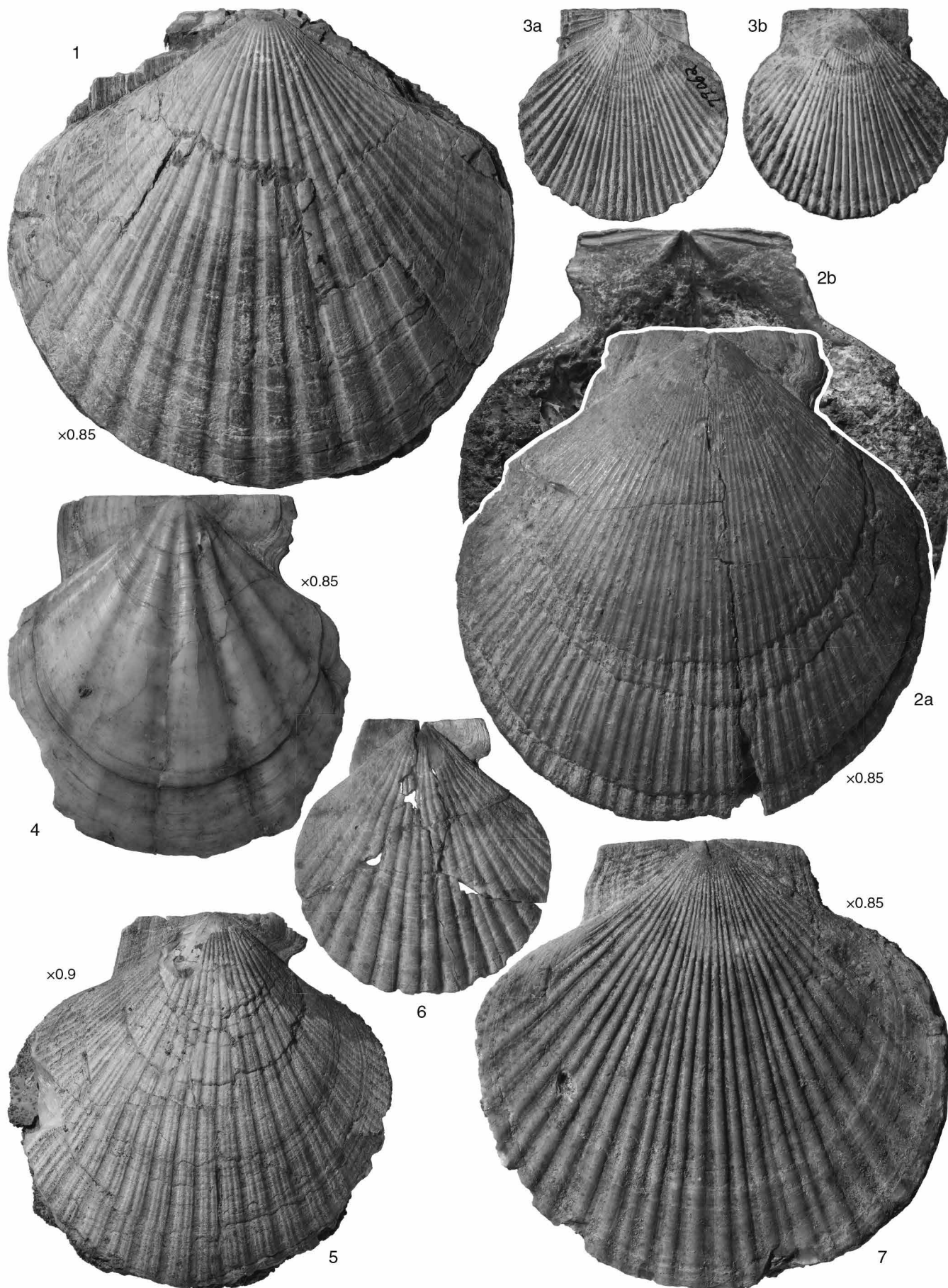


PLATE 19



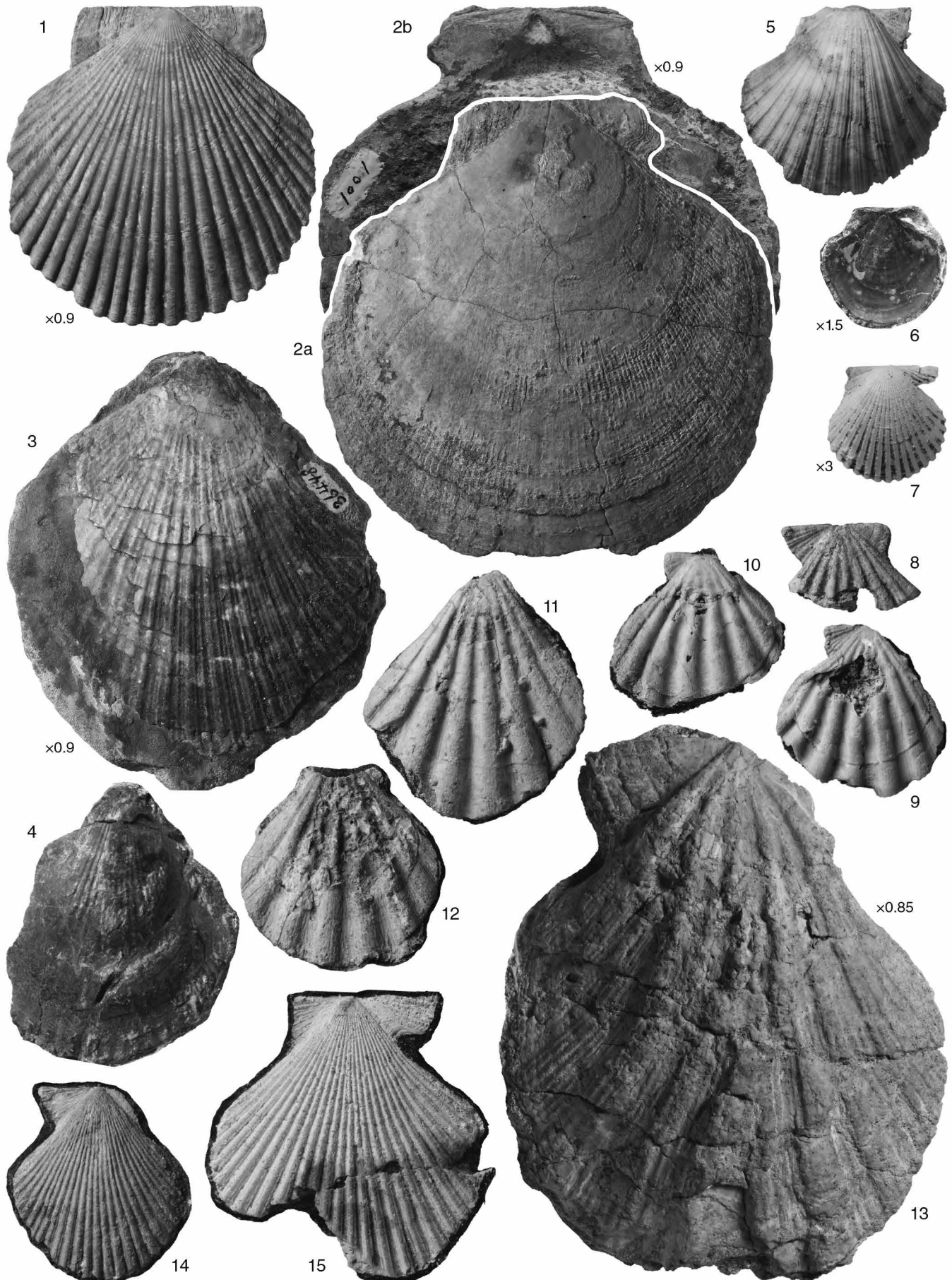


PLATE 21

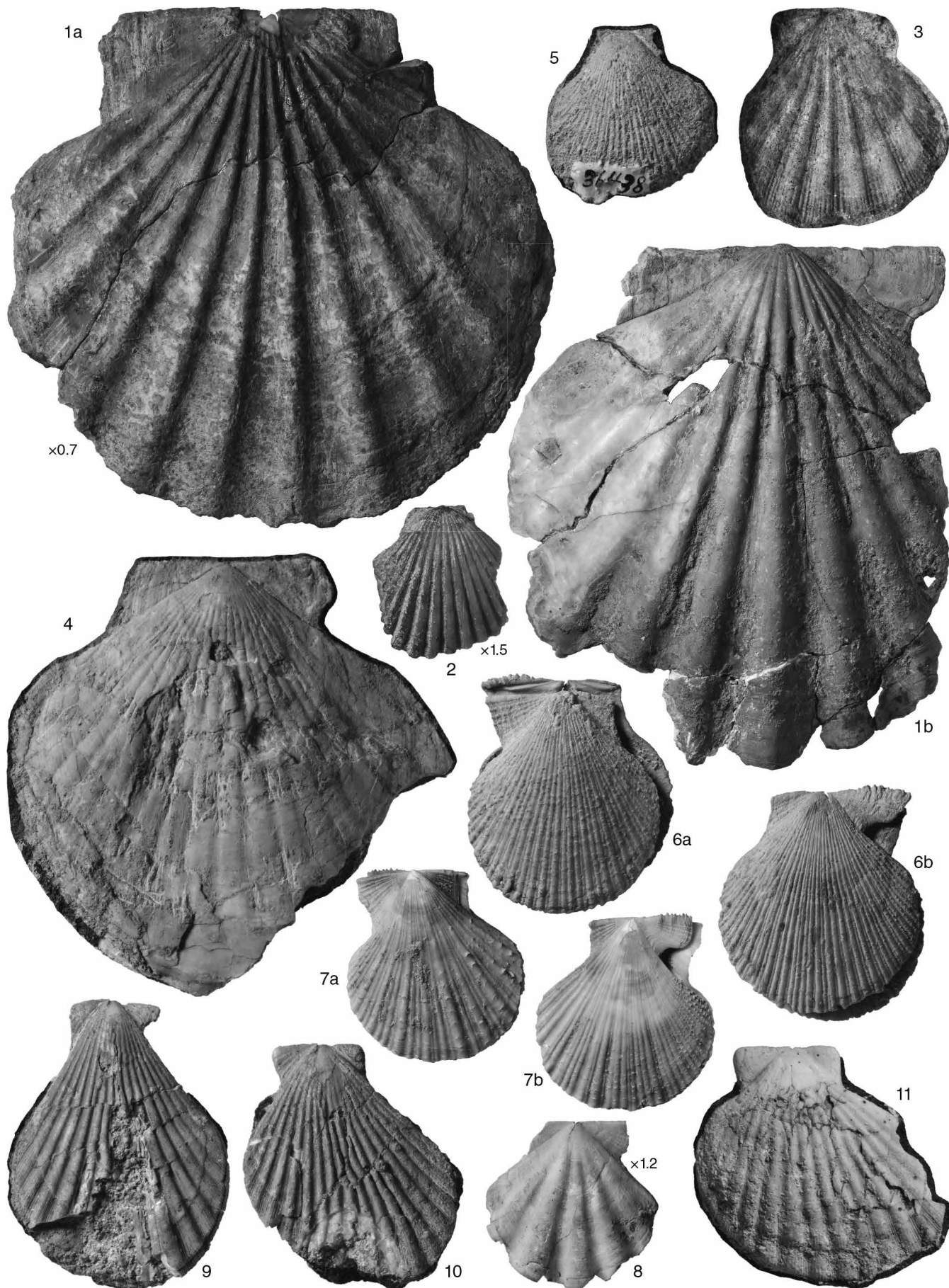
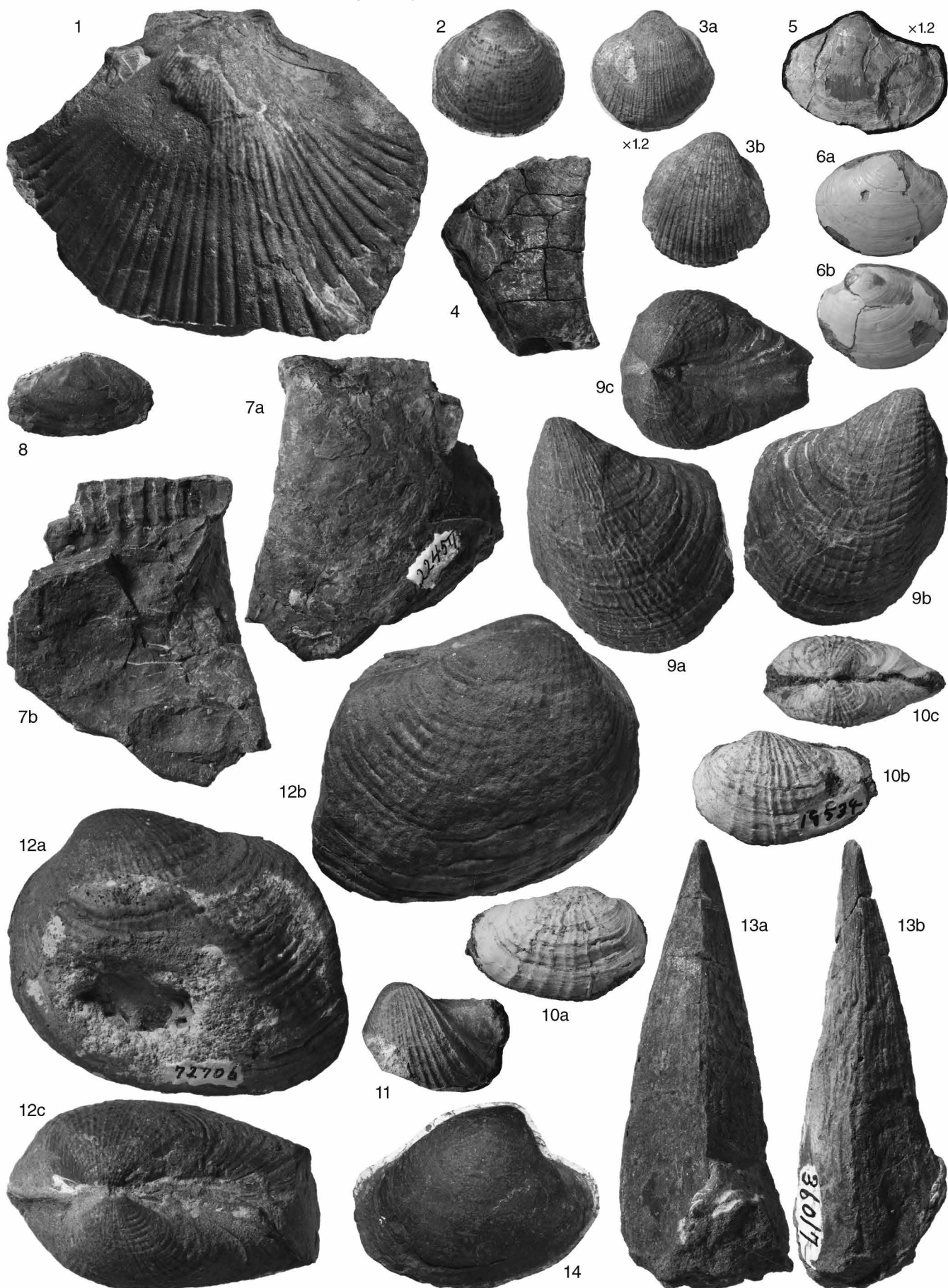
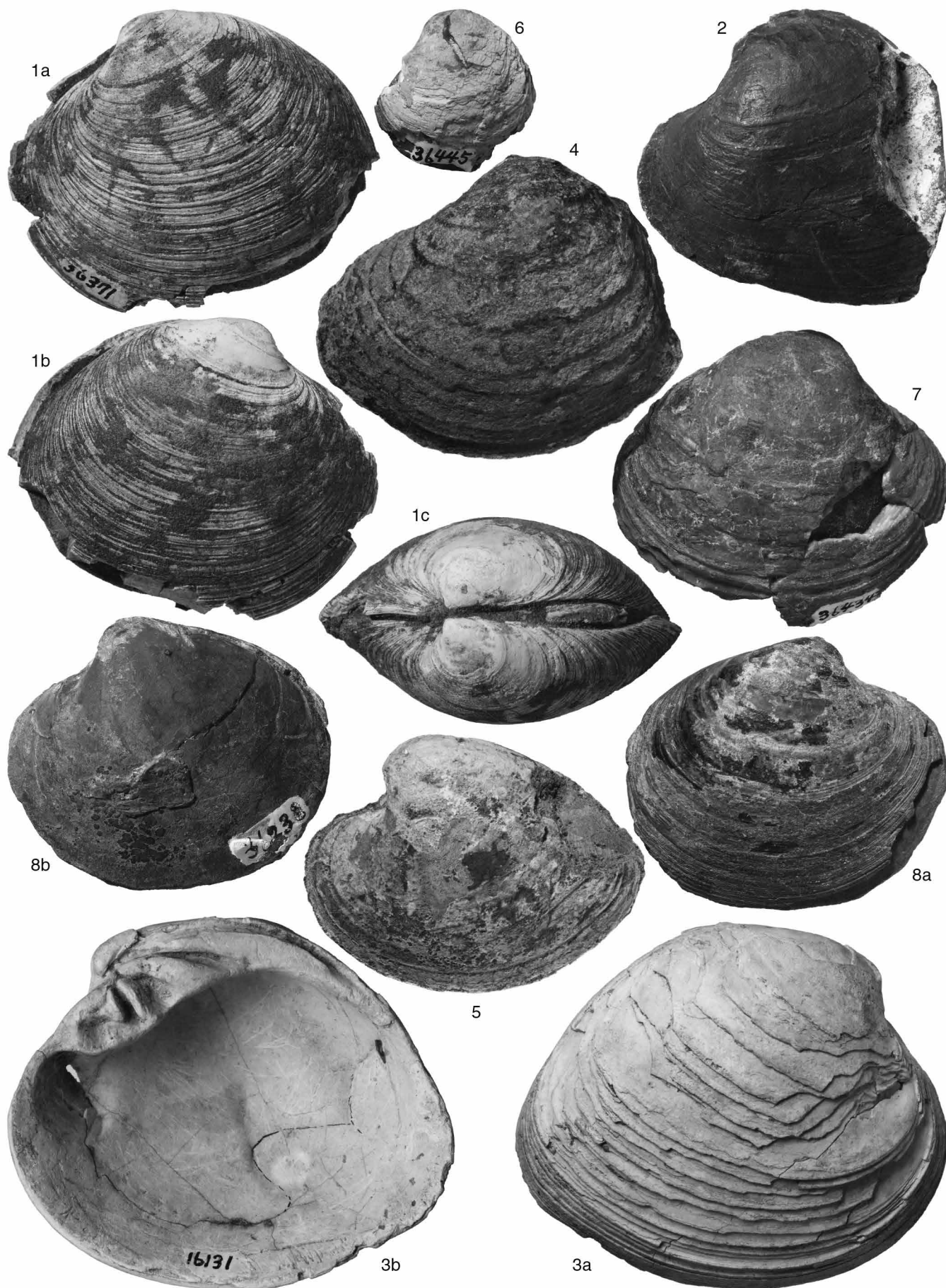
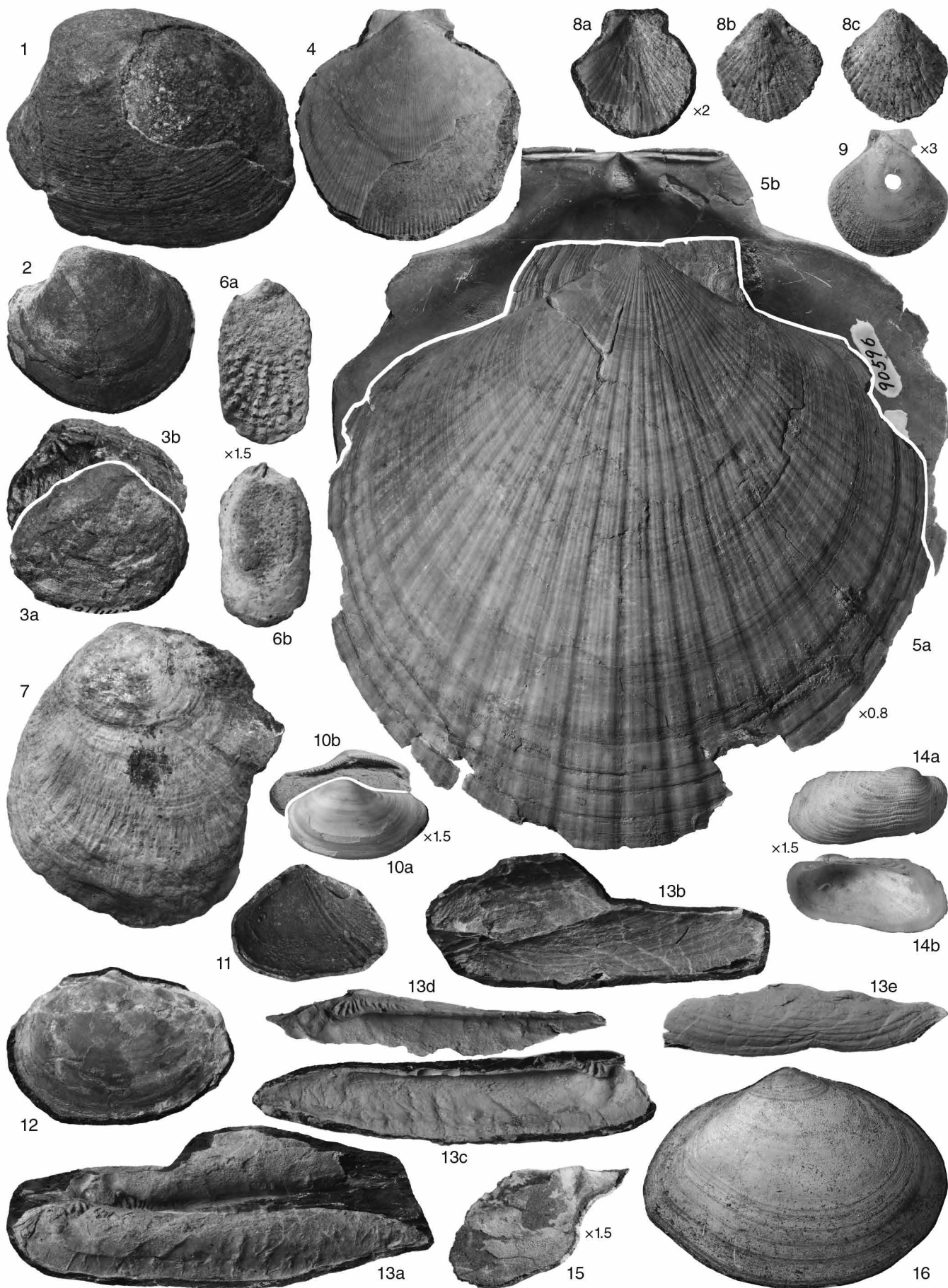
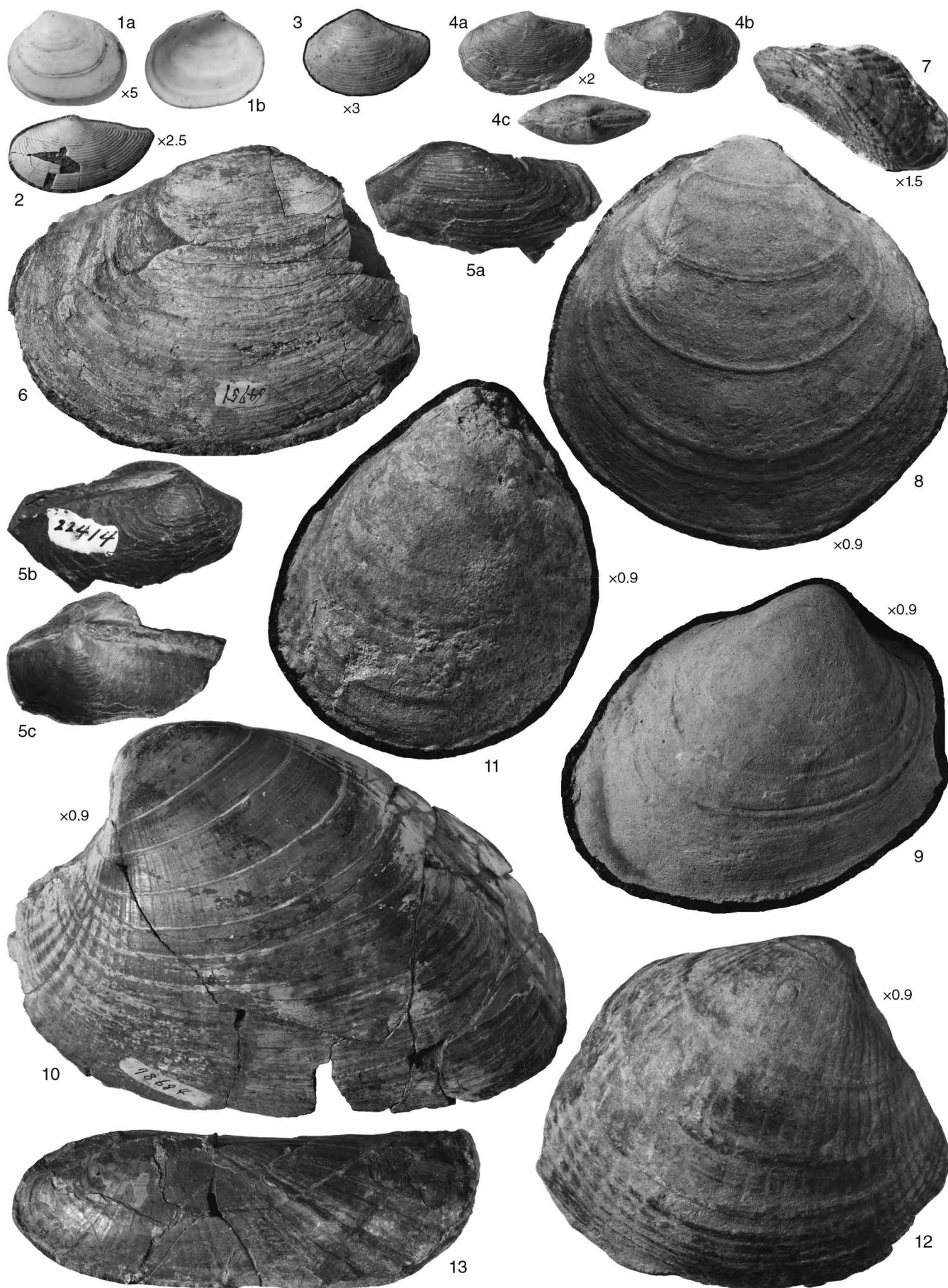


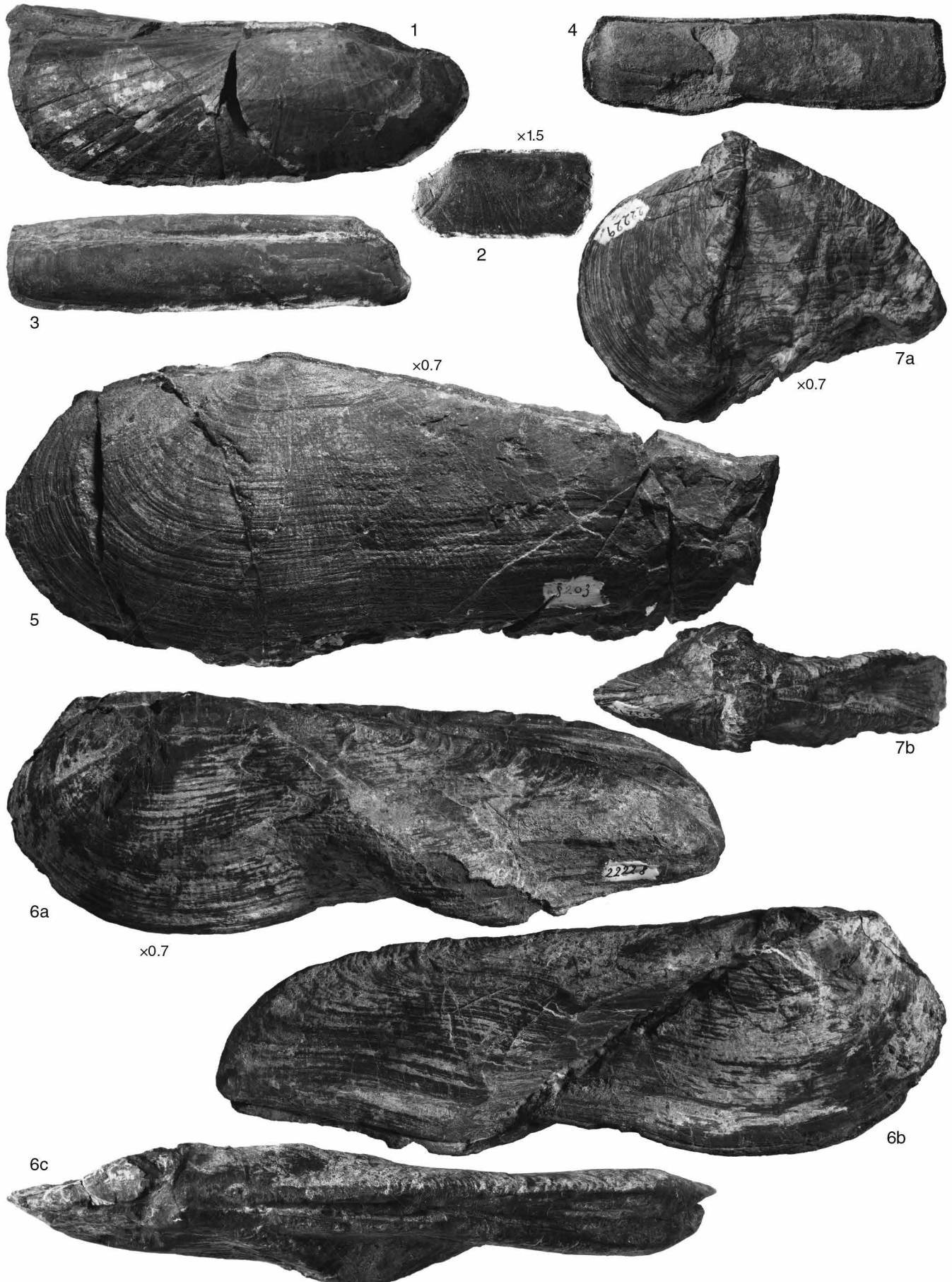
PLATE 22

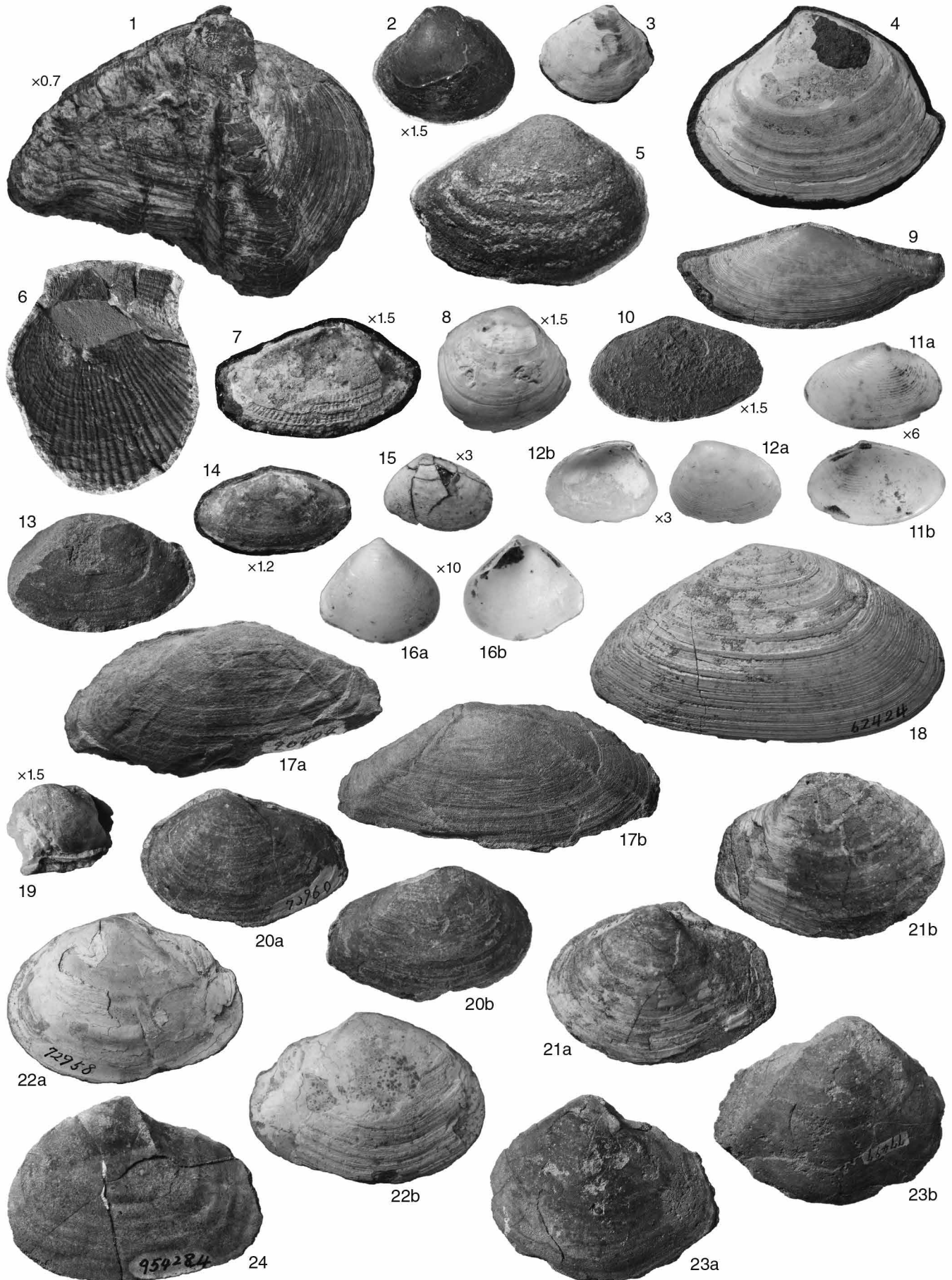


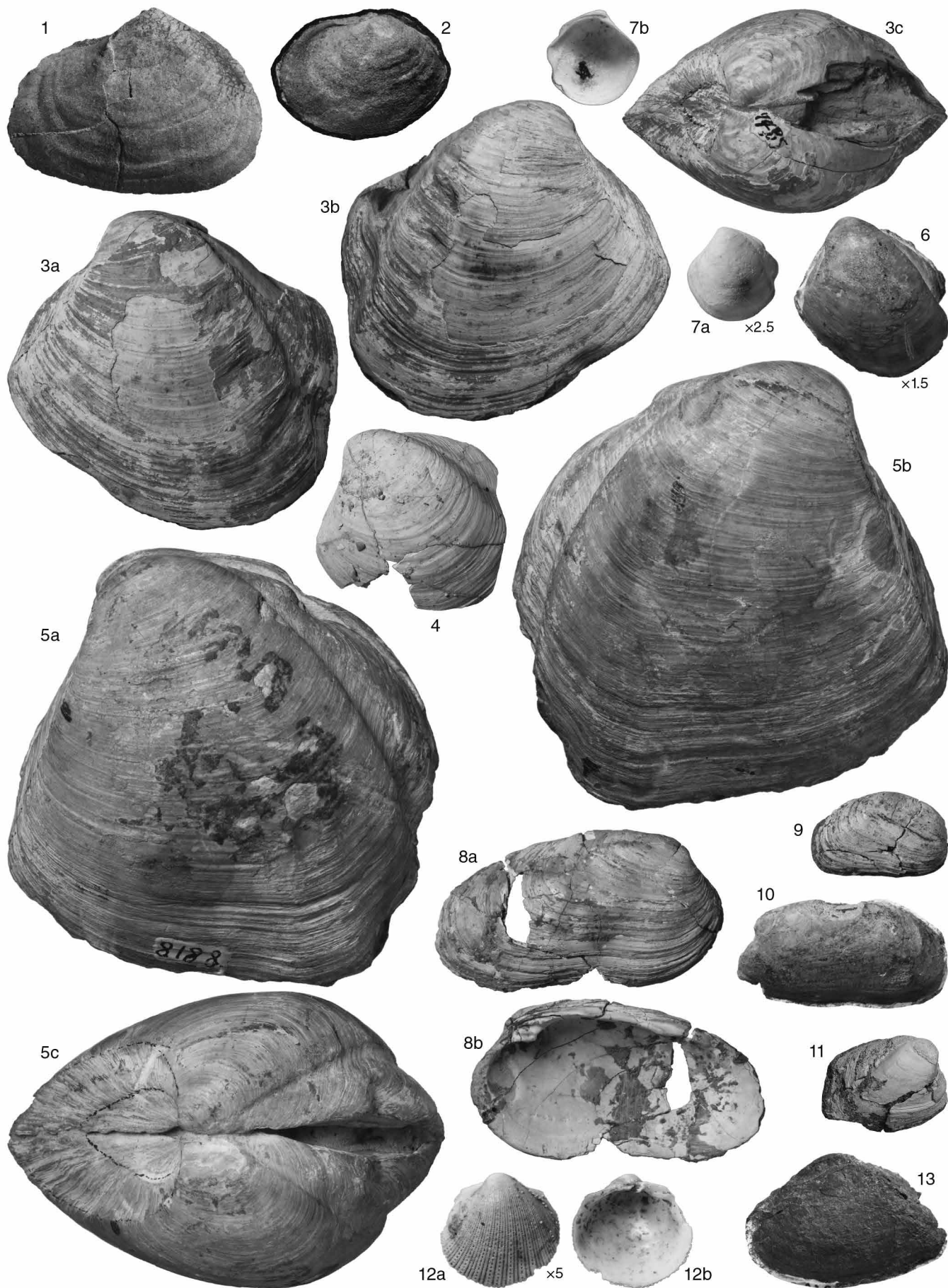












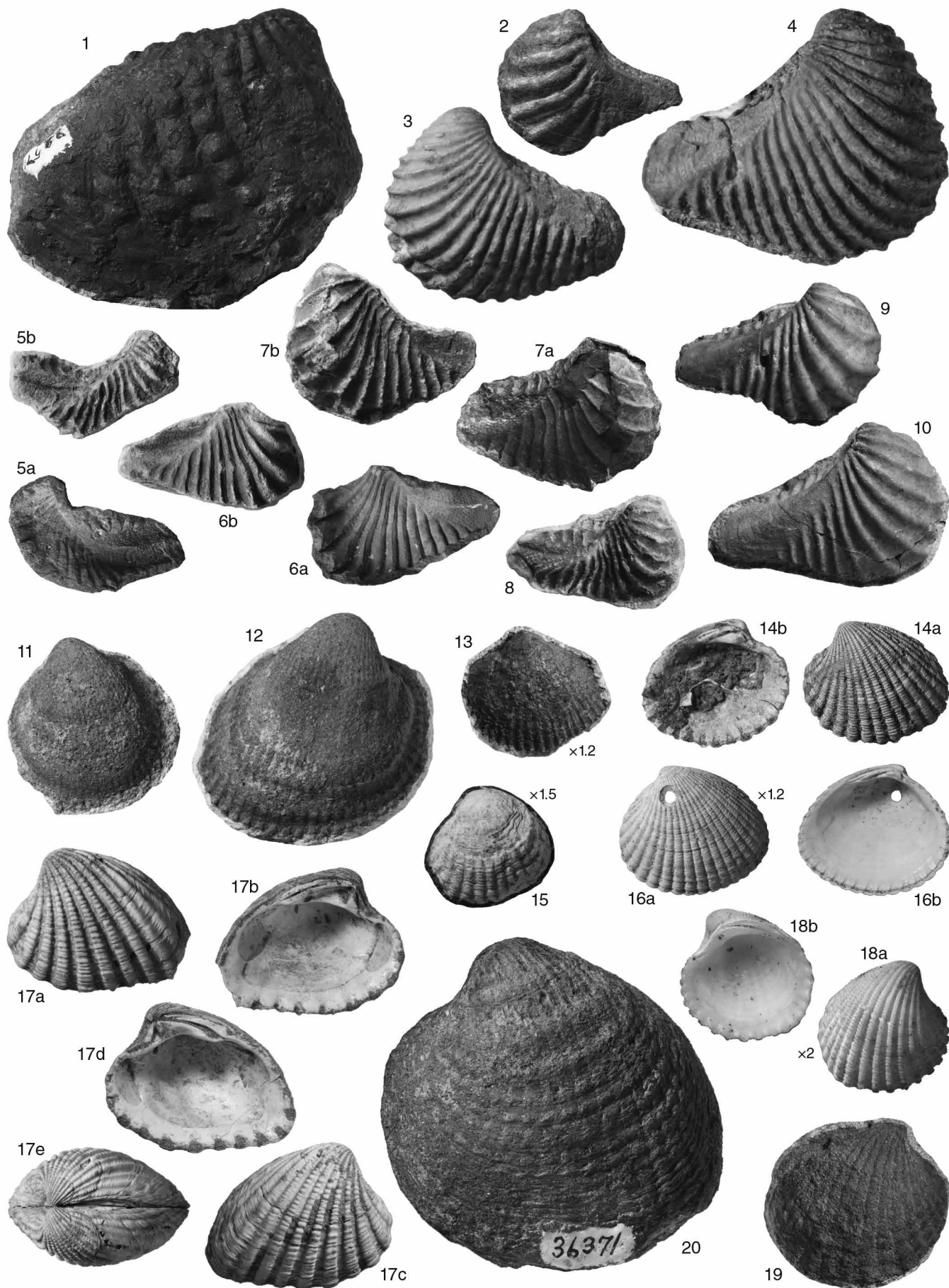


PLATE 30



Index

<i>ainuana</i> , <i>Trigonia</i>	p. 54	<i>datemasamunei</i> , <i>Trigonia</i>	p. 54
<i>akiana</i> , <i>Tellina</i> (<i>Pharaonella</i>)	p. 51	<i>deguchii</i> , <i>Meretrix</i>	p. 36
<i>akihoensis</i> , <i>Pecten</i> (<i>Pseudamysium</i>)	p. 43	<i>delicatostriata</i> , <i>Cucullaea</i>	p. 27
<i>akitaensis</i> , <i>Anadara</i> (<i>Scapharca</i>)	p. 13	<i>denselineata</i> , <i>Monia</i>	p. 37
<i>akitaensis</i> , <i>Halicardia</i>	p. 32	<i>denselineatus</i> , <i>Pecten</i> (<i>Chlamys</i>) <i>ashiyaensis</i> var	p. 43
<i>akiyamae</i> , <i>Amussiopecten</i>	p. 13	<i>densisulcata</i> , <i>Daonella</i>	p. 29
<i>akutsui</i> , <i>Chlamys</i> (<i>Chlamys</i>)	p. 21	<i>dubia</i> , <i>Homomya</i> ?	p. 33
<i>alata</i> , <i>Cyrena shiroiensis</i> var	p. 29	<i>elegantissima</i> , <i>Solenomorpha</i>	p. 50
<i>alta</i> , <i>Daonella kotoi</i> var	p. 29	<i>elongata</i> , <i>Anadara</i> (<i>Anadara</i>) <i>amicula</i>	p. 13
<i>altoumbonata</i> , <i>Glycimeris</i>	p. 31	<i>elongata</i> , <i>Waagenoperna</i>	p. 57
<i>altoumbonata</i> , <i>Pitaria</i> ?	p. 47	<i>enaensis</i> , <i>Portlandia</i> (<i>Portlandella</i>)	p. 48
<i>amakusensis</i> , <i>Glycimeris</i>	p. 31	<i>enaensis</i> , <i>Venericardia</i> (<i>Cyclocardia</i>)	p. 55
<i>andoi</i> , <i>Arca</i> (<i>Arca</i>)	p. 16	<i>endoi</i> , <i>Katelsysia</i> (<i>Nipponomarcia</i>)	p. 33
<i>arakawae</i> , <i>Clinocardium asagaiense</i>	p. 23	<i>eocenica</i> , <i>Lima</i>	p. 34
<i>arasawaensis</i> , <i>Anadara</i> (<i>Anadara</i>)	p. 13	<i>eoilensis</i> , <i>Crassostrea gravitesta</i>	p. 26
<i>arenicoloides</i> , <i>Vasticardium</i>	p. 55	<i>equideclivis</i> , <i>Tellina</i>	p. 51
<i>ariakensis</i> , <i>Macrocallista</i>	p. 35	<i>ettyuensis</i> , <i>Dosinia</i>	p. 29
<i>asagaiensis</i> , <i>Cyclina</i> (<i>Cyclina</i>)	p. 27	<i>ezoensis</i> , <i>Cucullaea</i>	p. 27
<i>asakuraensis</i> , <i>Crassatellites</i>	p. 25	<i>ezoensis</i> , <i>Modiolus</i>	p. 37
<i>asakuraensis</i> , <i>Pinna</i>	p. 46	<i>ezoensis</i> , <i>Spisula</i> (<i>Cymbophora</i>)	p. 50
<i>ashiyaensis</i> , <i>Nucula</i> (<i>Acila</i>) <i>mirabilis</i> var	p. 39	<i>formosanus</i> , <i>Crassatellites</i>	p. 25
<i>ashiyaensis</i> , <i>Pecten</i> (<i>Chlamys</i>)	p. 43	<i>fudozawaensis</i> , <i>Panope kanomatazawaensis</i>	p. 41
<i>ashiyaensis</i> , <i>Pitaria</i>	p. 47	<i>fujikuraense</i> , <i>Periploma</i>	p. 45
<i>asperaeformis</i> , <i>Mactra</i> (<i>Spisula</i>)	p. 36	<i>fujinaensis</i> , <i>Cyclocardia</i>	p. 28
<i>atsumiensis</i> , <i>Psammocola kazusensis</i>	p. 48	<i>fujinaensis</i> , <i>Dosinia</i> (<i>Kaneharaia</i>) <i>kaneharai</i>	p. 30
<i>atsunaiensis</i> , <i>Macoma</i> (<i>Macoma</i>)	p. 35	<i>fukasawaensis</i> , <i>Nucula</i>	p. 39
<i>bandoi</i> , <i>Limipecten</i>	p. 34	<i>gabusogaensis</i> , <i>Pecten</i> (<i>Aequipecten</i>)	p. 43
<i>bisectus</i> , <i>Sanguinolites</i>	p. 49	<i>gentaroensis</i> , <i>Anadara</i> (<i>Anadara</i>)	p. 14
<i>boshihoensis</i> , <i>Lucinopsis</i> ?	p. 35	<i>gorokuensis</i> , <i>Glycymeris</i>	p. 31
<i>bosoana</i> , <i>Solemya</i> (<i>Acharax</i>)	p. 50	<i>granulicostata</i> , <i>Venericardia</i>	p. 55
<i>brevicula</i> , <i>Trigonia</i>	p. 54	<i>haboroensis</i> , <i>Mytilus</i>	p. 38
<i>brevis</i> , <i>Cultellus</i> ?	p. 27	<i>hakushatonensis</i> , <i>Macoma</i>	p. 35
<i>brevitesta</i> , <i>Pholadomya</i>	p. 46	<i>hamadaensis</i> , <i>Myoconcha</i>	p. 38
<i>byoritsuensis</i> , <i>Pecten</i> (<i>Vola</i>)	p. 43	<i>hamadai</i> , <i>Tellina</i>	p. 51
<i>byoritsuensis</i> , <i>Venus</i> (<i>Chione</i>)	p. 56	<i>hanaishiensis</i> , <i>Chlamys</i> (<i>Chlamys</i>)	p. 21
<i>cancellatum</i> , <i>Cardium</i> (<i>Acanthocardia</i>)	p. 20	<i>hanpeizanense</i> , <i>Cardium</i> (<i>Trachycardium</i>)	p. 20
<i>cassis</i> , <i>Ostrea</i>	p. 40	<i>hanzawae</i> , <i>Chlamys cosibensis</i>	p. 21
<i>chikagawaense</i> , <i>Clinocardium</i>	p. 24	<i>hanzawai</i> , <i>Cardium</i> (<i>Cerastoderma</i>)	p. 20
<i>chikuzenensis</i> , <i>Dosinia</i>	p. 29	<i>hanzawai</i> , <i>Gafrarium</i> (<i>Circe</i>)	p. 30
<i>chinkopensis</i> , <i>Chlamys</i>	p. 21	<i>hanzawai</i> , <i>Glycymeris</i>	p. 31
<i>chitosensis</i> , <i>Acila divaricata</i>	p. 13	<i>hanzawai</i> , <i>Macrocallista</i>	p. 35
<i>complexa</i> , <i>Venericardia</i> (<i>Cyclocardia</i>) <i>ferruginea</i>	p. 55	<i>hasimotoi</i> , <i>Chlamys</i> (<i>Chlamys</i>)	p. 22
<i>compressa</i> , <i>Cyclina</i>	p. 28	<i>hataii</i> , <i>Anadara</i> (<i>Anadara</i>)	p. 14
<i>compressa</i> , <i>Glycimeris cisshuensis</i> var	p. 31	<i>hataii</i> , <i>Aviculopecten</i>	p. 18
<i>confusa</i> , <i>Diplodonta</i>	p. 29	<i>hataii</i> , <i>Chlamys</i>	p. 22
<i>connectens</i> , <i>Solen</i>	p. 50	<i>hataii</i> , <i>Clinocardium</i>	p. 24
<i>convexa</i> , <i>Mya</i>	p. 37	<i>hataii</i> , <i>Ctena</i>	p. 27
<i>costata</i> , <i>Astarte subsenecta</i> var	p. 18	<i>hataii</i> , <i>Dosinia</i> (<i>Phacosoma</i>)	p. 30
<i>crenulicostata</i> , <i>Venericardia</i>	p. 55	<i>hataii</i> , <i>Isognomon</i> (<i>Isognomon</i>)	p. 33
<i>daishakaensis</i> , <i>Chlamys</i>	p. 21	<i>hataii</i> , <i>Leptochondria</i> ?	p. 33

<i>hataii</i> , <i>Pitar</i>	p. 46	<i>kahoensis</i> , <i>Macrocallista</i>	p. 35
<i>hataii</i> , <i>Serripes</i>	p. 49	<i>kahoensis</i> , <i>Ostrea</i>	p. 40
<i>hataii</i> , <i>Thracia</i>	p. 52	<i>kakehataensis</i> , <i>Anadara</i> (<i>Anadara</i>)	p. 14
<i>hataii</i> , <i>Zirfaea</i>	p. 57	<i>kakisakiensis</i> , <i>Pecten</i> (<i>Pecten</i>)	p. 44
<i>hatakeyamae</i> , <i>Chlamys</i> (<i>Chlamys</i>)	p. 22	<i>kamayasakiensis</i> , <i>Thracia</i>	p. 52
<i>hayasakai</i> , <i>Aviculopecten</i>	p. 18	<i>kanezawaensis</i> , <i>Barbatia</i>	p. 19
<i>hayasakai</i> , <i>Barbatia</i> (<i>Acar</i>)	p. 19	<i>kannoi</i> , <i>Dosinia</i> (<i>Kaneharaia</i>)	p. 30
<i>hayasakai</i> , <i>Bassina</i> (<i>Callanatis</i>)	p. 19	<i>kanomatazawaensis</i> , <i>Panope</i>	p. 41
<i>hizenense</i> , <i>Cardium</i> (<i>Cerastoderma</i>)	p. 20	<i>karatsuensis</i> , <i>Nucula</i>	p. 39
<i>hizenensis</i> , <i>Nucula</i>	p. 39	<i>karihaensis</i> , <i>Nuculana</i> (<i>Nuculana</i>)	p. 39
<i>hokiensis</i> , <i>Macoma</i>	p. 35	<i>katsumatai</i> , <i>Cardita</i>	p. 20
<i>hokkaidoana</i> , <i>Trigonia</i>	p. 54	<i>kazusaensis</i> , <i>Pholadomya</i>	p. 46
<i>hokkaidoensis</i> , <i>Anadara</i> (<i>Anadara</i>)	p. 14	<i>kesenensis</i> , <i>Crenipecten</i>	p. 26
<i>hokkaidoensis</i> , <i>Nucula</i> (<i>Acila</i>)	p. 39	<i>kidoensis</i> , <i>Thracia</i>	p. 52
<i>hokkaidoensis</i> , <i>Pectunculus</i>	p. 45	<i>kiiensis</i> , <i>Acila</i> (<i>Acila</i>)	p. 13
<i>hokkaidoensis</i> , <i>Pitar</i>	p. 46	<i>kikaiensis</i> , <i>Pecten</i> (<i>Aequipecten</i>)	p. 44
<i>hokurikuensis</i> , <i>Patinopecten</i> (<i>Patinopecten</i>) <i>tokyoensis</i> ..	p. 42	<i>kikaizimana</i> , <i>Arca</i> (<i>Arca</i>)	p. 16
<i>ibaragiensis</i> , <i>Patinopecten</i>	p. 41	<i>kikaizimana</i> , <i>Tellina</i>	p. 51
<i>ibukii</i> , <i>Protocardia</i>	p. 48	<i>kimurai</i> , <i>Nuculites</i>	p. 40
<i>ichinohense</i> , <i>Trapezium</i> (<i>Neotrapezium</i>)	p. 53	<i>kintaichiensis</i> , <i>Patinopecten yamasakii</i>	p. 42
<i>imanishii</i> , <i>Chlamys</i>	p. 22	<i>kishimaense</i> , <i>Cardium</i> (<i>Cerastoderma</i> ?)	p. 21
<i>inconspicuus</i> , <i>Crassatellites</i>	p. 25	<i>kissyuensis</i> , <i>Schizothaerus nuttalli</i>	p. 49
<i>infantile</i> , <i>Cardium</i> (<i>Trachycardium</i>)	p. 20	<i>kitahukuokaensis</i> , <i>Mya arenaria</i>	p. 37
<i>inflata</i> , <i>Thyasira</i>	p. 53	<i>kitakamiensis</i> , <i>Annuliconcha</i>	p. 16
<i>intermedius</i> , <i>Solen</i>	p. 50	<i>kitamurai</i> , <i>Chlamys</i>	p. 22
<i>iriomotensis</i> , <i>Cucullaea</i>	p. 27	<i>kitamurai</i> , <i>Codakia</i>	p. 24
<i>iriomotensis</i> , <i>Glycymeris</i>	p. 32	<i>kobiyamai</i> , <i>Patinopecten</i>	p. 42
<i>ishidae</i> , <i>Chlamys</i> (<i>Chlamys</i>)	p. 22	<i>kogachiensis</i> , <i>Anadara</i> (<i>Hataiarca</i>)	p. 14
<i>ishidoense</i> , <i>Cardium</i>	p. 20	<i>kokozuraensis</i> , <i>Nucula</i>	p. 39
<i>ishidoensis</i> , <i>Lima</i> (<i>Limatula</i>)	p. 34	<i>kondo</i> , <i>Cardita</i>	p. 20
<i>ishidoensis</i> , <i>Modiola</i> ?	p. 37	<i>konnoi</i> , <i>Saccella</i>	p. 49
<i>ishidoensis</i> , <i>Nucula</i>	p. 39	<i>kosuiensis</i> , <i>Lucinopsis</i>	p. 35
<i>isohareense</i> , <i>Trapezium</i> (<i>Neotrapezium</i>)	p. 53	<i>kotakae</i> , <i>Chlamys</i> (<i>Chlamys</i>)	p. 22
<i>isomatsuense</i> , <i>Trapezium</i>	p. 53	<i>kotakai</i> , <i>Cardiomya</i> (<i>Cardiomya</i>)	p. 20
<i>itoigawae</i> , <i>Chlamys</i> (<i>Chlamys</i>)	p. 22	<i>kotakai</i> , <i>Corbicula</i> (<i>Corbicula</i>)	p. 24
<i>iwakiensis</i> , <i>Neoburmesia</i>	p. 38	<i>kotoi</i> , <i>Pitar</i>	p. 46
<i>iwashibaraensis</i> , <i>Anadara</i> (<i>Scapharca</i> ?)	p. 14	<i>kumanodoensis</i> , <i>Chlamys</i>	p. 22
<i>iwatensis</i> , <i>Anadara</i> (<i>Anadara</i>)	p. 14	<i>kumasoana</i> , <i>Lima amaxensis</i> var	p. 34
<i>iwatensis</i> , <i>Spisula</i>	p. 50	<i>kunigamiensis</i> , <i>Lucina</i>	p. 34
<i>iwatensis</i> , <i>Yoldia</i>	p. 57	<i>kuntsuipinensis</i> , <i>Tellina</i>	p. 51
<i>iwatonoensis</i> , <i>Anadara</i> (<i>Anadara</i>)	p. 14	<i>kurodae</i> , <i>Ezocallista</i>	p. 30
<i>izuensis</i> , <i>Pecten</i> (<i>Decadopecten</i>)	p. 44	<i>kuroishiensis</i> , <i>Fortipecten</i>	p. 30
<i>izumo</i> , <i>Panomya</i>	p. 41	<i>kurosawaensis</i> , <i>Thracia</i>	p. 52
<i>izurense</i> , <i>Gloripallium</i>	p. 31	<i>kurosawai</i> , <i>Entomonotis</i>	p. 30
<i>japonica</i> , <i>Clementia</i>	p. 23	<i>kurosedaniensis</i> , <i>Anadara</i> (<i>Anadara</i>)	p. 14
<i>japonica</i> , <i>Cyclina</i> (<i>Cyclina</i>)	p. 28	<i>kyushuensis</i> , <i>Corbula</i> (<i>Cunaecorbula</i>)	p. 25
<i>japonica</i> , <i>Myophoria</i>	p. 38	<i>kyushuensis</i> , <i>Pecten</i>	p. 44
<i>japonica</i> , <i>Serripes</i>	p. 49	<i>kyushuensis</i> , <i>Pitaria</i>	p. 47
<i>japonica</i> , <i>Thetironia affinis</i> var	p. 52	<i>leguminoides</i> , <i>Cultellus</i> ?	p. 27
<i>japonica</i> , <i>Veniella</i> ?	p. 56	<i>limopsis</i> , <i>Lima</i> (<i>Limea</i>)	p. 34
<i>japanicum</i> , <i>Trapezium</i>	p. 54	<i>lunaiformis</i> , <i>Ostrea</i>	p. 40
<i>kagaensis</i> , <i>Mizuhopecten kimurai</i>	p. 37	<i>makiyamae</i> , <i>Clinocardium asagaiense</i>	p. 24

<i>makiyamai</i> , <i>Anadara</i>	p. 14	<i>ninohensis</i> , <i>Patinopecten yamasakii</i>	p. 43
<i>manchuriensis</i> , <i>Ctenodonta</i>	p. 27	<i>nipponica</i> , <i>Cucullaea</i>	p. 27
<i>masagoi</i> , <i>Polynemamussium</i>	p. 48	<i>nipponica</i> , <i>Thyasira bisecta</i> var	p. 53
<i>masudai</i> , <i>Anadara</i> (<i>Scapharca</i>)	p. 15	<i>nipponicus</i> , <i>Inoceramus concentricus</i> var	p. 33
<i>matsukuchiensis</i> , <i>Nuculana</i> (<i>Nuculana</i>)	p. 40	<i>nipponicus</i> , <i>Leukomoides</i>	p. 33
<i>matsumoriensis</i> , <i>Miyagipecten</i>	p. 36	<i>nishizawaensis</i> , <i>Thracidora</i>	p. 53
<i>matsumotoi</i> , <i>Pitaria</i>	p. 47	<i>nodai</i> , <i>Cyclina</i> ?	p. 28
<i>matsunagiensis</i> , <i>Aequipecten</i>	p. 13	<i>noharai</i> , <i>Pododesmus</i> (<i>Monia</i>)	p. 48
<i>matsunoi</i> , <i>Chlamys</i> (<i>Chlamys</i>)	p. 22	<i>nomurae</i> , <i>Panopea</i>	p. 41
<i>matsuraensis</i> , <i>Crassatellites</i>	p. 26	<i>nomurai</i> , " <i>Clinocardium</i> "	p. 24
<i>matsuraensis</i> , <i>Macrocallista</i>	p. 36	<i>nomurai</i> , <i>Placopecten</i>	p. 47
<i>matsushimaensis</i> , <i>Teredo</i>	p. 52	<i>nomurai</i> , <i>Trifaricardium</i>	p. 54
<i>matumoriensis</i> , <i>Pecten</i> (<i>Patinopecten</i>) <i>kimuraip</i>	p. 44	<i>notoensis</i> , <i>Tellina</i>	p. 51
<i>maxima</i> , <i>Tellina</i>	p. 51	<i>nozokiensis</i> , <i>Glycymeris</i>	p. 32
<i>miikense</i> , <i>Cardium</i>	p. 21	<i>nuibetsuensis</i> , <i>Crenella</i> (<i>Megacrenella</i>)	p. 26
<i>millegrana</i> , <i>Venericardia</i>	p. 55	<i>numaensis</i> , <i>Barbatia</i> (<i>Acar</i>)	p. 19
<i>millepustulata</i> , <i>Taras</i>	p. 51	<i>obessa</i> , <i>Anadara</i> (<i>Tegillarca</i>)	p. 15
<i>minoensis</i> , <i>Aviculopecten</i>	p. 18	<i>obsoleta</i> , <i>Trigonarca</i> ?	p. 54
<i>minor</i> , <i>Astarte</i>	p. 17	<i>obsoletiformis</i> , <i>Parallelodon</i>	p. 41
<i>mirabilis</i> , <i>Cyrena</i>	p. 28	<i>obsoletoradiata</i> , <i>Rocheffortia</i>	p. 49
<i>miurensis</i> , <i>Arca</i> (<i>Arca</i>)	p. 16	<i>ochii</i> , <i>Peronidia</i>	p. 46
<i>miyagiensis</i> , <i>Halicardia</i>	p. 33	<i>ogachiensis</i> , <i>Palaeoneilo</i>	p. 40
<i>miyagiensis</i> , <i>Pecten</i> (<i>Chlamys</i>) <i>kagamianus</i>	p. 44	<i>ogasawarai</i> , <i>Yabepecten</i>	p. 57
<i>miyakoensis</i> , <i>Astarte</i>	p. 17	<i>ogawaensis</i> , <i>Mytilus</i>	p. 38
<i>miyamoriensis</i> , <i>Strebrochondria</i>	p. 51	<i>ogawaraensis</i> , <i>Glycymeris</i>	p. 32
<i>miyamotoi</i> , <i>Pholadomya</i> ?	p. 46	<i>ohiroi</i> , <i>Anisocorbula</i>	p. 16
<i>moniwaensis</i> , <i>Patinopecten kagamianus</i>	p. 42	<i>ohiroi</i> , <i>Paphia</i> (<i>Paphia</i>) <i>euglypta</i>	p. 41
<i>monstrosa</i> , <i>Pitar sendaica</i>	p. 46	<i>oidensis</i> , <i>Chlamys</i>	p. 23
<i>multistriata</i> , <i>Daonella kotoi</i> var	p. 29	<i>okadae</i> , <i>Myadora</i>	p. 37
<i>muraii</i> , <i>Serripes</i>	p. 49	<i>okinawaensis</i> , <i>Dosinia</i> (<i>Phacosoma</i>)	p. 30
<i>murataensis</i> , <i>Mizuhopecten paraplebejus</i>	p. 37	<i>okinawaensis</i> , <i>Oxyperas</i>	p. 40
<i>muroensis</i> , <i>Solemya</i> (<i>Acharax</i>)	p. 50	<i>okinawazimana</i> , <i>Codakia</i> (<i>Jagonia</i>)	p. 24
<i>nagahamaensis</i> , <i>Tapes</i>	p. 51	<i>okinoshimaensis</i> , <i>Venericardia</i>	p. 55
<i>nagakoensis</i> , <i>Spisula</i> (<i>Mactromeris</i>) <i>polynyma</i>	p. 50	<i>omagariense</i> , <i>Clinocardium</i>	p. 24
<i>naganoensis</i> , <i>Anadara</i> (<i>Anadara</i>)	p. 15	<i>omagariensis</i> , <i>Nucula</i> (<i>Ennucula</i>)	p. 39
<i>naganoensis</i> , <i>Patinopecten</i> (<i>Kotorapecten</i>)	p. 42	<i>omaruensis</i> , <i>Anadara</i> (<i>Scapharca</i>)	p. 15
<i>nagaoi</i> , <i>Batissa</i>	p. 19	<i>ommaensis</i> , <i>Nipponopagia</i>	p. 38
<i>nagaoi</i> , <i>Chlamys</i> (<i>Chlamys</i>)	p. 23	<i>ommaensis</i> , <i>Venericardia</i> (<i>Megacardita</i>)	p. 55
<i>nagaoi</i> , <i>Nicaniella</i> (<i>Trautscholdia</i>)	p. 38	<i>onukii</i> , <i>Acanthopecten</i>	p. 13
<i>nagaoi</i> , <i>Noetia</i>	p. 38	<i>onukii</i> , <i>Aviculopecten</i> ?	p. 18
<i>nagaoi</i> , <i>Venericardia</i>	p. 55	<i>onukii</i> , <i>Venericardia</i>	p. 56
<i>nakajimai</i> , <i>Patinopecten</i>	p. 42	<i>oshimaensis</i> , <i>Glycymeris</i>	p. 32
<i>nakatonbetsuensis</i> , <i>Patinopecten</i> (<i>Patinopecten</i>) <i>yessoensis</i>	p. 43	<i>otsukai</i> , <i>Cyrena</i>	p. 28
<i>nakayamaensis</i> , <i>Mactra</i>	p. 36	<i>otukae</i> , <i>Chlamys</i>	p. 23
<i>nakosoensis</i> , <i>Clementia</i> (<i>Clementia</i>)	p. 23	<i>otukai</i> , <i>Lithophaga</i>	p. 34
<i>nakosoensis</i> , <i>Glycymeris</i>	p. 32	<i>otukai</i> , <i>Lucinoma</i>	p. 35
<i>nakosoensis</i> , <i>Patinopecten kimurai</i>	p. 42	<i>owadaensis</i> , <i>Margaritifera</i>	p. 36
<i>nanakitaensis</i> , <i>Pecten</i> (<i>Swiftopecten</i>)	p. 44	<i>pacificus</i> , <i>Pseudogrammatodon</i>	p. 48
<i>naomiae</i> , <i>Glans</i>	p. 31	<i>pedalionoides</i> , <i>Inoceramus</i>	p. 33
<i>nigamiensis</i> , <i>Serripes makiyamai</i>	p. 49	<i>philippianus</i> , <i>Azorius</i>	p. 18
<i>niikappuensis</i> , <i>Chlamys</i> (<i>Chlamys</i>)	p. 23	<i>pitogoensis</i> , <i>Gari</i> (<i>Gari</i>)	p. 31
<i>ninohensis</i> , <i>Meretrix meretrix</i>	p. 36	<i>planicostulatus</i> , <i>Pecten</i> (<i>Patinopecten</i>)	p. 44

<i>ponderosa</i> , <i>Cyrena</i> (<i>Batissa</i>)	p. 28	<i>shitakaraensis</i> , <i>Thracia</i> (<i>Thracia</i>)	p. 53
<i>praenipponica</i> , <i>Ennucula</i>	p. 30	<i>shizuokaensis</i> , <i>Anadara</i> (<i>Scapharca</i> ?)	p. 15
<i>problematica</i> , <i>Diplodonta</i> ?	p. 29	<i>sinelnikovae</i> , <i>Septifer</i>	p. 49
<i>prototenuilirata</i> , <i>Tellina</i>	p. 52	<i>sokeishiensis</i> , <i>Arca</i> (<i>Arca</i>)	p. 17
<i>pseudomeretrix</i> , <i>Meretrix</i>	p. 36	<i>spinosus</i> , <i>Acanthopecten</i>	p. 13
<i>pseudoplana</i> , <i>Callista</i>	p. 19	<i>striatocostata</i> , <i>Crenella</i>	p. 26
<i>pseudosubcrenata</i> , <i>Anadara</i> (<i>Hataiarca</i>)	p. 15	<i>subexcavata</i> , <i>Thyasira</i>	p. 53
<i>pseudotruncata</i> , <i>Anomia</i>	p. 16	<i>subfornicata</i> , <i>Crenella</i>	p. 26
<i>pulchellum</i> , <i>Periploma</i>	p. 45	<i>submaximus</i> , <i>Angulus maximus</i>	p. 16
<i>pustulosa</i> , <i>Trigonia</i>	p. 54	<i>subnipponica</i> , <i>Venericardia</i>	p. 56
<i>quadrata</i> , <i>Thyasira</i>	p. 53	<i>subomalioides</i> , <i>Astarte</i>	p. 18
<i>quadriangulata</i> , <i>Venericardia</i>	p. 56	<i>subpectiniformis</i> , <i>Glycymeris</i>	p. 32
<i>radiatostriata</i> , <i>Cyrena</i>	p. 28	<i>subquadrata</i> , <i>Daonella densisulcata</i> var	p. 29
<i>rectangularis</i> , <i>Conularia</i>	p. 24	<i>subsenecta</i> , <i>Astarte</i>	p. 18
<i>reticularis</i> , <i>Aviculopecten</i>	p. 18	<i>subsquamatus</i> , <i>Pecten</i> (<i>Pecten</i>)	p. 45
<i>rhyconelloides</i> , <i>Glycymeris</i>	p. 32	<i>subtumida</i> , <i>Corbula</i> (<i>Corbula</i>)	p. 25
<i>ryukyuensis</i> , <i>Venericardia</i>	p. 56	<i>sulcataroides</i> , <i>Macra</i>	p. 36
<i>sachalinensis</i> , <i>Corbicula</i> (<i>Corbicula</i>)	p. 25	<i>sunakozakaensis</i> , <i>Crassostrea</i>	p. 26
<i>sachalinensis</i> , <i>Pectunculus</i>	p. 45	<i>sunakozakaensis</i> , <i>Pitar</i>	p. 47
<i>saikaiensis</i> , <i>Saccella</i>	p. 49	<i>sunakozakaensis</i> , <i>Pteria</i>	p. 48
<i>saikawai</i> , <i>Caryocorbula</i>	p. 21	<i>suzuensis</i> , <i>Myadora</i>	p. 37
<i>sakamizuensis</i> , <i>Arca</i>	p. 17	<i>suzuensis</i> , <i>Paphia</i> (<i>Paphia</i>)	p. 41
<i>sakitoensis</i> , <i>Ostrea</i>	p. 40	<i>taiwanensis</i> , <i>Batissa</i>	p. 19
<i>sakitoensis</i> , <i>Pecten</i> (<i>Chlamys</i>)	p. 44	<i>taiwanensis</i> , <i>Corbula</i> (<i>Corbula</i>)	p. 25
<i>sakoi</i> , <i>Limatula</i>	p. 34	<i>taiwanensis</i> , <i>Venus</i> (<i>Chione</i>)	p. 56
<i>sanchuensis</i> , <i>Corbicula</i> (<i>Veloritina</i> ?)	p. 25	<i>taiwanica</i> , <i>Anadara</i> (<i>Scapharca</i>)	p. 15
<i>sanchuensis</i> , <i>Nuculana</i>	p. 40	<i>taiwanus</i> , <i>Pecten</i> (<i>Patinopecten</i>)	p. 45
<i>sanchuensis</i> , <i>Perna</i>	p. 46	<i>takagii</i> , <i>Callista chinensis</i>	p. 19
<i>sasakii</i> , <i>Aviculopecten</i>	p. 18	<i>takahashii</i> , <i>Ctenodonta</i>	p. 27
<i>satoi</i> , <i>Parapholas</i>	p. 41	<i>takanabensis</i> , <i>Anadara</i> (<i>Scapharca</i>)	p. 15
<i>scabricostulata</i> , <i>Tellina</i>	p. 52	<i>takaoensis</i> , <i>Arca</i> (<i>Arca</i>)	p. 17
<i>scaphoides</i> , <i>Yoldia</i>	p. 57	<i>takasago</i> , <i>Corbicula</i>	p. 25
<i>sekiyaensis</i> , <i>Callista</i>	p. 20	<i>takashimaensis</i> , <i>Pitaria</i>	p. 47
<i>sekiyaensis</i> , <i>Psammocola</i>	p. 48	<i>takasimensis</i> , <i>Pholadomya</i>	p. 46
<i>semipolita</i> , <i>Codakia</i>	p. 24	<i>takayamai</i> , <i>Anadara</i> (<i>Hataiarca</i>)	p. 15
<i>setsukoe</i> , <i>Chlamys</i> (<i>Chlamys</i>)	p. 23	<i>takiensis</i> , <i>Brachidontes</i>	p. 19
<i>shimizui</i> , <i>Corbicula</i> (<i>Corbicula</i>)	p. 25	<i>tamurae</i> , <i>Chlamys</i>	p. 23
<i>shimotokuraense</i> , <i>Vasticardium</i>	p. 55	<i>tanakuraensis</i> , <i>Anadara</i> (<i>Anadara</i>)	p. 15
<i>shimotsukensis</i> , <i>Paphia</i>	p. 41	<i>tatunokutiensis</i> , <i>Dosinia</i>	p. 30
<i>shimotsukensis</i> , <i>Spisula</i>	p. 51	<i>tayamai</i> , <i>Pecten</i> (<i>Decadopecten</i>)	p. 45
<i>shinanoensis</i> , <i>Arca</i>	p. 17	<i>teshimaense</i> , <i>Vasticardium</i>	p. 55
<i>shinanoensis</i> , <i>Astarte</i>	p. 18	<i>tobai</i> , <i>Myophoria subelegans</i> var	p. 38
<i>shinanoensis</i> , <i>Gervillia</i>	p. 31	<i>tochigiensis</i> , <i>Meretrix</i>	p. 36
<i>shiobarensis</i> , "Pitar"	p. 47	<i>tokunagai</i> , <i>Thyasira</i>	p. 53
<i>shiobarensis</i> , <i>Serripes</i>	p. 50	<i>tomiyaensis</i> , <i>Crenella</i>	p. 26
<i>shirahamaensis</i> , <i>Pecten</i> (<i>Pecten</i>)	p. 44	<i>tomiyasui</i> , <i>Pedalion</i>	p. 45
<i>shiratoriensis</i> , <i>Rexithaerus</i>	p. 48	<i>tonohamanus</i> , <i>Loripes</i>	p. 34
<i>shiroiense</i> , <i>Cyrena</i>	p. 29	<i>torii</i> , <i>Cardium</i> (<i>Nemocardium</i>)	p. 21
<i>shiroyamaensis</i> , <i>Nucula</i> (<i>Nucula</i>)	p. 39	<i>tosaensis</i> , <i>Anadara</i> (<i>Tosarca</i>)	p. 16
<i>shitakaraensis</i> , <i>Chlamys</i>	p. 23	<i>tosana</i> , <i>Lioconcha</i>	p. 34
<i>shitakaraensis</i> , <i>Crenella</i> (<i>Megacrenella</i>)	p. 26	<i>tosanus</i> , <i>Crassatellites</i>	p. 26
<i>shitakaraensis</i> , <i>Solen</i>	p. 50	<i>toyajoanus</i> , <i>Inoceramus balticus</i> var	p. 33

<i>toyomaensis</i> , <i>Saccella confusa</i>	p. 49	<i>yaegashii</i> , <i>Horiopleura</i>	p. 33
<i>transversa</i> , <i>Arca</i> (<i>Noetia</i>) <i>pondaungensis</i> var	p. 17	<i>yaeyamaensis</i> , <i>Fimbria</i>	p. 30
<i>triangulus</i> , <i>Circe</i> (<i>Circe</i>)	p. 23	<i>yamadae</i> , <i>Macoma</i>	p. 35
<i>tricarinata</i> , <i>Tellina</i>	p. 52	<i>yamaguchii</i> , <i>Glycymeris</i>	p. 32
<i>tsudae</i> , <i>Patinopecten poculum</i>	p. 42	<i>yasudae</i> , <i>Polynemamussium</i>	p. 48
<i>tsudai</i> , <i>Anadara</i> (<i>Anadara</i>)	p. 16	<i>yasuhiro</i> , <i>Modiolus</i> (<i>Modiolatus</i>)	p. 37
<i>tsurushizakiensis</i> , <i>Barbatia</i> (<i>Pugilarca</i>)	p. 19	<i>yatsuoensis</i> , <i>Anadara</i> (<i>Hataiarca</i>)	p. 16
<i>tuberculosa</i> , <i>Plicatula</i>	p. 48	<i>yokoyamae</i> , <i>Patinopecten</i> (<i>Patinopecten</i>) <i>yessoensis</i> ...	p. 43
<i>uchigoensis</i> , <i>Nuttallia</i>	p. 40	<i>yokoyamai</i> , <i>Arca</i> (<i>Barbatia</i>)	p. 17
<i>uetsukiensis</i> , <i>Barbatia</i> (<i>Barbatia</i>)	p. 19	<i>yokoyamai</i> , <i>Grammatodon</i>	p. 32
<i>umbonata</i> , <i>Cyclina</i> (<i>Cyclina</i>)	p. 28	<i>yokoyamai</i> , <i>Ostrea</i> (<i>Ostrea</i>)	p. 40
<i>umedairensis</i> , <i>Tellina</i>	p. 52	<i>yokoyamai</i> , <i>Pitaria</i>	p. 47
<i>wakuyaensis</i> , <i>Placopecten</i>	p. 47	<i>yokoyamai</i> , <i>Trigonia</i>	p. 54
<i>wanizakiensis</i> , <i>Modiolus</i>	p. 37	<i>yokoyamai</i> , <i>Volsella</i>	p. 56
<i>yabei</i> , <i>Barbatia</i> (<i>Pugilarca</i>)	p. 19	<i>yoshidai</i> , <i>Nemocardium</i> (<i>Keenaea</i>)	p. 38
<i>yabei</i> , <i>Crassatellites</i>	p. 26	<i>yoshidai</i> , <i>Venericardia</i>	p. 56
<i>yabei</i> , <i>Inoceramus</i>	p. 33	<i>yubaensis</i> , <i>Angulararca</i>	p. 16
<i>yabei</i> , <i>Pecten</i> (? <i>Amussiopecten</i>)	p. 45	<i>yubarensis</i> , <i>Pecten</i> (<i>Propeamussium</i>) <i>cowperi</i> var	p. 43
<i>yabei</i> , <i>Pseudoactinodontophora</i>	p. 48	<i>yudaensis</i> , <i>Patinopecten kimurai</i>	p. 42
<i>yabei</i> , <i>Venus</i> (<i>Chione</i>)	p. 56	<i>zyonoensis</i> , <i>Tellina venulosa</i>	p. 52

***Nicaniella (Trautscholdia) nagaoi*, a new replacement name for *Astarte minor* Nagao, 1934, non *Astarte sulcata* var. *minor* Jeffreys, 1864 [“1863”] (Mollusca: Bivalvia: Astartidae)**

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During the course of the taxonomical and nomenclatural survey of fossil Bivalvia housed at the Tohoku University Museum (Sato *et al.*, 2016), I found *Astarte minor* Nagao, 1934 (Nagao, 1934: p. 220-221, pl. 28, figs. 5-10) from the Lower Cretaceous Hiraiga Formation of the Miyako Group in the Miyako district, Iwate Prefecture, Japan, is preoccupied by *Astarte sulcata* var. *minor* Jeffreys, 1864 [“1863”] (Jeffreys, 1864: p. 312) from England. Nagao's (1934) species was thought a distinct species belonging to *Trautscholdia* Cox and Arkell, 1948 (Hayami, 1975), which is thought a subgenus in the genus *Nicaniella* Chavan, 1945 (Chavan, 1969), and has no valid senior or junior synonyms (e.g. Hayami, 1975). Therefore, I herein propose ***Nicaniella (Trautscholdia) nagaoi*, nom. nov.** for *Astarte minor* Nagao, 1934. The name is in honor of the late Prof. Takumi Nagao (1891-1943) of Hokkaido Imperial University (later of Tôhoku Imperial University).

I also noticed that *Mya convexa* Noda, 1992 (Noda, 1992: p. 90-91, pl. 7, figs. 1-9), from the “Lower Miocene” [revised as Upper Eocene by Kurita *et al.*, 1992] Lower Sankebetsu Formation in Hokkaidô, Japan, is a primary junior homonym of *Mya convexa* Wood, 1815 (Wood, 1815: p. 92, pl. 18, fig. 1) [= *Thracia convexa* (Wood, 1815)] from Devonshire, England. As I informed its author, Dr. Yoshikazu Noda of the Fukui Dinosaur Museum, Katsuyama, Japan, of these homonyms following the “Code of Ethics” of ICZN (Appendix A; International Commission on Zoological Nomenclature, 1999), its new replacement name is to be proposed by himself elsewhere.

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北海道中央部芦別地域に分布する空知層群・ 蝦夷層群の古地磁気学的研究

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Paleomagnetism of the Sorachi and Yezo Group in the Ashibetsu area, central Hokkaido, Japan

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Abstract: Paleomagnetic study was performed on Upper Jurassic–Lower Cretaceous Sorachi Group and Yezo Group in Ashibetsu area, central Hokkaido for quantitative estimation of tectonic movements in reference to the northeastern Eurasia. Characteristic remanent magnetization (ChRM), which is carried by various ferromagnetic minerals, was isolated for five sites. To determine their origin, we executed isothermal remanent magnetization (IRM) experiments, and origin of ChRM is categorized into two groups. One of them is positive in reversal test, and enhanced precision parameter after tilt correction implied pre-folding origin. Untilted formation mean direction ($D=-12.0^\circ$, $I=47.7^\circ$, $\alpha_{95}=12.3^\circ$) is characterized by significantly shallower inclination than the expected value for coeval mother continent. These results suggest northward movement of 2100 km (± 1500 km) since the Cretaceous. In comparison with previous paleomagnetic studies and tectonic models, central Hokkaido could consist of at least two components and have experienced rapid northward movement driven by plate movements.

Keywords: Cretaceous, central Hokkaido, paleomagnetism, northward movement

1. はじめに

北海道はユーラシア大陸東縁に位置し（図1）、中新世の末頃から千島弧の衝突により日高山脈の隆起が始まる（木村, 1981）など、非常に活発な変動の場である。北海道は地質学的に西部・中央部・東部の3つに区分され、西部は東北日本弧の北方延長、中央部は東北日本前弧からサハリンへ南北に延びる構造区の一部、東部は千島弧の南西端部をなすと解釈される（加藤ほか, 1990）。しかし、それらの発達史は複雑で、特に中央部に関しては地体構造の帰属について議論の余地が残されている。そのため、多くの研究者によってその起源を解き明かそうと研究がなされてきた（君波ほか, 1985; Kimura et al., 1994; Takashima et al., 2006 など）。北海道中央部は、さらに西より礼文－樺戸帯、

空知－蝦夷帯、日高帯に区分される（図1b）。礼文－樺戸帯は前期白亜紀の島弧火山列、空知－蝦夷帯の上部を構成する蝦夷層群は前弧海盆堆積物、日高帯は西側沈み込みに伴う付加体と解釈されている。しかし蝦夷層群の下位にある空知層群については、付加した海台（Kimura et al., 1994）や島弧火山列（Takashima et al., 2006）、海洋地殻（新井田・紀藤, 1986）など諸説ある。空知層群が、付加した海台と島弧火山列という2説には、その起源が現在よりも南にあるという共通点がある。しかし、どのようなプロセスで北上してきたかという点に明確な違いがある。付加海台説では、空知層群は海洋プレートの運動に伴ってユーラシア東縁へ向かって北上し、衝突とともにその運動は停止するとされる。島弧火山列説では、海洋プレートの斜め沈み込みに伴う左横ずれ断層運動によって北上してきたと考えられ

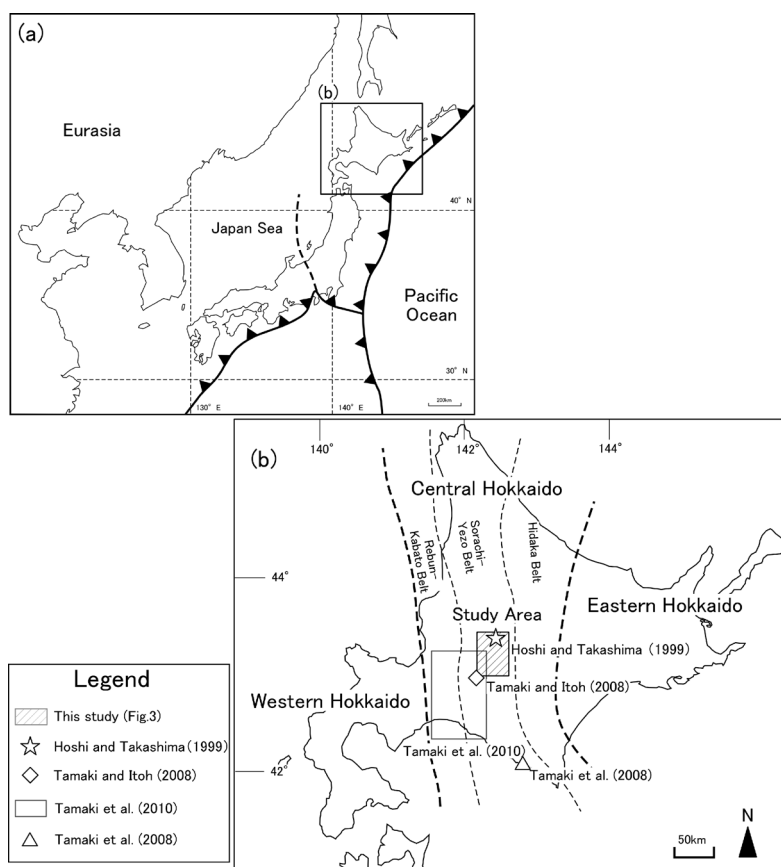


図1 (a) 日本列島周辺地図。(b) 北海道の構造区分（君波ほか，1986を編図）。これまでに報告されている古地磁気学的研究と本研究対象地域をシンボルで示す。

Fig. 1 (a) An index map around Japan arc. (b) Tectonic map of Hokkaido modified from Kiminami et al. (1986). Open symbols on the map show previous paleomagnetic studies, and a hatched area denotes this study area.

る。左横ずれ断層運動に関連した日本列島の古地理復元は、Otsuki (1992) や 田沢 (2004) でも試みられているが、これらの復元図における北海道の位置は大きく異なっており、更なる検証が必要であると思われる。

このように、日本海拡大以前の北海道のテクトニクスに関する混乱の一因は、空知-蝦夷帯とユーラシア東縁の地質ユニットとの連続性が乏しく、原位置を特定できないことにある。詳細な古地理復元を行うには、大陸プレートとの南北偏距を定量的に評価できる古地磁気学的研究が必要である。本研究では、芦別地域に分布する空知層群・蝦夷層群に対して古地磁気学的研究を行い、道央の主部を構成する地層の古緯度を推定し、北方移動量について考察する。

2. 研究史の概説

海台説を唱える Kimura et al. (1994) では、空知層群と神

居古潭帯に分布する玄武岩の岩石学的研究を行った。空知層群玄武岩は P_2O_5 - TiO_2 に乏しく、高い Y/Nb, Zr/Nb 比を示し、神居古潭帯の玄武岩は P_2O_5 - TiO_2 に富み、低い Y/Nb, Zr/Nb 比を示すことから、空知層群玄武岩を N or T-type MORB (normal or transition-type mid-oceanic ridge basalts) に、神居古潭帯の玄武岩を P-type MORB (plume-type mid-oceanic ridge basalts) と対比した。これらの多様性のある玄武岩形成を説明するモデルとして、海洋プレート直下のマントルブルームによるメルトの混合を考え、ブルームにより大量の玄武岩が供給され、空知海台が形成されるモデルを提唱した。このモデルに基づくと、空知海台は白亜紀初期 (140 Ma) には、赤道付近 (北緯約 5°) に存在し、そこから海洋プレートの運動に伴って北上し、前期白亜紀の終わり頃 (110 Ma) には現在の位置に到達している。

東北日本と北海道が左横ずれ断層運動によって北上したとする説については、いずれの場合も、前期白亜紀～古第

三紀の間に中央構造線や棚倉構造線などが大規模な左横ずれを起こしたことを想定している。田沢 (2004) は、南部北上帯・飛騨外縁帯・黒瀬川帯における古生代の腕足類群集や陸上植物群集などの古生物学的根拠から古地理復元を行っている。中央構造線や棚倉構造線の活動時期、断層の移動方向や変位量に関する研究を引用しつつ、古生代での各帯の位置関係を元に、前期白亜紀から古第三紀の間に南部北上帯は中央構造線・棚倉構造線などの左横ずれ断層系に沿って、約 1500~2000 km の移動を被ったとしている。本研究では、古地磁気データから算定される古緯度に基づく議論を行うので、総移動距離を南北偏距に換算する。当時のユーラシア縁辺の形状には不確定要素が残るが、現在とほぼ同じ形状であると仮定すると、北方移動量は約 1300~1700 km 程度と見積もられる。

一方、Takashima et al. (2006) は、空知層群の詳細な地質調査により、古環境復元と古地理復元を行った。道央奈江地域の空知層群から得られている古地磁気学的古緯度 ($31.5^{\circ} \text{N} \pm 5^{\circ}$, Valanginian [139.8~132.9 Ma], 星・高嶋, 1999) を元に、海洋プレートの運動方向の変化に伴って左横ずれ断層運動が起こり、北海道と東北日本の一部が北上してきたと推定した。彼らが論拠とした古緯度データから南北移動量を計算すると約 1200 km になる。しかし、Takashima et al. (2006) では、最も地点平均方位の信頼限界円半径が小さい 1 地点のデータのみを引用しており、地磁気永年変化の影響を排除できていない可能性がある。

Otsuki (1992) は、大槻・永広 (1992) が見積もった東北日本の左横ずれ断層系の断層変位をもとに、古地理復元を

行っている。大槻・永広 (1992) では、早池峰構造帯・母体変成岩類・宮守超塩基性岩類について、変成分帯の対比と連続性や、岩相や化学組成が類似する酸性～塩基性火山岩類によって、その西・南方延長部を識別し、断層変位を見積もっている。また、マイロナイトや花崗岩の放射年代測定結果などから、各断層の主な活動時期は前期白亜紀末頃で、一部の断層は始新世に再活動したとしている。

比較的詳細な古地理復元を行っており、北方移動量に相違のある Takashima et al. (2006) と Otsuki (1992) の古地理復元図を簡略化したものを図 2 に示す。これによると、Otsuki (1992) 古地理復元によって得られた北海道の古緯度は、現在とほぼ同じであることがわかる。一方、Takashima et al. (2006) では、前述のように古地磁気学的データを根拠として、大規模な北方移動を提唱している。

星・高嶋 (1999) は、富良野地域奈江川流域に分布する空知層群に対する古地磁気学的研究を行った。試料は、玄武岩およびドレライトから採取され、段階熱消磁実験によって、450 °C までに消去される低温成分と 450 °C 以上の高温で安定な成分が分離されている。高温で安定な成分は、Ti をわずかに含むチタノマグネタイトによって担われていると解釈される。安定な残留磁化成分が分離された 4 地点の傾動補正後の全地点平均方位は、 $D = -34.0^{\circ}$, $I = 40.9^{\circ}$, $\alpha_{95} = 22.3^{\circ}$ であった。高温で安定な成分の地点平均方位については、正・逆の両極性が確認されており、それらは逆転テスト (McFadden and Jones, 1981) に合格する。しかし、正帯磁を示す地点の平均方位については、95 % の信頼限界円半径 (α_{95}) が大きく ($25 \sim 45^{\circ}$)、データの信頼

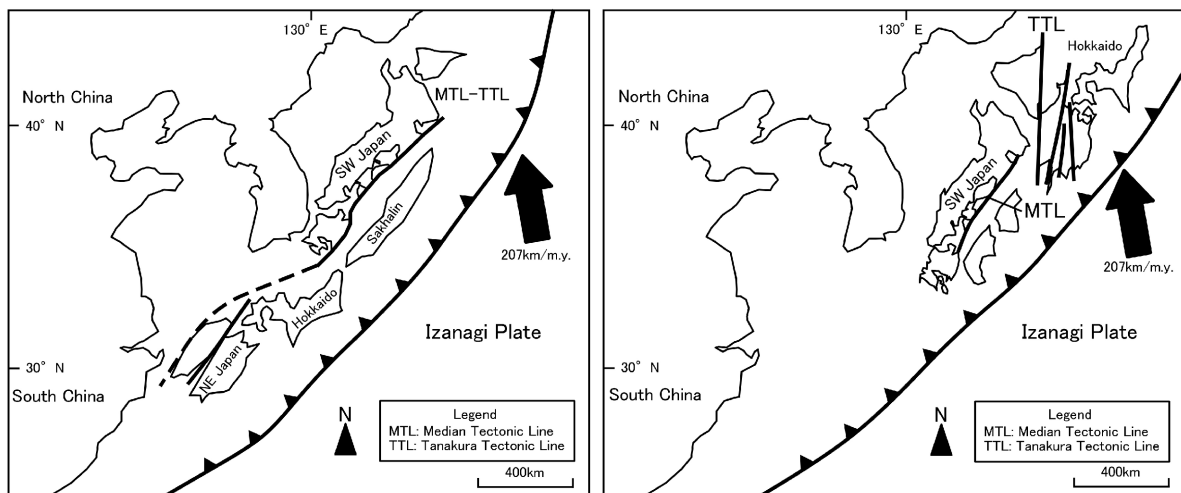


図 2 先行研究による前期白亜紀の古地理復元図。左図は Takashima et al. (2006)、右図は Otsuki (1992) を簡略化したもの。矢印は、119 Ma におけるイザナギプレートの運動速度 (Engelbreton et al., 1985) を表す。

Fig. 2 Paleoreconstruction maps in Early Cretaceous, simplified from Takashima et al. (2006; left), and Otsuki (1992; right). Thick arrow symbol shows the velocity of Izanagi plate at around 119Ma (Engelbreton et al., 1985).

性には疑問が残された。全地点の平均方位 (formation-mean direction) についても α_{95} の値が大きいため、高精度の古地理復元を行うためにはさらなる研究が望まれる。

3. 調査地域の地質的背景

芦別地域では空知層群・蝦夷層群が南北走向で帯状に分布し (図3)、大きな背斜構造を形成している。本研究地域はその西翼にあたり、西側上位の同斜構造を示す。神居古潭帯は、北海道中央部の南北に断続しながら分布する蛇紋岩・各種高压変成岩を含む構造体である (加藤ほか, 1990)。本研究地域の空知層群・蝦夷層群は、N-S から N20°E 程度の走向と垂直もしくは 70°以上東側に傾く逆転構造を示す。本研究では、高嶋ほか (2001)・Takashima

et al. (2006) の定義に従い、空知層群を下位より極楽平層・芦別川層・中天狗層・尻岸馬内川層の4層に区分し、蝦夷層群下部を惣芦別川層、シューパロ川層の2層に区分した (図4)。極楽平層は、ピクライトおよびピクライト質玄武岩・ハイアロクラスタイトを主体とする。芦別川層は、赤色泥岩を主体とし、安山岩質の暗緑色火山性砂岩層を伴う。中天狗層は、粗面安山岩質角礫岩・礫質砂岩層を主とし、基底部に玄武岩質角礫岩層を伴う。尻岸馬内川層は、珪質の凝灰質泥岩と安山岩質火山碎屑物からなる砂岩を主とし、下位より御茶々岳泥岩部層、布部岳砂岩部層の2部層に区分される (図4)。御茶々岳泥岩部層下部には、ウーイドを主体とする石灰質タービダイト層が数層挟まる。惣芦別川層は、やや珪質の暗灰色泥岩を主体とし、白色の珪長質細粒凝灰岩層を頻繁に挟在する。シューパロ川層は主にタービダイトからなり、砂岩優勢の礼振峰砂岩部層、オルビトリナ石灰岩を含む大規模なオリストストローム層からなる岨山オリストストローム部層、砂岩優勢の奥境の沢砂岩泥岩部層の3部層に区分される (図4)。空知層群・蝦夷層群惣芦別川層にかけては、多くの放散虫を産出し、蝦夷層群奥境の沢砂岩泥岩部層から、アンモナイト・浮遊性有孔虫化石が産出し始める。放散虫化石群集に基づくと、極楽平層は Kimmeridgian~Tithonian (157.3~145.0 Ma) に、芦別川層・中天狗層は Berriasian (145.0~139.8 Ma) に、尻岸馬内川層は Valanginian~Barremian (139.8~125.0 Ma) に対比される (Takashima et al., 2006)、浮遊性有孔虫化石から、蝦夷層群下部の惣芦別川層・礼振峰砂岩部層・岨山オリストストローム部層は Aptian (125.0~113.0 Ma) に、奥境の沢砂岩泥岩部層は Albian (113.0~100.5 Ma) にそれぞれ対比される (高嶋ほか, 2001)。

3. 古地磁気試料とその測定方法

古地磁気用試料として芦別川ルートより6地点、奥境の沢ルートより1地点、計7地点において、エンジンドリルを用いて9~10本のコア試料 (直径 25 mm) を採取した。それぞれの地点の、模式柱状図における層序学的位置と試料の岩相など基本データを、図4と表1に示す。試料採取時に、磁気コンパスを用いてコアの定方位付けを行った。

各コアから切り出した円筒形試料片 (直径 25 mm、高さ 22 mm) の自然残留磁化 (natural remanent magnetization; NRM) は、京都大学のシールドルーム内に設置された超伝導磁力計 (model 760 - R SRM, 2 - G Enterprise, Pacific Grove, CA, USA) を用いて計測した。各地点1~2個のパイロット試料片を選び、段階熱消磁 (progressive thermal demagnetization; PThD) 実験、段階交流消磁 (progressive alternating field demagnetization; PAFD) 実験を行い、どちらが安定な残留磁化成分の分離に有効かを検証した。段階熱消磁実験では、試料片位置での磁場が 10 nT 以下となる

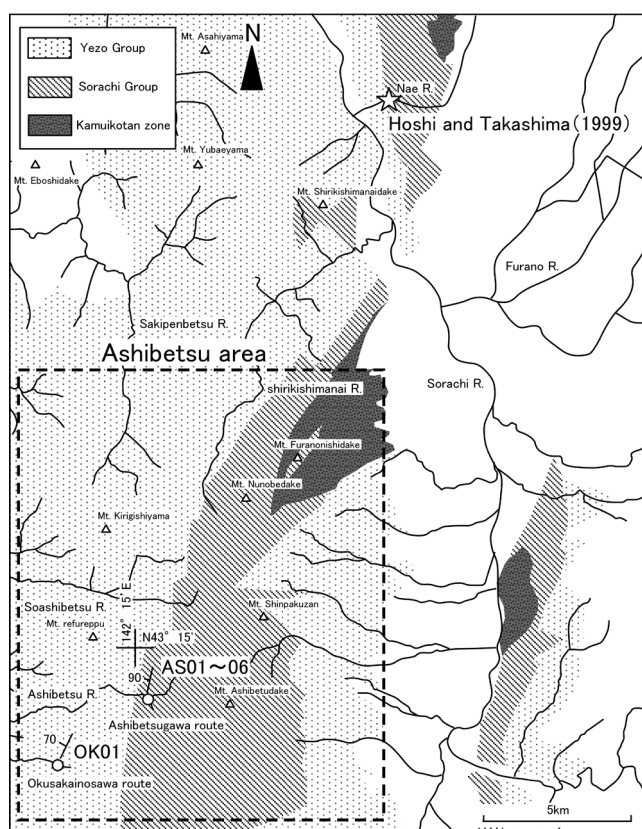


図3 古地磁気試料サンプリング地点 (AS01~06, OK01) と周辺地質図。地質図は Takashima et al. (2006) を簡略化。奈江川流域で報告されている古地磁気研究を星印で示す (星・高嶋, 1999)。

Fig. 3 Geological map around Ashibetsu area with paleomagnetic sampling points. Star denotes a previous paleomagnetic study (Hoshi and Takashima, 1999). Geological data is simplified from Takashima et al. (2006).

Age (Ma)	Period	Group	Formation	Member	Paleomagnetic sampling horizon (this study)	Radiolarian datum
110	Cretaceous	Early Albian	Shuparogawa Fm.	Okusakainosawa Sst. &Mst. Mem.	◀ OK01 (Orbitolina limestone)	↓ "Cecrops" septemporatus ↑ Pseudodictyonira carpalica
113.0				Kirigishiyama Olistostrome Mem.		
120				Refureppu Sst. Mem.		
125.0		Soashibetsugawa Fm.				
130		Valanginian~Barremanian	Shirikishi-manaigawa Fm.	Nunobedake Sst. Mem.	◀ AS06 (Vol. sst)	
				Ochachadake Mst. Mem.	◀ AS01 (Oolite limestone) ◀ AS02 (Oolite limestone)	
139.8			Nakatengu Fm.		◀ AS05 (Vol. sst)	
140			Ashibetsugawa Fm.		◀ AS04 (Shale, vol. sst) ◀ AS03 (Andesite sill)	
145.0	Gokurakudaira Fm.					
150	Jurassic					

図 4 芦別地域の層序と古地磁気サンプリング層準。層序、地質年代、放散虫基準面は、高嶋ほか（2001）と Takashima et al. (2006) に従った。絶対年代は Gradstein et al. (2012) に従った。

Fig. 4 Paleomagnetic sampling horizons. Stratigraphy of Sorachi and Yezo Groups in Ashibetsu area is from Takashima et al. (2006) and Takashima et al. (2001). Radiolarian datum is cited from Takashima et al. (2006). Geological time scale is cited by Gradstein et al. (2012).

表 1 古地磁気サンプルリスト
Table. 1 Paleomagnetic samples

Site name	Lithology	Stratigraphy	N demag./total	Tilting (S, D)	Demag. method
AS01	Oolite limestone	Shirikishimanaigawa Fm.	14/31	180, 76	PAFD
AS02	Oolite limestone	Shirikishimanaigawa Fm.	14/24	199, 92	PAFD
AS03	Andesite sill	Ashibetsugawa Fm.	11/17	191, 88	PThD
AS04	Shale	Ashibetsugawa Fm.	4/4	196, 92	PThD
AS04st	Volcanic sandstone	Ashibetsugawa Fm.	7/8	196, 92	PThD
AS05	Volcanic sandstone	Nakatengu Fm.	12/18	188, 90	PThD
AS06	Volcanic sandstone	Shirikishimanaigawa Fm.	11/15	189, 100	PThD
OK01	Orbitolina limestone	Syuparogawa Fm.	13/19	205, 70	PAFD

N demag., number of specimens treated by progressive thermal demagnetization (PThD) or progressive alternating field demagnetization (PAFD); total, number of total specimens in a site; Tilting, bedding attitude of a sampling site (S=strike, D=dip); Demag. method, applied demagnetization method for a site.

磁気シールド環境下で、無誘導に巻いた電気炉を用いて空气中で加熱した。天然に存在する強磁性鉱物の中で、最も高いヘマタイトのキュリー温度である 680 °C まで加熱を行っても、完全に消磁されない試料については、さらに 690 °C と 700 °C の熱消磁を行った。パイロット試料片の段階熱消磁で、安定な残留磁化成分を分離できた地点については、残りの試料片についても段階熱消磁を行い、試料の熱変質による磁化強度の急激な上昇や、残留磁化方位のランダムなふるまいがみられた地点については、段階交流消磁を採用した。測定後、主成分解析 (Kirschvink, 1980) を行い、特徴的残留磁化 (characteristic remanent magnetization; ChRM) 成分の方位決定を試みた。

残留磁化を担う強磁性鉱物を同定するため、段階交流消磁を行った試料片を用いて、等温残留磁化 (isothermal remanent magnetization; IRM) の段階着磁実験 (Kruiver et al., 2001) を行った。IRM の着磁実験では、段階的に直流磁場強度を大きくし、試料の磁化強度を測定する。そのため、実験結果は試料片中の強磁性鉱物の保磁力分布を反映する。保磁力は強磁性鉱物の種類や粒径に依存し、鉱物粒子の粒径分布は、一般に対数正規分布を取ることが知られている (Kruiver et al., 2001)。実験結果は、着磁された IRM の強度を縦軸にとった LAP (linear acquisition plot)、LAP の勾配を縦軸にとった GAP (gradient acquisition plot) などを用いて表される。これらの結果は、いくつかの保磁力スペクトル成分の重ね合わせで近似され、飽和残留磁化の半分を獲得するのに必要な磁場強度である $B_{1/2}$ 、分散を表す DP、飽和残留磁化強度 M が、強磁性鉱物同定のための主なパラメータとなる。続いて、同じ試料片の直交する 3 軸に 3.0 T, 0.40 T, 0.12 T の外部磁場によって IRM を着磁させた後、段階熱消磁を行った (Lowrie, 1990)。実験結果は、熱消磁の各段階での、3.0 T (hard) ・ 0.40 T (middle) ・ 0.12 T (soft) の 3 成分の磁化強度比で表され、試料片中の高保磁力成分・中間保磁力成分・低保磁力成分の存在比や熱安定性についての実験データを獲得できる。

段階熱消磁中の繰り返し加熱による、試料の熱変質の影響を評価するために、各段階において、Bartington MS2 susceptibility meter を用い、初磁化率測定を 2 種類の周波数 (LF= 0.47 kHz, HF=4.7 kHz) で行った。初磁化率の測定は、測定誤差の影響を最低限に抑制するため、周波数ごとに、5 回ずつ行いその平均をとった。初磁化率には、周波数依存性が存在することが知られており、一般に高周波数での初磁化率 (χ_{HF}) は、低周波数での初磁化率 (χ_{LF}) より小さくなる。これは、超常磁性粒子が高周波数磁場に追従しにくいためであると考えられている (Heller et al., 1991)。初磁化率の周波数依存性は、2 つの異なる周波数で測定された初磁化率を用いて、f-factor [$= (\chi_{LF} - \chi_{HF}) / \chi_{LF} \times 100$; Heller et al. (1991)] によって表され、超常磁性粒子の存在度を表す 1 つのパラメータとして扱われる。

初磁化率の異方性 (anisotropy of magnetic susceptibility; AMS) を AGICO KappaBridge KLY-3 S magnetic susceptibility meter を用いて測定した。AMS は、個々の強磁性鉱物粒子の異方性と粒子配列の異方性を反映し、比較的簡便に大量の定量的なデータを取得できるため、歪解析や古流向解析、マグマの流動方向の解析などに広く利用されている。AMS は 2 階の対称テンソルで表現され、その三次元的形態は、楕円体で表される。楕円体の直交する 3 主軸の長さ (K_1 , K_2 , K_3 もしくは K_{max} , K_{int} , K_{min}) が基本的なパラメータとなる。 K_1 , K_2 , K_3 を用いて磁化率は、 $K_{mean} = (K_1 + K_2 + K_3)/3$ と表される。これら 3 主軸の値から異方性をどのように表現するかは多くの例があるが (Tarling and Hrouda, 1993)、本研究ではその中でもよく利用される、 P_j パラメータ [$= \exp \sqrt{2[(\ln K_1 - \eta_m)^2 + (\ln K_2 - \eta_m)^2 + (\ln K_3 - \eta_m)^2]}$], $\eta_m = \sqrt[3]{\ln K_1 \cdot \ln K_2 \cdot \ln K_3}$, 異方性の大きさを表す, Jelínek (1981)] と T パラメータ [$= (2 \ln K_2 - \ln K_1 - \ln K_3) / (\ln K_1 - \ln K_3)$], 異方性楕円体の形状を表す, Jelínek (1981)] を用いる。T パラメータは、 $-1 < T < 1$ の値をとり、負の場合は扁長、正の場合は扁平な AMS ファブリックをもつことを示す。

4. 実験結果

4-1. 特徴的残留磁化方位の決定

各地点の代表的な消磁結果を図 5 に示す。消磁結果を、消磁方法や残留磁化のふるまいに注目し、以下の 4 つに区分した。1) 段階熱消磁によって、最高アンブロッッキング温度 580 °C と 690 °C の 2 つの成分が認められた地点 (AS04, AS05; 図 5-1)。2) 段階熱消磁によって、580 °C 以下のアンブロッッキング温度をもつ、1 つの成分が認められた地点 (AS03; 図 5-2)。3) 段階熱消磁では ChRM を分離できなかったが、段階交流消磁によって 1 成分の ChRM を分離できた地点 (AS02, OK01; 図 5-3)。4) 段階熱消磁でも段階交流消磁でも、安定な ChRM を分離することができなかった地点 (AS01, AS04st, AS06; 図 5-4)。AS04 においては、岩相によって著しく異なる消磁結果が得られたため、頁岩の試料片を AS04、凝灰質砂岩の試料片を AS04st とした。AS04st ・ AS06 では、段階熱消磁によって、400~500 °C 程度で残留磁化がほぼ消磁され、高アンブロッッキング温度の安定成分が得られなかった (図 5-4; AS0611)。AS01 では、PAFD によって試料片ごとの ChRM を分離することはできたが、地点平均では特定の方向を示さず、 α_{95} の値が 100 ° を上回ったため、同時期に獲得した ChRM を分離できなかったと判断した。

AS04, AS05 においては、最高アンブロッッキング温度 580 °C (低温) と 690 °C (高温) の 2 成分の残留磁化が分離された (図 5-1) ので、低温成分に関しても高温成分と同様に方位決定を行った。石灰岩試料 (AS01, AS02, OK01) の段階熱消磁では、約 500 °C 以上で磁化強度が上昇し、残

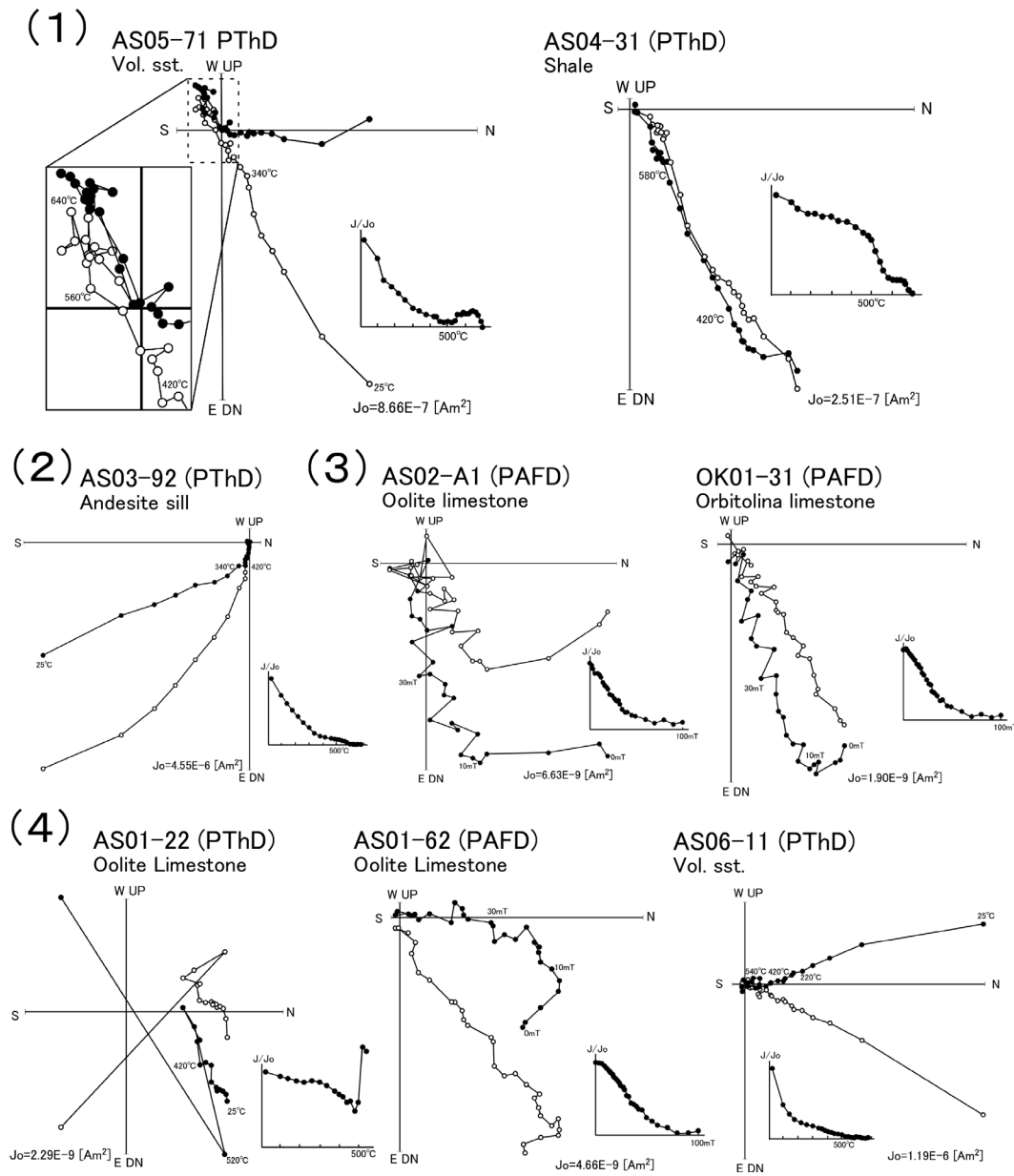


図5 代表的な段階熱消磁 (progressive thermal demagnetization; PThD) と段階交流消磁 (progressive alternating field demagnetization; PAFD) 結果 (傾動補正前)。ベクトル投影図の黒塗り円 (●) は水平面、白塗り円 (○) は N-S 鉛直面へのベクトル終点投影を示す。 J/J_0 は各段階での磁気モーメントの大きさを自然残留磁化 (natural remanent magnetization; NRM) で規格化したものを表す。(1) は段階熱消磁によって2つの安定な残留磁化成分が分離された地点。(2) は段階熱消磁によって1つの安定な残留磁化成分が分離された地点。(3) は段階交流消磁によって安定な残留磁化成分が分離された地点。(4) は安定な残留磁化成分が分離されなかった地点を示す。

Fig. 5 Representative results of progressive thermal demagnetization (PThD) and progressive alternating field demagnetization (PAFD) in *in situ* coordinates. Solid (open) circles on the Zijderveld diagrams represent the projection of vector end-points on the horizontal (N-S vertical) plane. J/J_0 shows relative intensity of magnetic moments for each demagnetization step, standardized by natural remanent magnetization (NRM). (1) representative sites in which two stable components are isolated by PThD. (2) representative site in which a stable component is isolated by PThD. (3) representative sites in which a stable component are isolated by PAFD. (4) representative sites in which no stable component are isolated.

留磁化方位がランダムに変化するふるまいが特徴的に認められた。石灰岩にしばしば含まれるシデライト (FeCO_3) は、実験室での加熱によりマグネタイトやヘマタイトに変化し、シールドルーム内であっても化学残留磁化 (chemical remanent magnetization; CRM) を獲得することが、Dunlop and Özdemir (1997) によって指摘されている。岩相が石灰岩である地点のうち、AS02, OK01 では段階交流消磁により ChRM を分離することができた。以上の検討の結果、ChRM が分離できた地点について、地点平均方位を求め、表 2 に示した。

4-2. Isothermal remanent magnetization 実験結果

IRM の段階着磁実験結果を、図 6 に示す。実験を行った 3 地点 (AS01, AS02, OK01) は同様の傾向を示し、僅かに中間～高保磁力成分が含まれているが、低保磁力成分 ($B_{1/2}=40\sim60$ mT) が支配的である。中間～高保磁力成分の磁化は全体の約 3 % 程度であり、残留磁化についても低保磁力で特徴づけられる強磁性鉱物が大半を担っていると考えられる。低保磁力成分の $B_{1/2}$ は、典型的なマグネタイトの保磁力 (~ 10 mT; Dunlop and Özdemir, 1997) よりも大きく、細粒で保磁力の高い単磁区サイズのマグネタイトが強磁性鉱物として主体をなす可能性を示唆している。

Lowrie (1990) の 3 軸 IRM の段階熱消磁結果を図 7 に示す。低保磁力成分 (~ 0.12 T) が支配的であり、その最高アンプロッキング温度は約 580°C である。これは、低保磁力成分を担う強磁性鉱物がマグネタイトであることを示唆している。中間保磁力成分 ($0.12\sim 0.40$ T) に関しても、最高アンプロッキング温度は、低保磁力成分と同じ約 580°C であり、中間

保磁力成分を担う強磁性鉱物もマグネタイトである可能性がある。IRM の段階着磁実験からも示唆された高い保磁力については、細粒マグネタイトの卓越を示唆していると考えられる。

4-3. 初磁化率の周波数依存性

段階熱消磁実験の各ステップで測定した初磁化率と、f-factor の値の変化を図 8 と図 9 に示す。石灰岩試料 (AS01, AS02, OK01; 図 8) においては、 500°C 付近まで測定値の変動が大きい (図 8-b)、これはバルク初磁化率の値が Bartington MS2 のノイズレベルに近いことで、計測誤差の影響を強く受けている可能性が高い。

石灰岩試料について、初磁化率が上昇した 500°C 以上では、f-factor の値も安定している (図 8-c)。これを見ると f-factor は、 500°C から 680°C に向かって単調に増加する傾向がみられる。これは、加熱により新たに析出した強磁性鉱物が、存在することを示唆している。

AS05 を除くその他の地点においても、 $500\sim 600^\circ\text{C}$ 付近から f-factor の上昇がみられた。注目すべきは、初磁化率の増減と f-factor の増減との間には必ずしも明瞭な相関が認められないことである (図 9)。f-factor の増加は、新たに析出した超常磁性領域の極微粒強磁性鉱物の存在を示す。一方、初磁化率の増加には新たに析出した強磁性鉱物が、初磁化率の減少には加熱による強磁性鉱物の変質が大きく関係しており、それらのバランスが初磁化率の増減を決定していると考えられる。したがって、新たに強磁性鉱物が析出している場合でも、試料片中の強磁性鉱物が増加することにより、初磁化率は減少し得る。

表 2 芦別地域に分布する空知層群・蝦夷層群の古地磁気方位
Table. 2 Paleomagnetic directions of Sorachi Group and Yezo Group in Ashibetsu area.

No.	Site name	N	Lithology	Dec.	Inc.	Untilted dec.	Untilted inc.	α_{95}	Demag. method
1	AS02	8	Oolite limestone	78.6	11.8	-6.3	56.8	8.5	PAFD
2	AS03m	7	Andesite sill	93.5	53.3	-73.3	38.3	10.0	PThD
3	AS04m	4	Shale	63.7	48.5	-43.8	27.6	6.1	PThD
4	AS04h	3	Shale	59.1	21.4	-13.6	38.5	4.5	PThD
5	AS05m	10	Vol. sst	62.9	51.1	-57.1	30.9	6.5	PThD
6	AS05h	7	Vol. sst	-119.7	-23.0	153.2	-46.7	2.9	PThD
7	OK01	7	Orbitolina limestone	68.6	31.5	-0.1	47.0	13.4	PAFD
formation-mean									
BC Group (No. 1, 4, 6, 7)		(4)		(66.8)	(22.1)	(-12.0)	(47.7)	12.3 (13.4)	
A Group (No. 2, 3, 5)		(3)		(72.8)	(61.8)	(-57.4)	(32.8)	20.8 (16.9)	

N, number of specimens (sites); Dec. and Inc., site (formation)-mean declination and inclination before tilt correction; Untilted dec. and Untilted inc., site (formation)-mean declination and inclination after tilt correction; α_{95} , radius of 95 % confidence circle, values before tilt correction are shown in parentheses; Demag. method, demagnetization method (PAFD is progressive alternating field demagnetization, PThD is progressive thermal demagnetization) adopted for each site.

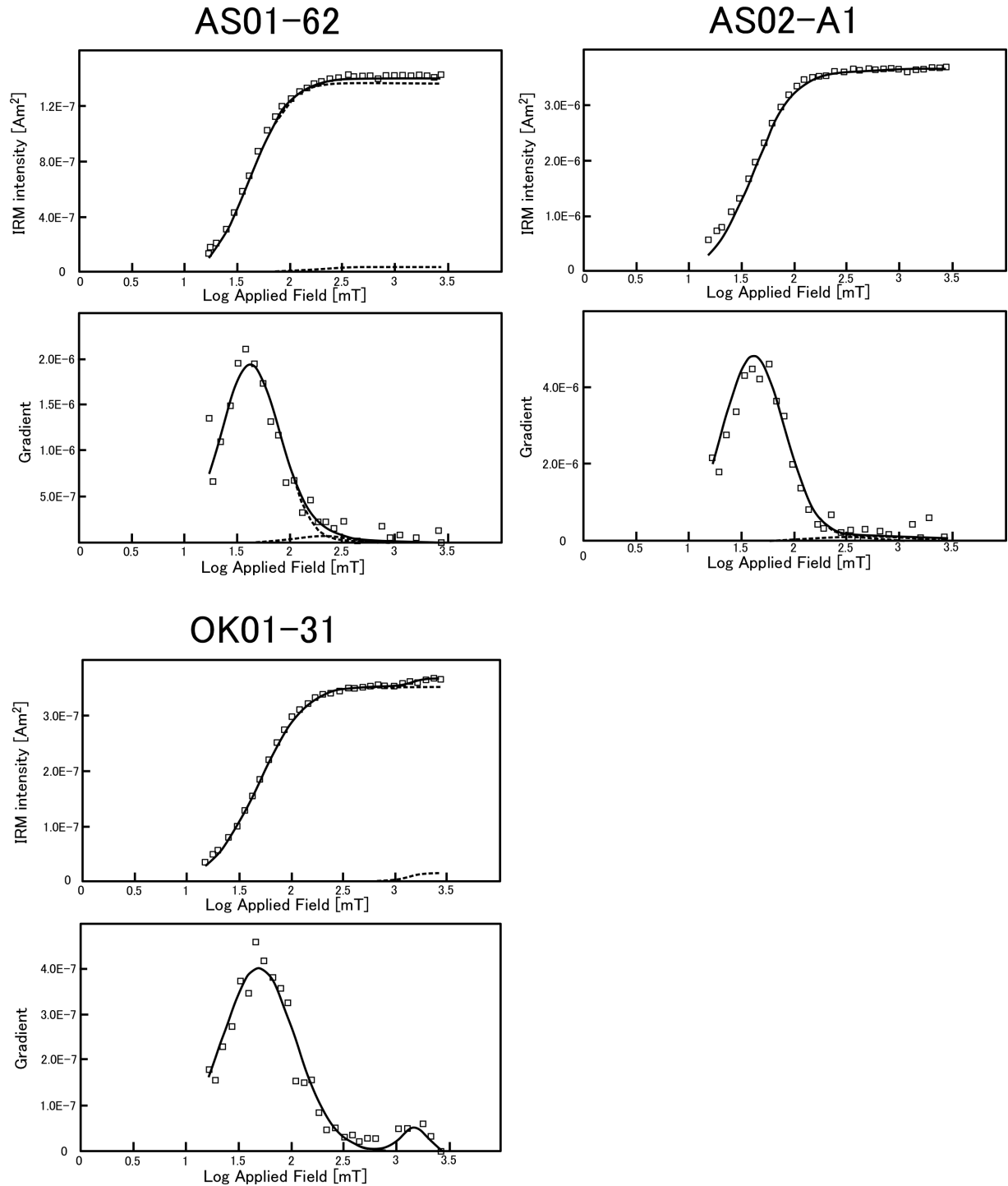


図 6 等温残留磁化 (isothermal remanent magnetization; IRM) の段階着磁実験 (Kruiver et al., 2001) 結果。シンボル ($\square$) は測定データ。実線は合計フィッティングデータ。破線は各フィッティングの各保磁力スペクトル成分。

Fig. 6 Results of progressive IRM acquisition experiments (Kruiver et al., 2001). Open squares are raw data, and broken (solid) lines are individual (total) fitting data, respectively.

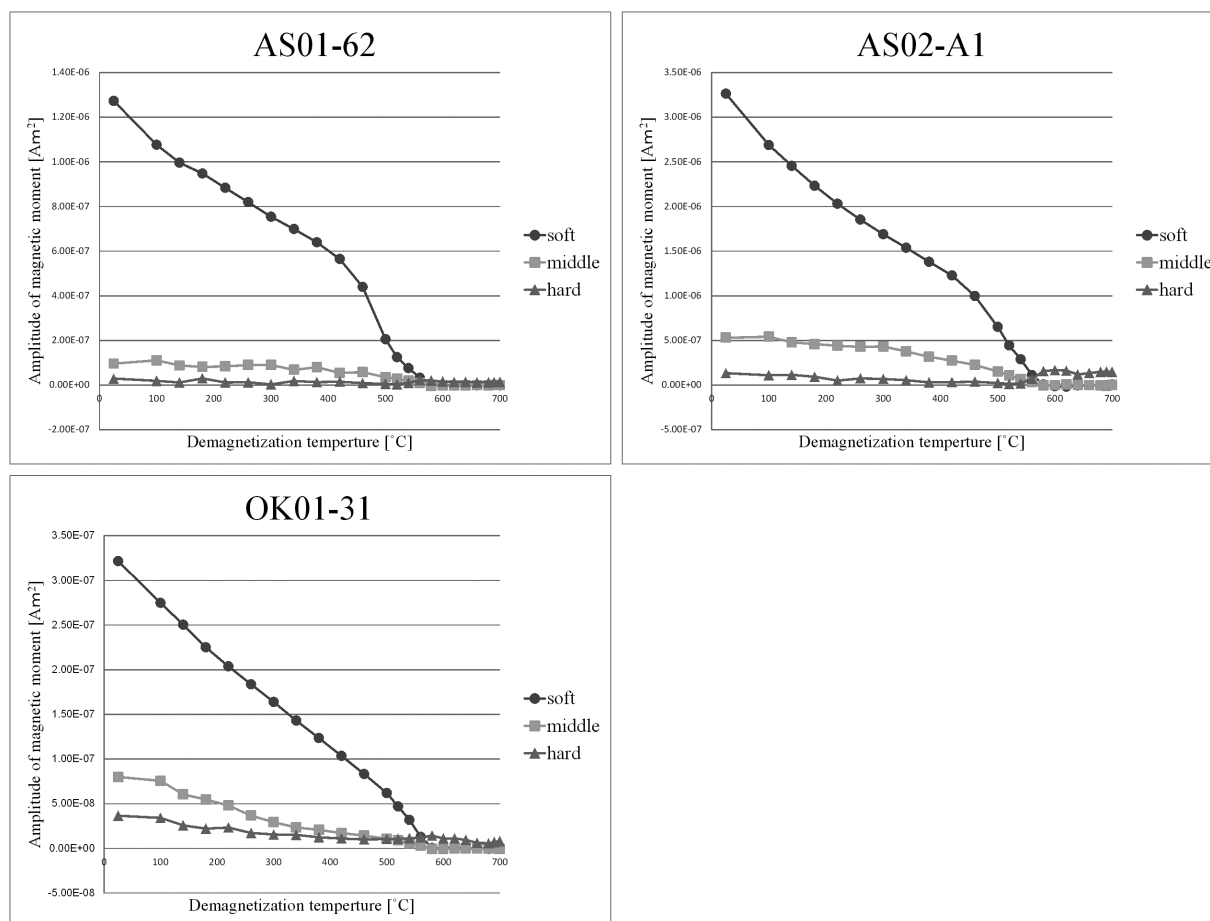


図7 直交3軸IRM (hard=3.0 T, middle=0.40 T, soft=0.12 T) の段階熱消磁実験 (Lowrie, 1990)。Hard成分が550 °C付近から増加しているのは、消磁途中に加熱などの影響により新たな磁化を獲得したためと思われる。

Fig. 7 Progressive three-axes IRM demagnetization experiment (hard=3.0T, middle=0.40T, soft=0.12T, Lowrie, 1990). Slight increase of hard component around 550°C is caused by chemical change of ferromagnetic minerals during repeated heating.

以上の結果は、初磁化率の周波数依存性が、新たな強磁性鉱物の析出についてバルク初磁化率とは別種の情報を与えるパラメータとなりうることを示している。

4-4. 初磁化率異方性

初磁化率異方性 (anisotropy of magnetic susceptibility; AMS) データを図10に表す。AMSは、鉄を含む鉱物粒子の配列方向を反映する。Tarling and Hrouda (1993)によると、一般に堆積岩においては、初期の堆積構造が保存されている場合、AMSの K_3 軸が地層面と垂直な方向に束縛され、AMSファブリックは扁平 ($T>0$) になる。AS02, AS04, AS05では、 K_3 軸が地層面と垂直に近く、堆積初期の構造を保持していることを示唆している。

5. 議 論

5-1. 特徴的残留磁化の起源

芦別地域の古地磁気試料片から得られた磁化方位は、段階消磁に対する特徴から3つのグループに分類される (図11)。1つ目は段階熱消磁によりChRMが分離された、最高アンブロッキング温度560~580 °CのAグループ (AS03m, AS04m, AS05m)、2つ目は段階熱消磁によりChRMが分離された最高アンブロッキング温度690 °CのBグループ (AS04h, AS05h)、最後に段階交流消磁によってChRMが分離されたCグループ (AS02, OK01) である。

Aグループ (AS03m, AS04m, AS05m) は、予察的に行った段階交流消磁においても、段階熱消磁と同様の成分が確認された。MDF (median destructive field) は10 mT以下

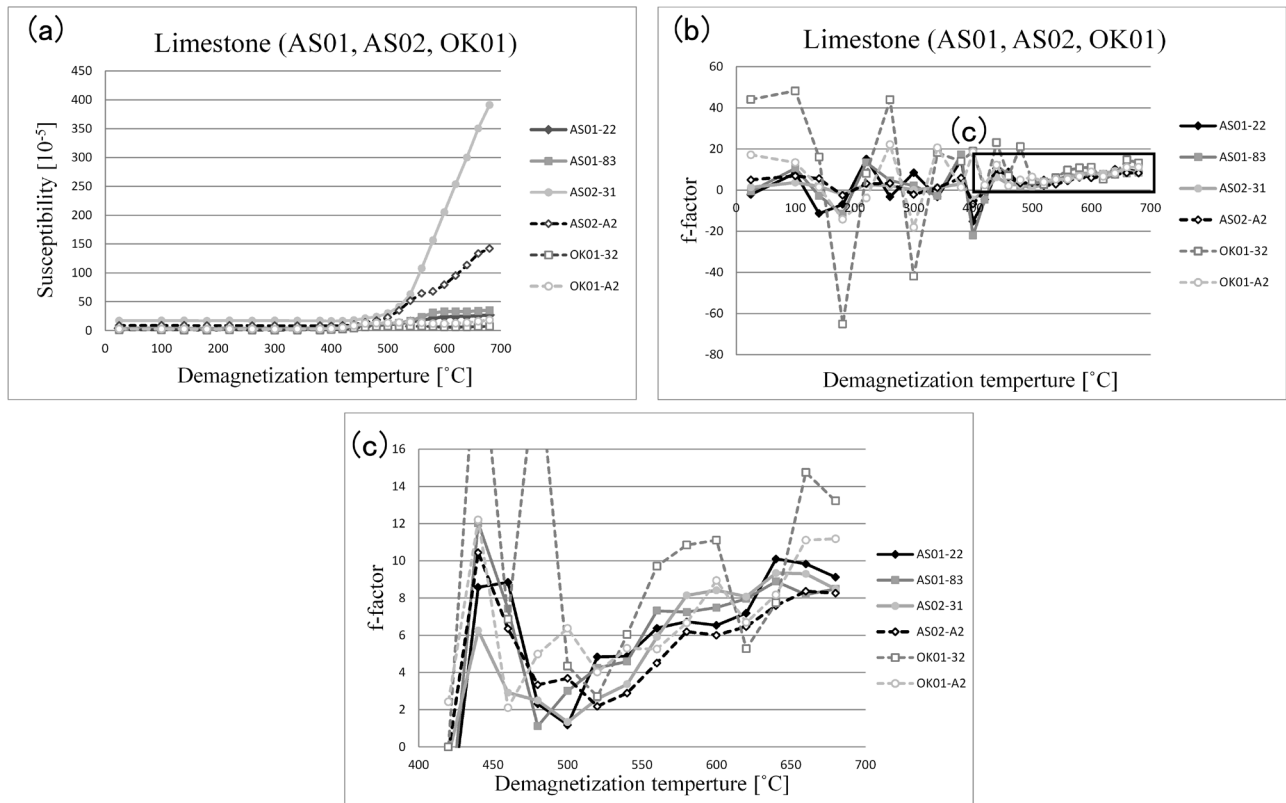


図 8 (a) 石灰岩試料 (AS01, AS02, OK01) の段階熱消磁中、各段階の初磁化率強度。 (b) f-factor [= $(\chi_{LF} - \chi_{HF}) / \chi_{LF} \times 100$; Heller et al. (1991)] の値。 (c) 高温領域の f-factor 拡大図。

Fig. 8 (a) Low-field susceptibility of limestone specimens (AS01, AS2, OK01) during progressive thermal demagnetization. (b) f-factor [= $(\chi_{LF} - \chi_{HF}) / \chi_{LF} \times 100$; Heller et al. (1991)] of limestone specimens. (c) enlarged f-factor changes in high temperature treatments.

であったことと、最高アンブロッキング温度が 560~580 °C であることから、残留磁化を担う強磁性鉱物はマグネタイトあるいは Ti に乏しいチタノマグネタイトであると考えられる。

B グループ (AS04h, AS05h) はその最高アンブロッキング温度 (約 690 °C) から、残留磁化を担う強磁性鉱物はヘマタイトであると考えられる。

C グループの試料は、以下の特徴をもつ。1) 石灰岩からなる、2) IRM の段階熱消磁実験の最高アンブロッキング温度は約 580 °C であった、3) MDF は 10~30 mT 程度であり、IRM の着磁実験では $B_{1/2}$ =40~60 mT であった。以上のことを踏まえると、残留磁化を担う強磁性鉱物は、保磁力の高い単磁区サイズのマグネタイトであると考えられる。

全地点の平均方位を求めるにあたり、B グループと C グループをまとめたものを、BC グループとし全地点平均方位 (formation-mean direction) を求めた (表 2、図 12)。A グループ

(AS03m, AS04m, AS05m) では、傾動補正後の集中度パラメータ k (Fisher, 1953) は減少し (図 12)、McElhinny (1964) の統計テストも不合格であった。BC グループでは、傾動補正後に集中度パラメータ k の値は改善されている。これは BC グループの残留磁化が、傾動前に獲得したものであることを示唆している。また、正帯磁・逆帯磁のほぼ反平行な地点平均方位が得られており、逆転テスト (McFadden and Jones, 1981) に合格した。したがって、BC グループの全地点平均方位は、地球磁場の永年変化を平均化しているものと解釈できる。以上の結果より、BC グループの残留磁化は、初生的あるいは初生的に近い磁化であると解釈し、以下の議論を進める。

5-2. 北方移動量の見積もり

全地点平均方位は、傾動補正後に、 $D = -12.0^\circ \pm 18.5^\circ$ 、 $I = 47.7^\circ \pm 12.3^\circ$ 、 $\alpha_{95} = 12.3^\circ$ となった。 ΔD は、信頼限界円の半径 (α_{95}) と伏角 I を用いて、 $\Delta D =$

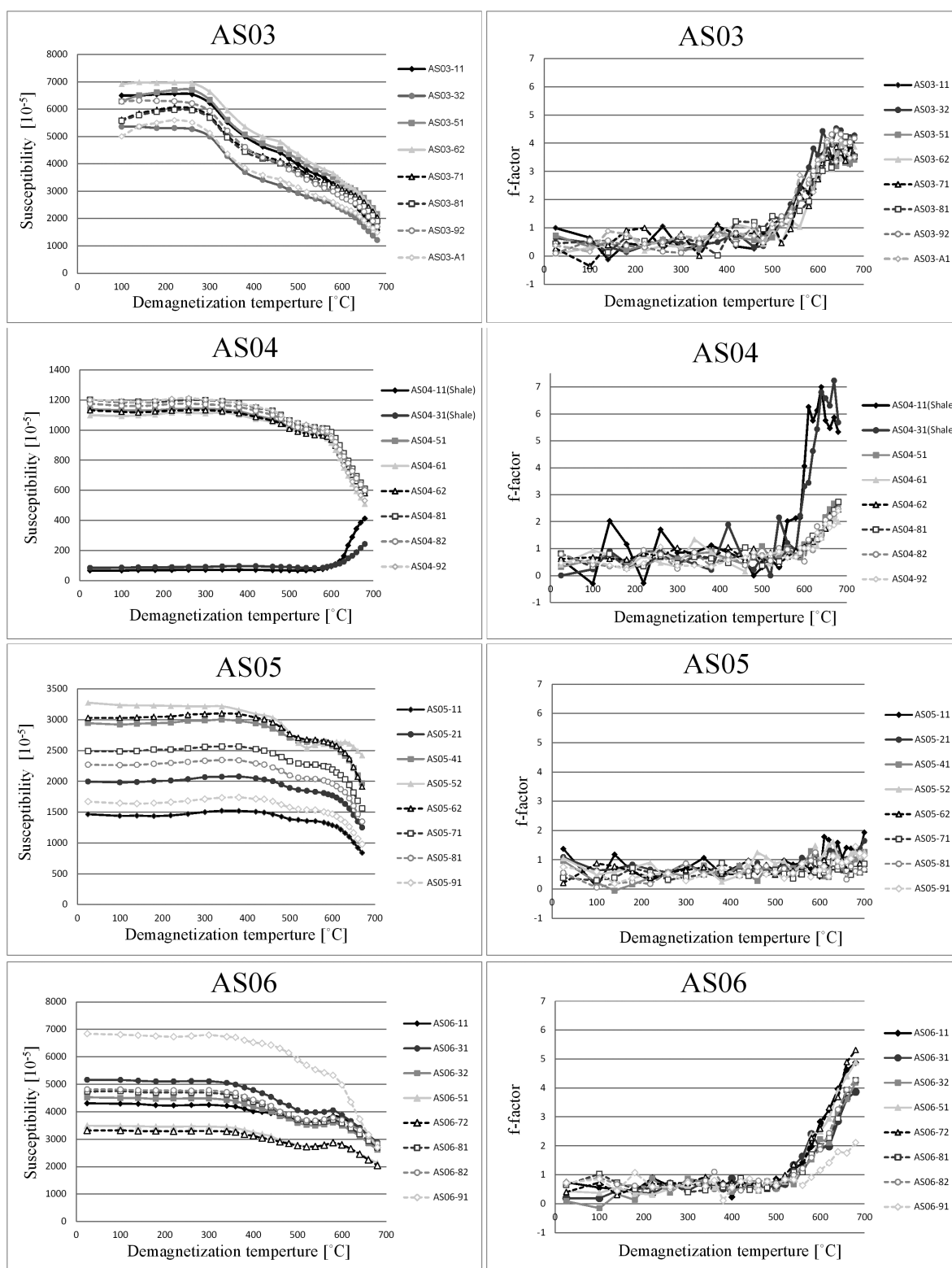


図9 段階熱消磁中各段階での初磁化率と f-factor (Heller et al., 1991) の値。
 Fig. 9 Low-field susceptibility and f-factor (Heller et al., 1991) during progressive thermal demagnetization.

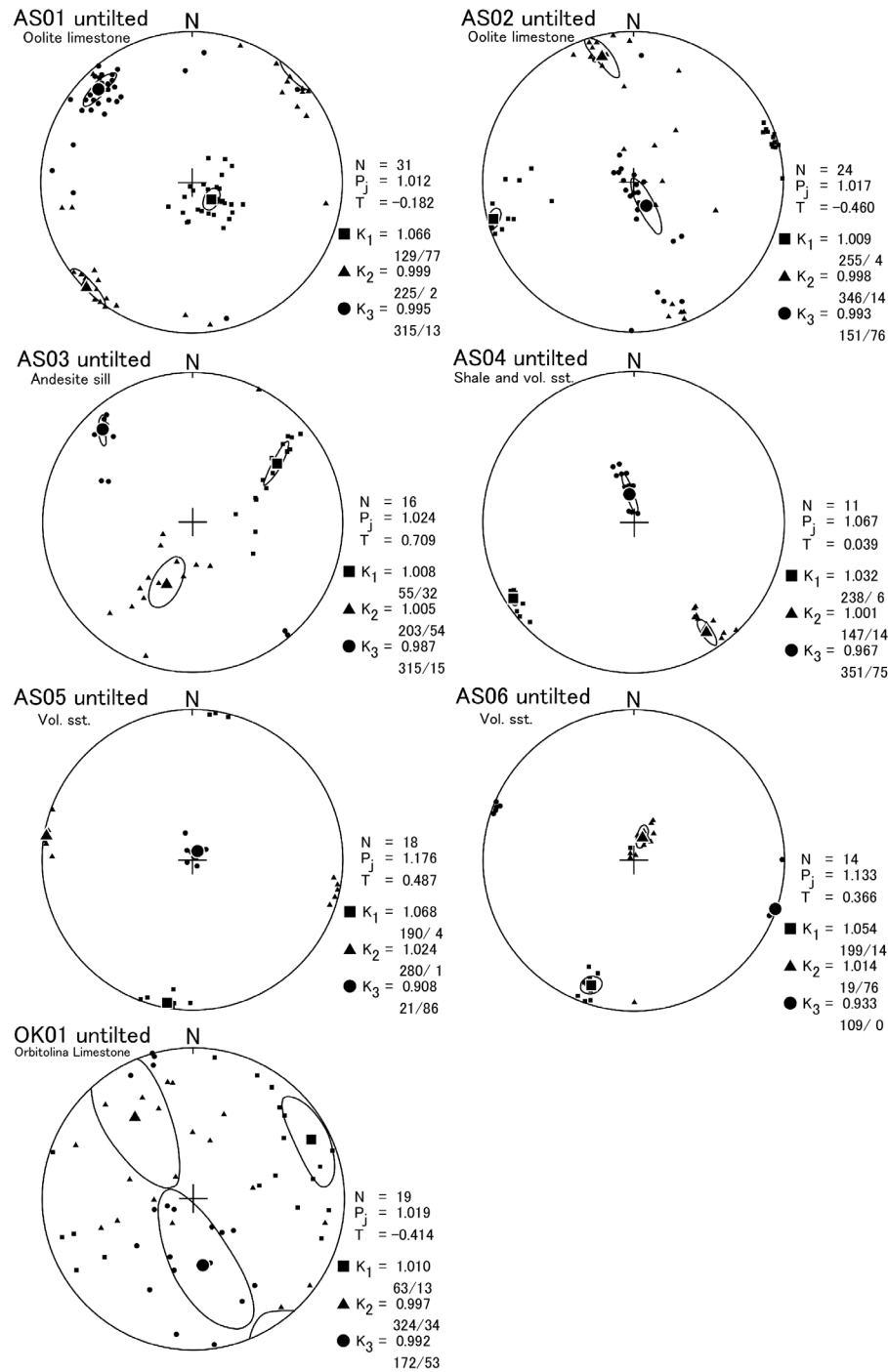


図 10 初磁化率異方性 (anisotropy of magnetic susceptibility; AMS) データ (傾動補正後) を等面積投影図上に表したものの。K₁, K₂, K₃ は異方性を表す楕円体の直交する 3 主軸の方向と、3 主軸の大きさの平均で規格化した各軸の長さを表す。実線楕円は 95 % 信頼限界 (Bingham, 1974) を表す。N, 試料片数; $P_j = \exp \sqrt{2[(\ln K_1 - \eta_m)^2 + (\ln K_2 - \eta_m)^2 + (\ln K_3 - \eta_m)^2]}$, $\eta_m = \sqrt[3]{\ln K_1 \cdot \ln K_2 \cdot \ln K_3}$, 異方性の大きさを表すパラメータ; $T = (2 \ln K_2 - \ln K_1 - \ln K_3) / (\ln K_1 - \ln K_3)$, 形状パラメータ。

Fig. 10 Three principal axes of anisotropy of magnetic susceptibility (AMS) on equal-area projection after tilt correction. K₁, K₂, K₃ are principal axes of the magnetic susceptibility ellipsoid, and their value is normalized by average of them $[(K_1 + K_2 + K_3)/3]$. Solid oval is 95 % confidence limit (Bingham, 1974). N, number of specimens; $P_j = \exp \sqrt{2[(\ln K_1 - \eta_m)^2 + (\ln K_2 - \eta_m)^2 + (\ln K_3 - \eta_m)^2]}$, $\eta_m = \sqrt[3]{\ln K_1 \cdot \ln K_2 \cdot \ln K_3}$, degree of anisotropy; $T = (2 \ln K_2 - \ln K_1 - \ln K_3) / (\ln K_1 - \ln K_3)$, shape parameter.

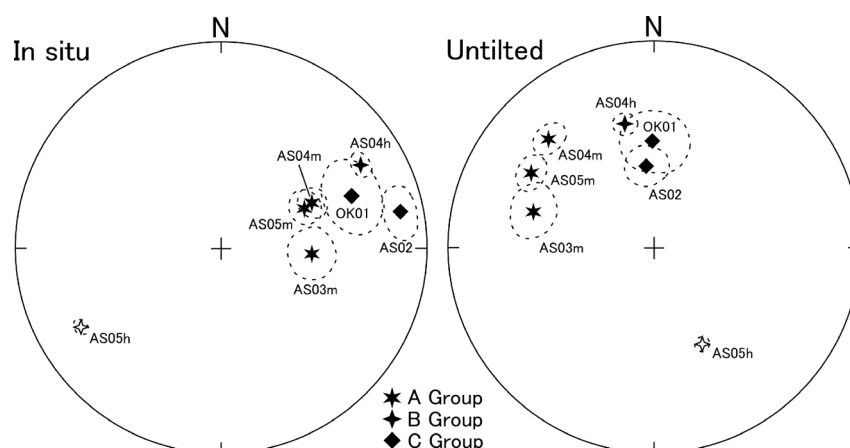


図 11 傾動補正後と傾動補正前の地点平均方位を等面積投影図上に表したものの。黒塗りは下半球への投影、白塗りは上半球への投影を表す。破線楕円は 95 % 信頼限界を表す。六稜星(★), A グループ; 四稜星(◆), B グループ; 菱形(◇), C グループ。

Fig. 11 Site-mean directions in *in situ* and untilted coordinates on equal-area projections. Solid (open) symbols are on the lower (upper) hemisphere. Broken ovals are 95 % confidence limits. Six-pointed stars, A Group (AS03m, AS04m, AS05m); four-pointed stars, B Group (AS04h, AS05h); diamonds, C Group (AS02, OK01).

$\arcsin(\sin \alpha_{95}/\cos l)$ から求められる。 Δl は α_{95} に等しい。期待される地磁気方位と、観測された残留磁化方位の比較に際し、Beck (1980) の定義より、時計回り回転量 $R = D_{\text{observed}} - D_{\text{expected}}$ ($\Delta R = (\sqrt{\Delta D_{\text{observed}}^2 + \Delta D_{\text{expected}}^2})$)、南北偏距 $F = I_{\text{expected}} - I_{\text{observed}}$ ($\Delta F = \sqrt{\Delta I_{\text{expected}}^2 + \Delta I_{\text{observed}}^2}$) を用いる。

比較には、データがカバーする時代と地域の範囲が十分であり、初生磁化の認定が厳密に行われ、ユーラシア大陸の複数ブロックの衝突した時期が明瞭に記されている研究として、Gilder and Courtillot (1997) を用いた。Gilder and Courtillot (1997) によると、北中国ブロックと南中国ブロックの衝突は中期ジュラ紀には完了し、これらのブロックを含むユーラシア東部は、白亜紀には現在とほぼ同じ位置に達していたとしている。そのため、本研究では、Gilder and Courtillot (1997) による、白亜紀の北中国ブロックにおける仮想地磁気極から予測される地磁気方位と、今回得られた残留磁化方位を比較した。その結果、時計回り回転量 $R = -26.8^\circ \pm 20.7^\circ$ 、南北偏距 $F = 18.0^\circ \pm 13.2^\circ$ が得られ、有意な北方移動を被っていることが示された (表 3)。

北海道中央部では過去に蝦夷層群を対象とした古地磁気学的研究が行われている (Tamaki and Itoh, 2008; Tamaki et al., 2008)。図 13 に、周辺から報告されている空知層群・蝦夷層群の古地磁気方位と、本研究の古地磁気方位との南北偏距・年代の比較を示す。比較に用いたデータは表 3 に示す。図 13 をみると、白亜紀の古地磁気データは、大夕張

(Tamaki and Itoh, 2008) を除く 3 地域で、有意な北方移動量を示していることがわかる。夕張～南長沼地域で報告されている後期始新世～前期漸新世の古地磁気方位 (Tamaki et al., 2010) は、現在の地球磁場方位から予想される伏角と同程度の値を示しており (表 3)、北海道中央部は少なくとも後期始新世には、現在と同程度の緯度に位置していたものと思われる。

本研究データの伏角から計算される北方移動量は、 2100 ± 1500 km となる。これは、Takashima et al. (2006) や田沢 (2004) で示される移動量と調和的である。一方、Otsuki (1992) から推測される北方移動量と比較すると 2100 km という値は明らかに大きい (図 2)。北海道中央部から得られている古地磁気データを説明するためには、より大規模な北方移動量を想定する必要がある。

Kimura et al. (1994) によると、空知層群は太平洋赤道付近で形成され、その後イザナギプレートの運動に伴って北上し、110 Ma 頃には、ユーラシア東縁に衝突する。Kimura et al. (1994) のモデルから予想される南北偏距との比較を図 13 に示す。図を見ると、プレート上のブロックの北方移動は、前期白亜紀の間に急速に起こっており、奈江地域・大夕張地域・芦別地域の古地磁気データと調和的である一方、浦河地域のデータとは矛盾する。これは、北海道中央部が異なるブロックから構成されていることを示唆している。

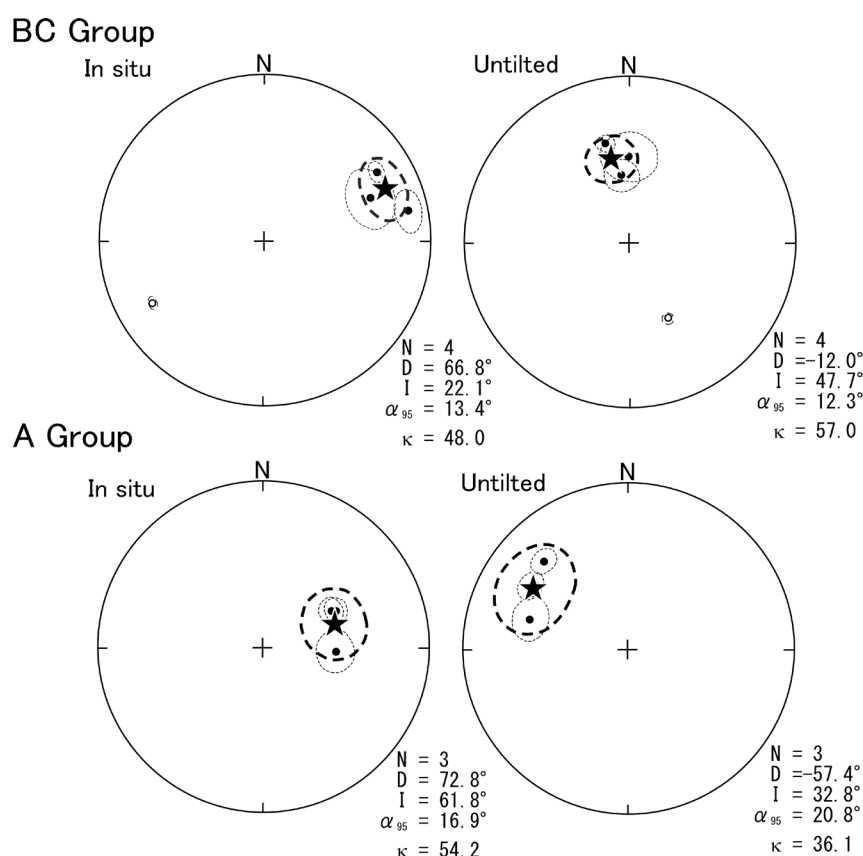


図 12 傾動補正前（左）と傾動補正後（右）のサイト平均方位を等面積投影図上に表したものである。黒塗り（白塗り）は下半球（上半球）への投影を表す。円は地点平均方位、星印は全地点平均方位を示す。太い破線楕円は全地点平均方位（formation-mean direction）の 95 % 信頼限界、細い点線楕円は地点平均方位（site-mean directions）の 95 % 信頼限界を示す。BC グループは、AS02, AS04h, AS05h, OK01 からなり、C グループは AS03m, AS04m, AS05m からなる。N, 地点数; α_{95} , 95 % 信頼限界円の半径; κ , 集中度パラメータ（Fisher, 1953）。

Fig. 12 Site-mean directions and a formation-mean direction in *in situ* (left) and untilted (right) coordinates on the equal-area projection. Solid (open) symbols are on the lower (upper) hemisphere. Circles show site-mean directions and a star shows formation-mean direction. Thick (thin) broken (dotted) ovals are 95 % confidence limits of formation-mean (site-mean) directions. The BC Group consists of AS02, AS04h, AS05h and OK01. The A Group consists of AS03m, AS04m and AS05m. N, number of sites; α_{95} , 95 % confidence limit; κ , precision parameter (Fisher, 1953).

表 3 北海道中央部における後期ジュラ紀から古第三紀の古地磁気データ
Table. 3 Upper Jurassic ~ Paleogene paleomagnetic data from central Hokkaido.

Area	Age	D [°]	I [°]	α_{95} [°]	F [°]	R [°]	Reference pole	Reference
Yubari and Minaminaganuma	Late Oligocene	32.4	67.4	13.3	3.4±14.1	33.2±38.8	Eurasia	Tamaki et al. (2010)
	Late Eocene~Early Oligocene	8.4	58.1	7.4	12.7±8.7	9.2±18.7	Eurasia	Tamaki et al. (2010)
Urakawa	Campanian	-146.6	31.0	15.4	34.7±16.1	-161.5±20.3	NCB	Tamaki et al. (2008)
Oyubari	Cenomanian/Turonian	7.5	65.9	6.6	-0.2±8.1	-7.3±18.8	NCB	Tamaki and Itoh (2008)
Ashibetsu	Berriasian~Aptian	-12.0	47.7	12.3	18.0±13.2	-26.8±20.7	NCB	This study
Nae	Tithonian~Barremian	-34.0	40.9	22.3	24.8±22.8	-48.8±31.5	NCB	Hoshi and Takashima (1999)

F and R, inclination flattening ($=I_{\text{expected}} - I_{\text{observed}}$) and clockwise rotation ($=D_{\text{observed}} - D_{\text{expected}}$) (Beck, 1980). Reference pole: NCB (North China Block), Gilder and Courtillot (1997) (Cretaceous, 78.6 °N, 202.6 °E, $A_{95} = 6.2$ °); Eurasia, Besse and Courtillot (1991) (30~50 Ma, 78 °N, 140 °E, $A_{95} = 7$ °)

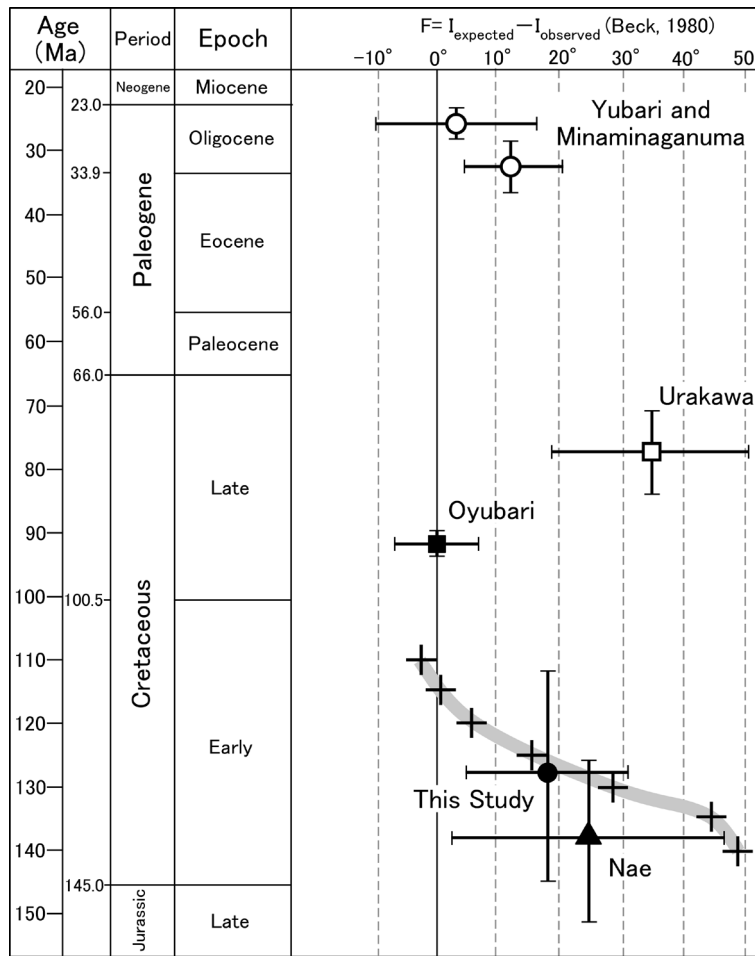


図 13 北海道中央部での、古地磁気学的研究から見積もられる南北偏距 $F (=I_{\text{expected}} - I_{\text{observed}}; \text{Beck, 1980})$ と年代をプロットしたもの。十字のシンボル (+) と灰色の太線は、Kimura et al. (1994) のモデルから見積もられる南北偏距。黒塗り三角 (▲), 奈江地域 (星・高嶋, 1999); 黒塗り円 (●), 芦別地域 (本研究); 黒塗り四角 (■), 大夕張地域 (Tamaki and Itoh, 2008); 白塗り四角 (□), 浦河地域 (Tamaki et al., 2008); 白塗り円 (○), 夕張～南長沼地域 (Tamaki et al., 2010)

Fig. 13 Plot of inclination flattening ($F = I_{\text{expected}} - I_{\text{observed}}; \text{Beck, 1980}$), estimated by paleomagnetic studies, versus age for the central Hokkaido. Cross symbols and thick gray line is northward block transportation estimated from Sorachi-plateau model (Kimura et al., 1994). Solid triangle, Nae area (Hoshi and Takashima, 1999); solid circle, Ashibetsu area (this study); solid square, Oyubari area (Tamaki and Itoh, 2008); open square, Urakawa area (Tamaki et al., 2008); open circle, Yubari and Minaminaganuma area (Tamaki et al., 2010).

6. まとめ

(1) 北海道中央部の芦別地域に分布する空知層群・蝦夷層群の火山碎屑物からなる砂岩・頁岩・安山岩・石灰岩試料について古地磁気測定を実施した。段階熱消磁・段階交流消磁によって分離された安定残留磁化のうち、褶曲テストによって、4地点から初生的な磁化成分を決定することができた。

(2) NRM の段階消磁実験と IRM の着磁・消磁実験の結果、

初生的残留磁化の担い手は、ヘマタイトと細粒なマグネタイトであることが示された。

(3) 段階熱消磁中のバルク初磁化率値は、繰り返し加熱による強磁性鉱物の変化と新たに析出した強磁性鉱物のバランスに影響されるのに対し、初磁化率の周波数依存性パラメータは、新たに析出した超常磁性粒子サイズの強磁性鉱物の存在比を示す。これら2つの測定データは、異なる情報を提供してくれると考えられる。

(4) 安定な残留磁化成分の傾動補正後の伏角は、東アジ

アの同時期の仮想地磁気極から計算される伏角に対し有意に浅く、北方移動量は 2100 ± 1500 km と見積もられる。

(5) 周辺地域を対象とした古地磁気データとの比較の結果、北海道中央部は前期白亜紀に急激な北方移動を被っており、少なくとも2つの異なるブロックが存在することが示唆された。

7. 謝 辞

京都大学人間・環境学研究科自然環境動態論講座の石川尚人教授には、岩石磁気実験室の使用に関して各種の便宜を図っていただくとともに、古地磁気データの意義について貴重なコメントをいただきました。ここに記して、深謝いたします。

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Standard use-wear chart of TUMRT (2): Microflaking (2)

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INTRODUCTION

The present paper is the second part of the results of microflaking analysis by Tohoku University Microwear Research Team (TUMRT). It is the continuous and expanded explanation of standard identification criteria of a category of use-wear traces, that is, microflaking. The part 1 was published in the Bulletin of the Tohoku University Museum, No. 13 (Akoshima and Hong 2014). The present article is to be utilized with part 1 which is available through the Tohoku University Library website (TOURS). Part 1 mainly explains overall experimental framework of microflaking analysis by TUMRT, typical patterns of microflaking scar appearance, and variables in experimental control.

Part 2 here expands the range of microphotographs in order to accommodate various different appearances of microflaking scar patterns which are observable on actual experimental artifacts. The reader may recognize representative chipping phenomena (flaking phenomena) and the varieties of chipping scars which are observable on the same working edges used in the same task (the motion and the worked materials). Part 2 also explains the method of analyzing the actual wide range of microflaking varieties by counting frequencies and classifying attributes of chipping scars. Methodological explanation is presented with tables and graphs for the basis of statistical analysis of flaking scar variability, as was already summary published in Japanese (Akoshima 1981) and English (Akoshima 1987).

The theoretical basis of the present article is experimental archaeology as one realm of “Middle Range Research” by Binford (1981, pp.21-30, 1983, pp.19-30, ed. 1977, pp.1-10). Binford argues that all archaeological records exist in the present world and also in the shape of static facts. It is necessary to transform archaeological facts into statements about the past. The criteria of adequate interpretation derive from “actualistic” studies where movements of cultural systems and resultant static facts from them both can be observed in real cases. Such a situation might be studied in three fields of research, that is, ethno-archaeology, experimental archaeology, and historical archaeology. Our lithic use-wear study duly purports to this epistemological

premise in that “actualistic” situations in the controlled experiments provide concrete basis for interpretations of static microwear traces which are existent on the surface of stone artifacts excavated in the present world.

We reiterate here that the study of prehistoric lithic artifacts entails three fundamental realms of research, namely, typological, technological, and functional analysis. All these areas of course need to establish robust methods of meaning assignment in the sense of Binford, to any patterns in archaeologically observed records. In the case of the use-wear analysis, experimental replication plays critical roles for bridging arguments between wear patterns and human activities, in other words, between the statics and the dynamics. It is essentially important to construct extensive databases of experimental use-wear formation for the purpose of reliable interpretation of archaeological patterns.

A prevalent problem lies in the gap or discrepancy between experimentally produced use-wear patterns and actually excavated archaeological patterns. Binford recognizes that this sort of ambiguity would be the cause of learning for scientists (Binford 1987). Use-wear patterns on experimental artifacts do not always coincide with archaeological wear patterns. Empirical archaeologists in favor of inductive reasoning often criticize experimental use-wear study because of this discrepancy and ambiguity, for example, in the history of Japanese archaeology in 1970s (c.f., Akoshima 2008). However, we are aware that fundamental linkage between stone tool using activities and resultant wear patterns had to be constructed as prerequisite to reliable behavioral reconstruction.

EXPERIMENTAL DATABASE

The present paper continues to introduce essential criteria of micro-wear interpretation accumulated by TUMRT since 1976. The team was initiated by the late Prof. Chosuke Serizawa and has been active up to the present (for its history, e.g. Akoshima 2008). This is to be the second of a series of presentations resulting from the TUMRT inferential criteria. We apologize for not having presented our inferential standards due to various circumstances in

our Tohoku University Archaeological Laboratory since 1983, even if we were repeatedly requested to publish openly our criteria for functional interpretation especially by use-wear analysts nationwide. The data presented here focus on characteristics of replicated microflaking scar patterns. Although our inferential method of microflaking was published in summarized way (e.g., Akoshima 1981, 1987, 1989), and a number of actual analysis of excavated artifacts have been conducted widely in Japan, basic database for interpretation has yet to be fully presented. We hope the microphotographs presented in this volume will assume a role of standard use-wear chart for references.

The database presented here is a part of the first series of TUMRT project directed by Serizawa. Microflaking data were analyzed by Akoshima (Akoshima 1981, 1989) and the data have been utilized by TUMRT members since then. Microphotographs were printed and served on file at the Department of Archaeology, Faculty of Arts and Letters.

The procedure of photographic data presentation in the present publication is the same as our previous "Part 1" report (Akoshima and Hong 2014), so only short descriptions are repeated here for readers' reference. The paper photo-micrographs in the TUMRT file were scanned at 600 dpi and colour digitized for adjusting gray tones. For the Part 1 report, representative images were chosen for presentation of "typical microflaking patterns", but here wider varieties of microflaking patterns are shown for better recognition of overall wear patterns. By referring the present data and previous data, the range of flaking patterns are roughly knowable.

On the other hand, the microflaking scars were numerically described in statistical graphs in Akoshima (1987, after 1981). Thus, the pictures compiled here are the photographic version of inferential criteria. The data are the same, but their expression is different. (They are shown as Figure 1 to Figure 28 in the previous volume, and as Figure 36 to Figure 88 for the present volume. In addition, from Figure 29 to Figure 35, explanatory remarks and calculating methods are provided for more concrete understanding of microflaking phenomena.) Microphotographs are arranged in the order from working soft materials (meat, rawhide, leather, soft plant) to medium (wood, bamboo), to hard materials (bone, antler). Within the category of similar hardness, they are sub-divided and arranged by the method of use, from parallel motions (cutting, sawing) to perpendicular motions (scraping, whittling).

The raw materials in the experimental project were the shale collected from the riverbed of the Mogami River in Sagae City, Yamagata Prefecture. It is notable that the shale in the Japanese terminology of lithic analysis denotes a type of fine grained sedimentary rock with breaking feature of conchoidal fracture. The rock type was in wide use

throughout prehistory in northeastern part of the Honshu Island of Japan. Out of about 160 experimental artifacts, 80 specimens were photo-presented in this volume, including the same specimens in the previous volume. They are flake tools utilized without any secondary retouch along the edge. Thus, the micro-sized scars seen on these photos are produced exclusively by utilization. They are presented with the scale bar for 2 mm, because the size of microflaking scars has concrete relationships with the hardness of the worked materials and the direction of use motion (Akoshima 1981).

The order of presenting these photographic data is as follows. Basically, they are arranged so that the general patterns of groups of microflaking scars are recognized according to the numerical presentation as in Akoshima (1987). The Figures are captioned with the category of worked materials and working edge motions. From Figure 36 on, they are shown in the following order (the same order as Akoshima and Hong 2014). It is presented here again for quick reference of the reader :

1. Meat, 1.1 cattle (beef), 1.2 pig (pork), 1.3 lamb (mutton), 1.4 duck, 1.5 chicken
2. Plant, 2.1 grass, 2.2 wheat crop, 2.3 rice crop, 2.4 reed, 2.5 pampas grass
3. Hide, 3.1 rawhide, 3.2 half dried hide, 3.3 dry hide
4. Wood, 4.1 paulownia, 4.2 cedar, 4.3 pine, 4.4 alder, 4.5 zelkova, 4.6 others
5. Bamboo
6. Gourd
7. Shell
8. Bone, 8.1 raw, fresh, 8.2 wet and boiled, 8.3 boiled
9. Antler, 9.1 soaked, 9.2 dry, 9.3 others

For the third digit of each photo caption number, the type of motion in use is indicated as follows.

- Longitudinal, -1 cutting, -2 sawing
 Transversal, -3 whittling, -4 scraping
 Varied, -5 chopping, -6 butchering
 Incising, -7 graving

Microphotographs were taken using a macro-photo equipment of Olympus OM-2 camera system. The magnification shown in the caption is at the time of photography.

In the photo caption, "d" means the dorsal surface, while "v" means the ventral surface (the main flake surface) of the working edge of the experimental flake.

NUMERICAL AND PHOTOGRAPHIC EXPRESSIONS

For the analysis of microflaking scars, a variety of attributes were recorded and classified. A total of 3840 flaking scars were counted one by one and recorded for 72 specimens. They were statistically investigated and summary

published in Akoshima (1981). Major attributes of analytical interests include the shape of microflaking scar, the size of microflaking scar, the initiation of microflaking scar breakage, the termination of microflaking scar breakage, the density of microflaking scar per centimeter, the degree of concentration of scars to one face of the tool, ventral or dorsal. The summary of conducted experiments is shown in Table 1 to Table 3 in the previous report (Akoshima and Hong 2014). Also, other than the information in the table for each controlled experiment, thirty conditions were recorded on experiment recording sheets which are available on file at Tohoku University. Experimental recording system was presented in the previous report and not repeated here.

Actual appearances of microflaking are rich in variety even along one working edge, but there are portions which are evaluated as representing typical patterns. For each experiment, two micro-photos are selected, one on dorsal aspect and one on ventral aspect. They are presented as Figure 1 to Figure 28 in our first report, as basic representation of scar patterns. Explanation of identifying scar patterns is given in Figure 29. Scar patterns are more adequately recognized when they are analyzed collectively as a group of numerous scars. A method of recognizing numerical attributes as statistical graphs is presented. Six cases are explicated from Figure 30 to Figure 35, namely for soft, medium, hard worked materials in longitudinal and transverse motions. In order to recognize actual variations in chipping scar patterns, other micro-photos of the same experiment are abundantly shown from Figure 36 to Figure 88.

IDENTIFICATION OF MICROFLAKING SCARS

Microflaking is, needless to say, a microscopic version of flaking that occurs to conchoidally fracturing rocks. The mechanical principles involved in the fracturing process of microflaking is expected to be essentially the same as that in manufacturing process of lithic artifacts. Classification in general, in a sense, ignores diversity existing among classified objects or phenomena. Classification of microflaking in order to get quantitative data is of course no exception. Each microflaking scar has individual characteristics that would be disregarded when it is classified into a type, or categorized coding. In order to alleviate this missing feature, microphotographs were taken and presented, rather than simply categorizing scars into types. The diversity of microflaking scars is evaluated from them. It should be borne in mind, however, that these microphotographs do not necessarily represent all types of microflaking that occurred on the edge of flakes that were used in the particular work.

Microphotographs only partially exhibit the area ranging

over a few millimeters depending on the magnification, while a working edge usually spans as long as several centimeters or more. However in spite of the areal limitations, distinctive patterns are recognized in many cases. In Figure 29, three microphotographs are shown for soft, medium, and hard worked materials as was mentioned above. Over the photographed area, examples of description of the scars are presented as characterizing scar patterns. In the photos, thin white lines indicate each identified flaking scars. They are of course overlapped with one another and formerly produced scars are crosscut by later formed scars. The formerly produced scars changed their shapes accordingly.

ATTRIBUTES AND GRAPHIC PATTERN RECOGNITION

Every experimental specimen was observed for all the resultant microflaking scars. They were recorded one by one for attributes such as shape and size. They were then counted as cross tabulation (Figure 30 to 35 for the left side tables). Numbers cross tables were converted to bar graph diagrams for scar pattern recognition (Figure 30 to 35 for the right side bar graphs). Here 6 cases are explained as examples of collective scar patterns due to limitation of space. In this analysis, actually 72 numerical tables and graph diagrams were made, and they indicate that concrete patterns virtually exist among microflaking. The patterns are partially presented as statistical tendencies as were described in Akoshima (1981), in such expression as “degree of concentration of scars to ventral aspect”.

The analyzed attributes are as follows. They are, so to speak, characterization as collective group of scars by making combined bar graphs from cross tabulations of attributes type categorization.

The Shape of Microflaking

The “shape” is the horizontal shape of the microflaking scar. Although there are many intermediate shapes, they are classified into the following “shapes”. Their variations were illustrated in Akoshima (1981, p.10).

“Scalar” (“S”). Semi-circular shape and its variations.

“Rectangular” (“R”). Either side of the scar runs parallel to each other.

“Trapezoidal” (“T”). The sides of the scar broaden toward the inside.

“Triangular” (“Tr”). When the axis of rectangular or trapezoidal scar becomes oblique to the edge, one side of the scar often protrudes from the edge line of the flake, and as a result, triangular scar occurs.

“Irregular” (“I”). Several types of complicated or overlapped scars are often found. It can be termed “others”.

“Sliced” (“Sl”). It looks “crescent” in horizontal shape. Thin

edge is often snapped off and as a result, sliced scar occurs. When any overhang is observed, it is counted as “stepped sliced scar”.

The Size of Microflaking

It is problematic to define the size of flaking scars. Its ratio of length and width are diverse and the area is difficult to measure. However, considering the characteristics that most scars occur along the edge between ventral and dorsal aspects, the size is here measured as the distance between two ends of the scar on the edge line. The size was defined as follows. It was measured with a lattice scale (which was printed on glass plate), under the magnification of 10 X.

“Micro” (“mi”). A scar which is smaller than 0.5 mm in width.

“Small” (“s”). A scar which is between 0.5 mm and 1.0 mm in width.

“Middle” (“m”). A scar which is between 1.0 and 2.0 mm in width.

“Large” (“l”). A scar which is larger than 2.0 mm in width.

The Termination of Microflaking

Microflaking scars as the result of breakage of the edge entail attributes as “conchoidal fracture”. In case of stone knapping, usually “feather end”, “step fracture” or “step flaking” (and “hinge fracture”) is conventionally used as criteria of termination. But also the negative “curvature” of flaked scar surface is an important feature to evaluate the depression of the surface. So here the termination is classified into three categories, as follows.

“Deep” (“D”).

“Shallow” (“Sh”).

“Step” (“St”).

“Deep” and “Shallow” scars terminate with feather ending. Hinge fracture was included in “Step”. Absolute quantitative definition was not made between D and Sh, though the curvature of scars can be observed three dimensionally with a stereoscopic microscope.

The “Initiation” of scars as well as termination has been employed widely as a standard of scar classification. Initiation can be divided into two major categories, that is, “Cone” and “Bending”. Systematic analysis of initiation was not carried out in the present article, though it was observed that both initiations actually occurred and scars can be divided by the standard.

Edge angle was measured at several points of the edge for each experimental specimen. Edge width is the length of edge that was analyzed for microflaking phenomena. It does not mean the length of edge that was actually in contact with the worked material.

Converted graph diagram

The above mentioned attributes and classification results

were converted to the bar graph diagram for each specimen. Some cases are exemplified here as Figure 30 to Figure 35 on the right side of the chart. The cross tabulation frequencies and the bar charts are self-evident, but it is emphasized that the bar graphs on symmetric framework denote particular characteristics of microflaking scar patterns. The diagnostic bar graph patterns correspond to numerical summary of scar attributes which were explained in Akoshima (1981 and 1987). The same relationships are recognized between microflaking attributes and working conditions (hardness of the worked materials and the direction of working motion). For example, such characteristics are expressed in the bar graph diagrams as the diversity or homogeneity of scar shapes, the ratio of step flaking, the size variation of scars, and the degree of concentration of scars to one aspect of the edge (or relatively symmetric distribution between both faces), scar pattern differences between ventral and dorsal faces. In the former publications, the method of finding diagnostic statistical summary was not fully presented, and we would apologize for the inconveniences there of, up to the present.

CHARACTERISTIC APPEARANCES OF SCARS

Combination and disposition of microflaking scars sometimes exhibit certain characteristic appearances as a group along the working edge. Here some examples of such particular characteristic patterns are described for explanation. The figure numbers denote both our previous article (Akoshima and Hong 2014) and this volume.

Soft Worked Materials.

1) SH55 [Figure 1(6), Figure 2(1), Figure 37(2)(3)]

Meat cutting, 1600 strokes. Scalar micro deep (SmiD for short) is predominant type of scar. Scars are intermittent or scattered.

2) SH108 [Figure 3(5)(6), Figure 39(5)(6), Figure 40(1)(2)]

Wild ducks butchering. Scars of various shapes and sizes are found on both aspects. Their dispositions are irregular.

3) SH20 [Figure 4(3)(4), Figure 41(3)(4)(5)]

Grass cutting – chopping, 1700 strokes. Scars of various shapes and sizes are found on both aspects, and their dispositions are irregular. A good example of Triangular (Tr) scar (middle) is shown in Figure 4(3). An example of Scalar large shallow scar is shown in Figure 41(4). This is the same pattern as SH108.

4) SH42 [Figure 6(5)(6), Figure 45(4)(5)]

Reed cutting – chopping, 2650 strokes. A number of intermittent micro size scars are shown. The edge is a little rounded.

5) SH121 [Figure 7(6), Figure 8(1), Figure 50(1)(2)]

Rawhide scraping, 2000 strokes. All scars are Micro sized,

and concentrate on dorsal aspect intermittently. There are also some Trapezoidal (T) scars.

6) SH122 [Figure 8(2)(3), Figure 50(3)]

Rawhide scraping, 2000 strokes. The predominant type is Scalar micro deep (SmiD), continuous or intermittent, concentrating on one aspect. This pattern of microflaking is also seen above mentioned SH121.

7) SH124 [Figure 8(6), Figure 9(1), Figure 48(6), Figure 49(1)(2)]

Rawhide scraping, 800 strokes. A handful of soil was sprinkled on the hide. Continuous scalar scars were found on both aspects. There are more frequency on ventral than dorsal. Most common type is Scalar micro deep (SmiD), but there are also Scalar small deep (SsD) type scars. The edge is heavily abraded. The abrasion blurs the shape of microflaking.

8) SH126 [Figure 9(4)(5), Figure 51(6), Figure 52(1)]

Rawhide scraping with sand, 2000 strokes. This is the same patterns as SH124. Heavy abrasion even produced the rounded edge. Continuous or intermittent scars consist mainly of Scalar micro deep (SmiD).

Medium Worked Materials

9) SH114 [Figure 12(5), Figure 58(1)(2)(3)(4)]

Wood whittling, 1000 strokes. Continuous Scalar micro deep scars (SmiD) are shown in Figure 12(5), Rectangular middle step (RmSt) is shown in Figure 58(4).

10) SH111 [Figure 12(6), Figure 13(1)(2), Figure 58(5)(6), Figure 59(1)(2)(3)(4)]

Wood scraping, 1000 strokes. It is characterized by Rectangular or Trapezoidal step scars of micro, small and middle size (mi, s, m), concentrating on one aspect (in this case, on dorsal). This pattern often occurs in case of scraping of medium or hard materials. Step scars often overlap vertically [Figure 59(3), 58(5)]. In Figure 59(2), Rectangular (R) scars are similarly oblique to the edge in their axes.

11) SH96 [Figure 14(1)(2), Figure 60(1)(2)(3)(4)]

Wood whittling, 1000 strokes. The texture of the shale is very fine grained. Various types of scars (mainly Scalar) are irregularly disposed.

12) SH150 [Figure 14(3)(4)(5), Figure 60(5)]

Wood scraping, 500 strokes. There are scar concentrations on dorsal aspect, continuous Scalar or Rectangular scars, step but shallow.

13) SH149 [Figure 16(6), Figure 17(1), Figure 64(4)(5)]

Wood scraping, 500 strokes. Continuous scars including many large ones concentrate on dorsal aspect. They are Rectangular step or Scalar deep type, but when termination is step, the curvature of scar surface is rather flat [Figure 64(4)]. Many small or middle vertically overlapping step scars on the edge crosscut these scars.

Scars are rare on ventral aspect. The pattern is similar to the case of SH150.

14) SH80 [Figure 21(3)(4), Figure 75(5)(6), Figure 76(1)(2)]

Bamboo sawing, 4000 strokes. Continuous Scalar or Rectangular small shallow scars are horizontally overlapping. Various shapes and sizes of scars are also found, Scalar large deep (SID) [Figure 75(5)], Continuous Rectangular [Figure 76(2)], Trapezoidal middle step (TmSt) [Figure 21(4)], and so on.

15) SH77 [Figure 22(6), Figure 23(1)(2), Figure 78(2)(3)(4)(5)]

Gourd sawing, 5000 strokes. A number of continuous tiny scars consisting mainly of Scalar micro deep (SmiD) type are shown. Several small size scars on ventral aspect are also shown (intermittent).

Hard Worked Materials

16) SH86 [Figure 23(4)(5), Figure 78(6), Figure 79(1)(2)(3)(4), Figure 81(2)]

Bone sawing, 3000 strokes. Scars occur on both aspects similarly. They are of various types, Scalar deep, Triangular [Figure 79(3)], overlapping step [Figure 78(6)]. Their dispositions are irregular. Slight abrasion is found on the edge.

17) SH93 [Figure 24(4)(5), Figure 82(4)(5)(6), Figure 83(1)]

Bone scraping, 1500 strokes. Almost all scars are on dorsal aspect. Large step or shallow scars are crosscut by a number of vertically overlapping step scars. These overlapping scars give a "crushed" appearance.

18) SH92 [Figure 25(1)(2), Figure 81(3)(4)]

Bone sawing, 5000 strokes. Various types of scars are found on both aspects. Continuous Scalar small deep (SsD) scars are shown in Figure 81(3). This specimen exhibits a similar pattern to SH86.

19) SH48 [Figure 26(2)(3), Figure 84(6), Figure 85(1)(2)(3)]

Antler sawing, 15000 strokes. There are mainly intermittent Scalar scars. They are irregularly disposed. Slight abrasion is found on the edge.

20) SH68 [Figure 26(4)(5)(6), Figure 86(2)(3)(4)(5)(6)]

Antler sawing, 4300 strokes. Sawing dry antler gives a very angular appearance. Various types of scars are irregularly overlapping. "Alternate flaking" like microflaking scars are found [Figure 26(4), 86(3)], consisting of Scalar scars.

21) SH70 [Figure 27(3)(4), Figure 87(1)(2)(3)]

Antler whittling, 2000 strokes. The angular appearance is also caused by dry antler. Scars are of various types, with no predominant type.

22) SH153 [Figure 27(5)(6), Figure 87(4)(5)]

Dry antler scraping, 100 strokes. Large or middle step but flat (in curvature) scars are crosscut by irregularly, vertically overlapping step scars, on dorsal aspect. Few scars are found on ventral aspect.

CONCLUSIONS

The databases presented here as a main addition to our previous database in 2014 will serve for a means of fundamental pattern recognition of the category of use-wear which can be observable with a standard equipment of low magnification microscope. So far, it seems there has been a common understanding in Japan that the “high power approach” is always superior to the “low power approach” in their interpretative power. However, we take a methodological position that each category of use-wear, namely micro-polish (or microwear polish), striation, micro-edge damage (here referred as microflaking), and even macro-wear such as “impact fracture” of projectile weapons (often observable with a hand magnifier), has its own potential strength and weakness.

For instance, micro-polish is difficult to identify when heavy patination, or “post-depositional surface modification” phenomena, affected the working edge of the tool. Another restriction of micro-polish is the quality of raw materials. Very coarse-grained lithic materials, or extra-hard materials such as quartz and quartzite in the Paleolithic period of the Korean peninsula, prevent from reliable identification of micro-polishes. The other way around is very soft materials such as rhyolite, fine-grained mud-stone, or acidic volcanic rocks. Surface alteration and abrasion of the edge often makes polish identification a difficult endeavor. Our conclusion has been that all types of use-wear should be paid enough attention as long as they are observable along the working edge. This article of database presentation is an effort for this problem oriented methodological thinking.

This collection of microphotography and presentation of calculating method of varied scar patterns, we believe, will play some essential roles in the future development of use-wear analysis in general. Extra-hard lithic raw materials, or very soft lithic raw materials, both require considerable amount of additional experimental research, because our standard charts presented here only entail raw materials typically utilized in the Tohoku District of Japan during prehistoric times, namely, siliceous hard shale. Also, meticulous experimental researches are further necessary concerning the relationship between use-wear microchipping scars and technological secondary retouch micro scars, such as those produced along the backed edges of knife blades. The two sorts of microchipping scars were conventionally treated as indistinguishable from each other. Is the distinction so difficult that there would be no means to identify these? We are still in need of serious experimental endeavors toward this direction.

It is again emphasized here that the actual looks of microchipping phenomena are very variable. The appearances of microflaking scars exhibit wide ranges of

variation, even in the case where the tool was utilized in the same task. It was a reason why Akoshima (1989) adopted a statistical approach to reduce such weak points in use-wear identification. Utility of the category of micro-scale chipping as the “diagnostic feature” of use of lithic artifacts needs to be properly evaluated. In research history, microflaking has been considered as a major criterion for functional interpretation since the inception of experimental research (e.g., Tringham, et al. 1974) in American archaeology (e.g., Odell 1996), and has been recently applied to Asian countries (e.g., Gao and Chen eds. 2008). We wish in Japan too, this category of use-wear will be given appropriate importance in functional analysis of lithic artifacts, and the study will be integrated with other categories of wear such as microwear polishes and striations, for the purpose of elucidating the processes of prehistoric human adaptations to the given environments.

ACKNOWLEDGEMENT

Prof. Hiroshi Kajiware of Tohoku Fukushi University actually conducted many of the replicative experiments together with the first author while he was at Tohoku University. We are grateful to Prof. emeritus Toshio Yanagida of the Tohoku University Museum for recommending publication in its Bulletin series. The database publication of this page size sometimes faces difficulties to find places to be accommodated. We hope that in the future Bulletin series, essential parts of TUMRT research standards may find their places, as our functional database so far served for basic reference purposes nationwide. Lastly, this article is a result of KAKENHI (Grant-in-aid for Scientific Research) by the Japanese government, which was granted to Akoshima (2015, number 25370885).

ERRATA

In the previous article (2014), there was miss-printing of figure caption as follows.

(wrong) Figure 22 (6) 5.0-2. bamboo saw 2000st (SH79d) 8x.

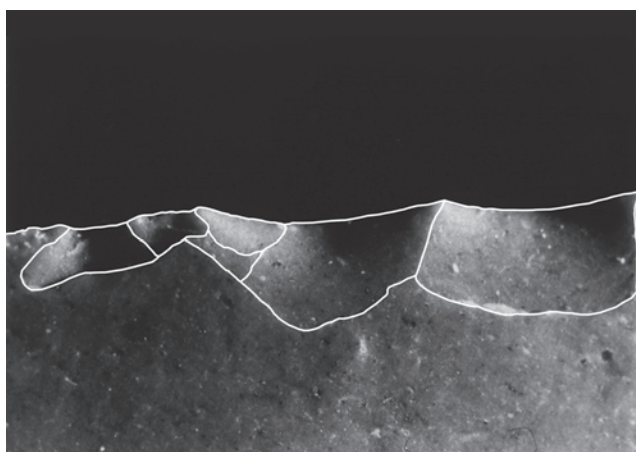
(correction) Figure 22(6) 6.0-2 gourd saw 5000st (SH77d) 8x

We sincerely apologize for the error.

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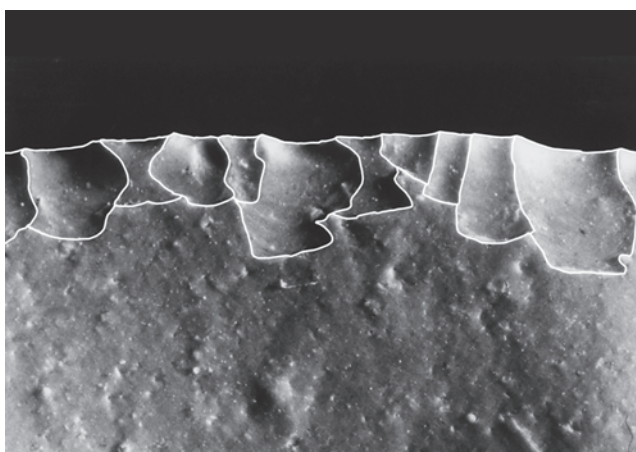


SH148d, dry hide chop, 306st, from Fig.11(6)

(1) Example of soft worked materials

2mm

The working edge was used to chop dry hide surface. Strong impact onto the edge produced irregularly arranged scars of various shape, size, and termination on both facets of the edge. On the photo from right, rectangular, scalar, smaller scalar overlapping on rectangular, then smaller rectangular, and trapezoidal scars, are arranged side by side. Some rectangular and trapezoidal scars have step flaking termination. On the other side of the same edge [Figure 12(1)], very large deep scalar scar is observed indicating the impact of chopping motion.

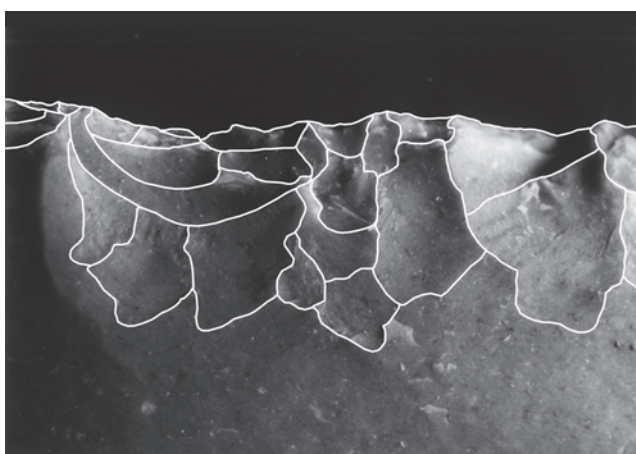


SH150d, wood scrape 500st, from Fig.14(4)

(2) Example of medium worked materials

2mm

The working edge was used to scrape fresh cedar branch, with this dorsal surface being the rear side of movements. Relatively flat microflaking scars are arranged regularly along the edge. Most of them are of rectangular shape but also there are some trapezoidal shape scars. Terminations of these rectangular and trapezoidal scars are step flaking in most cases. However, the scars are flat and shallow, and the negative bulbs of percussion of scars are not deep.



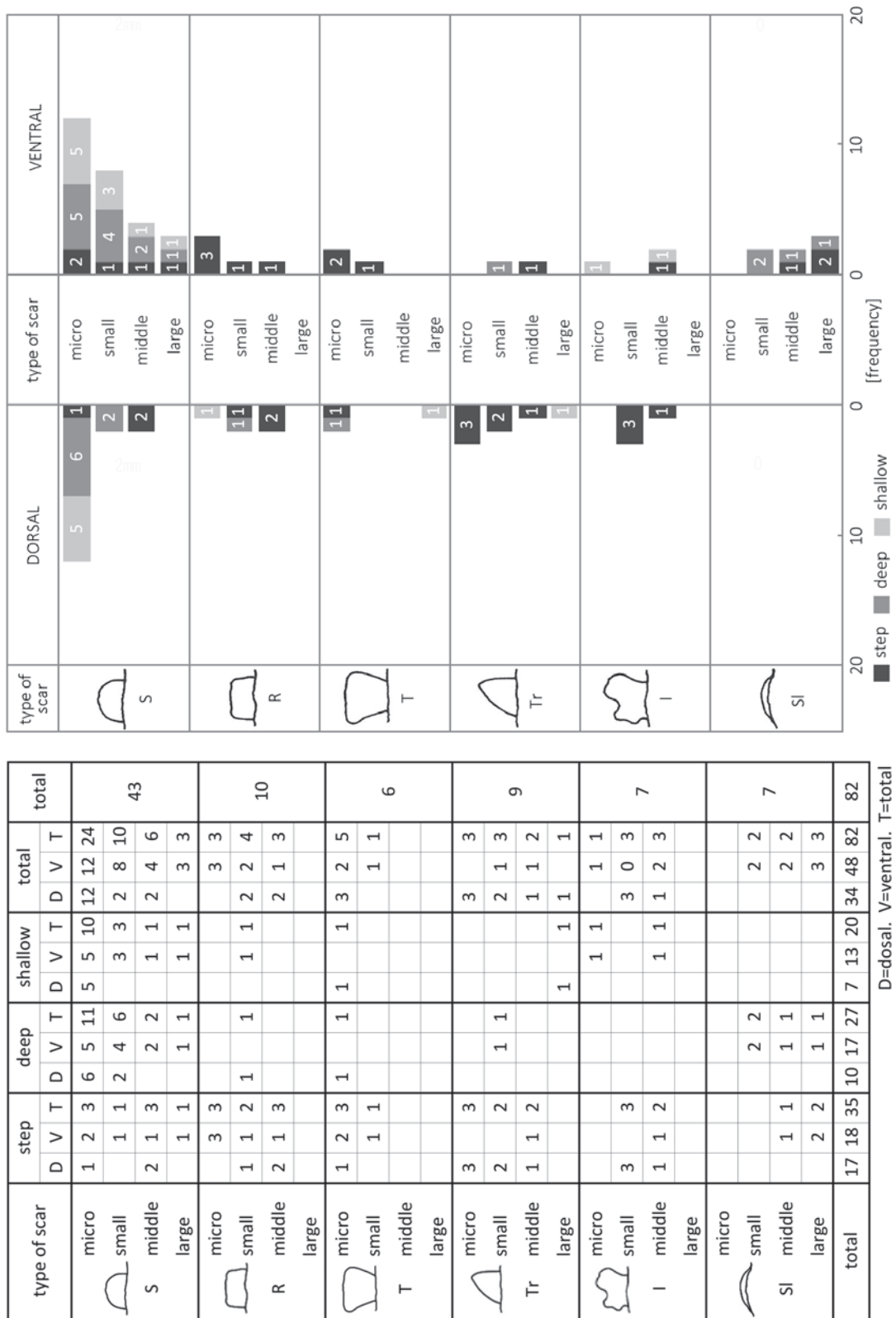
SH153d, dry antler scrape 100st, from Fig.27(5)

(3) Example of hard worked materials

2mm

The working edge was used to scrape dry antler surface. The extreme hardness of the worked material is reflected on the pattern of microflaking. That is, very irregular arrangement of various shape and size of many scars which are overlapping one another. In addition, the edge line is affected with vertically overlapping step termination scars. Some scars are large and deep, some are small and flat. The shapes of scars are also varied, and many are of irregular type with both step and feather terminations. The other side of the same edge [Figure 27(6)] shows only sporadic small microflaking scars. In such cases, the concentration of microflaking scars onto only one face of the working edge is prominent.

Figure 29. Identification of microflaking scars.



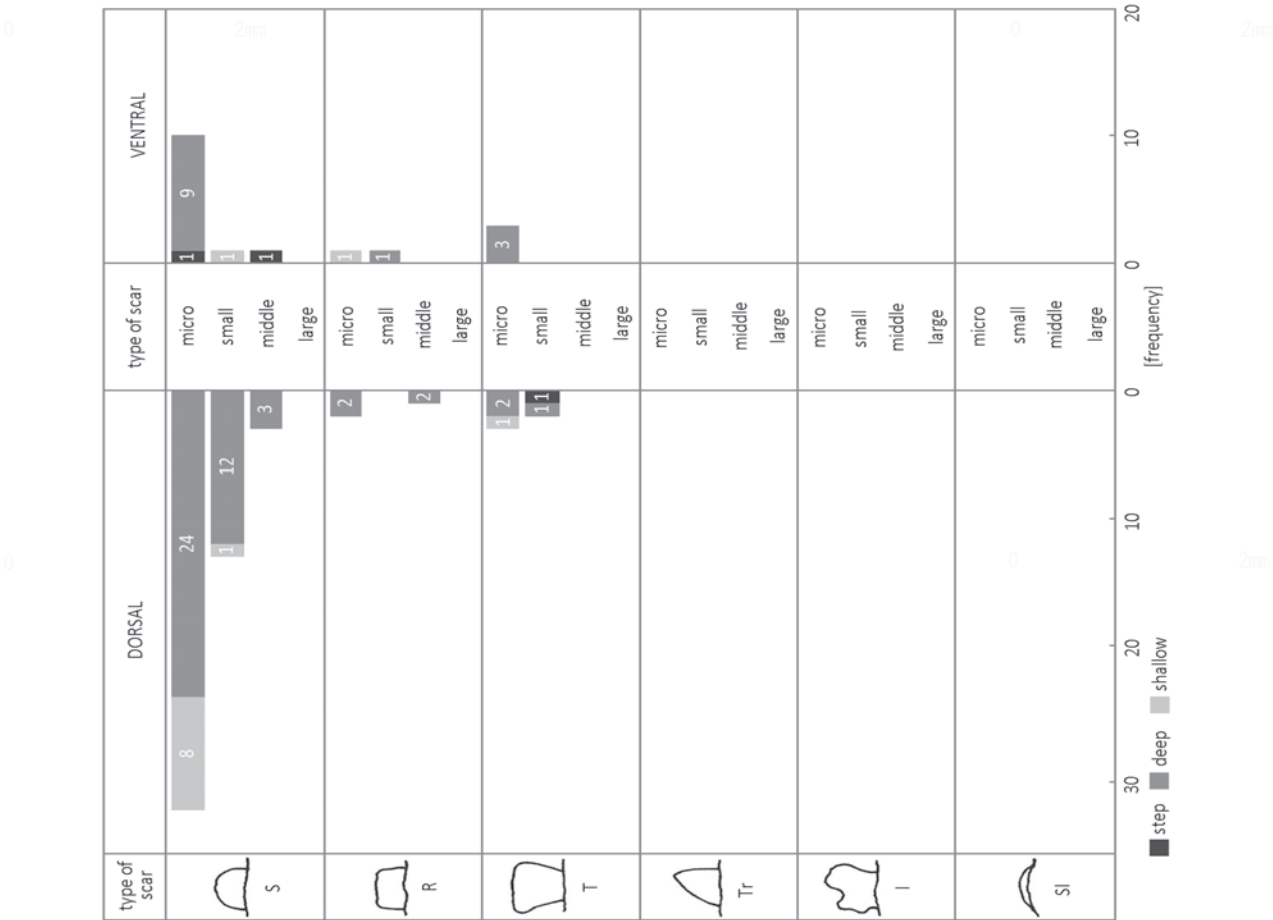
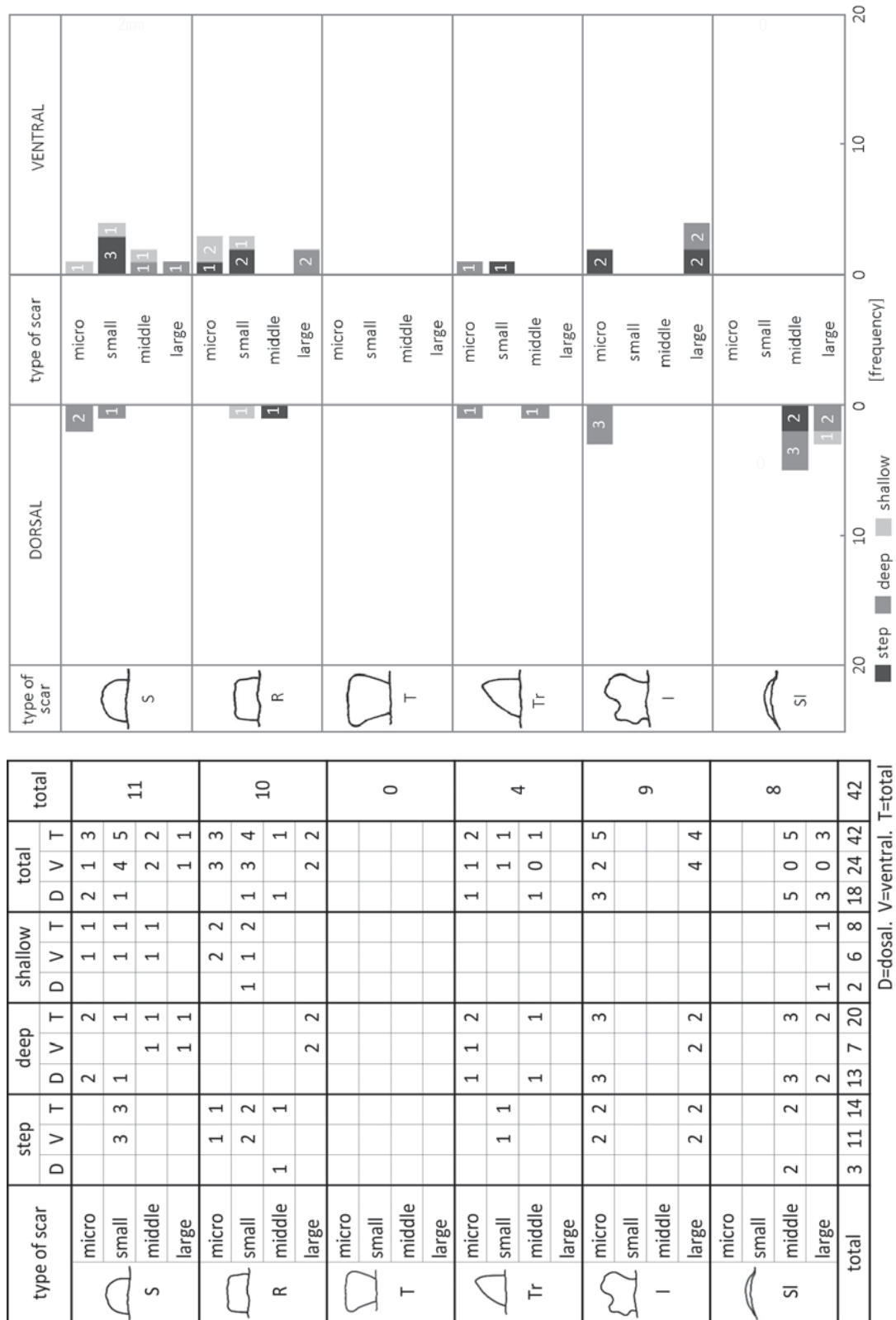


Figure 31. Characteristics of microflaking scars (soft worked materials)
SH123 rawhide scraping, 2000 strokes (pig, +soil) edge angle 45°-50° edge width 30 mm



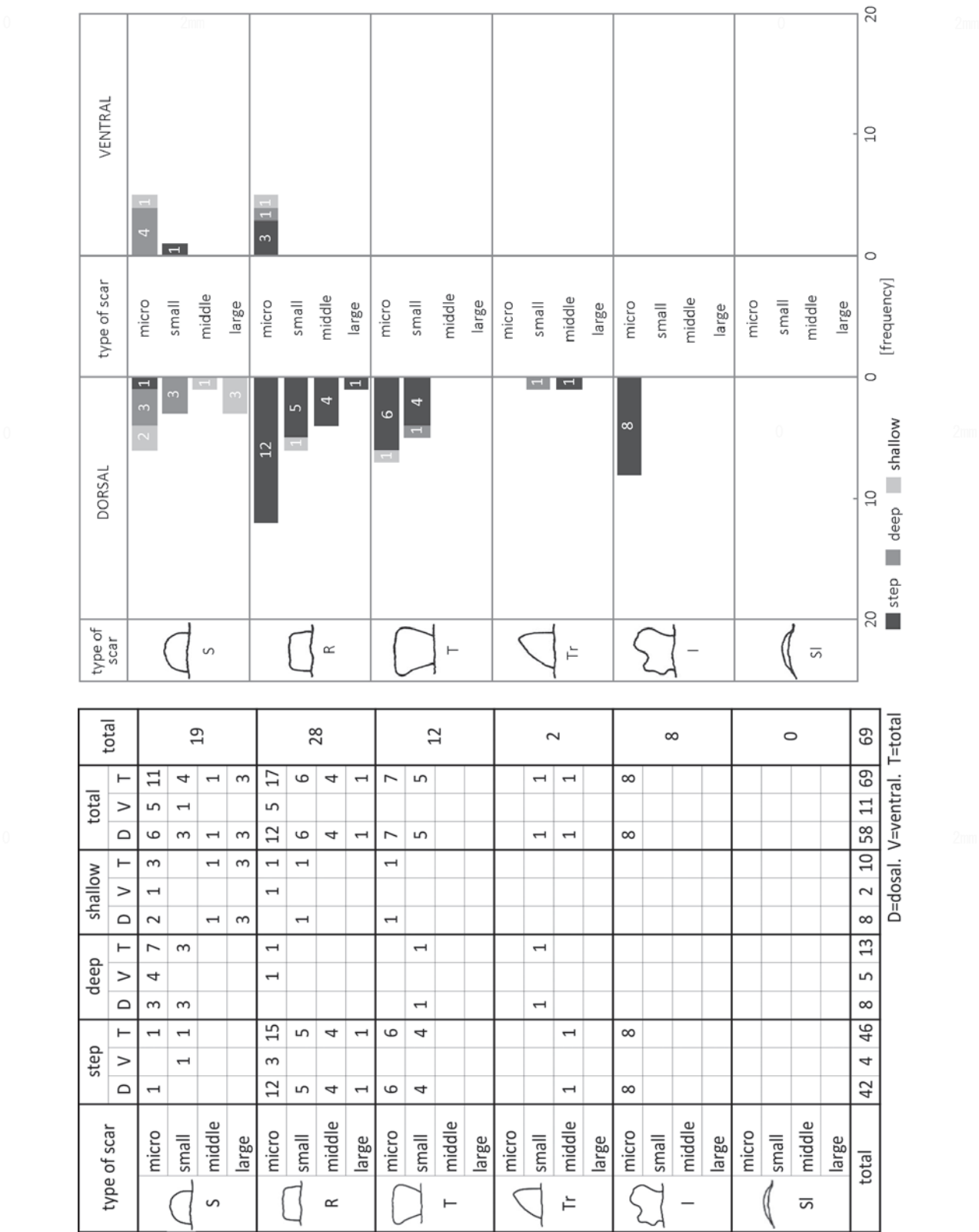


Figure 33. Characteristics of microflaking scars (medium worked materials)

SH111 wood scraping, 500 strokes (paulownia) edge angle 60° edge width 40 mm

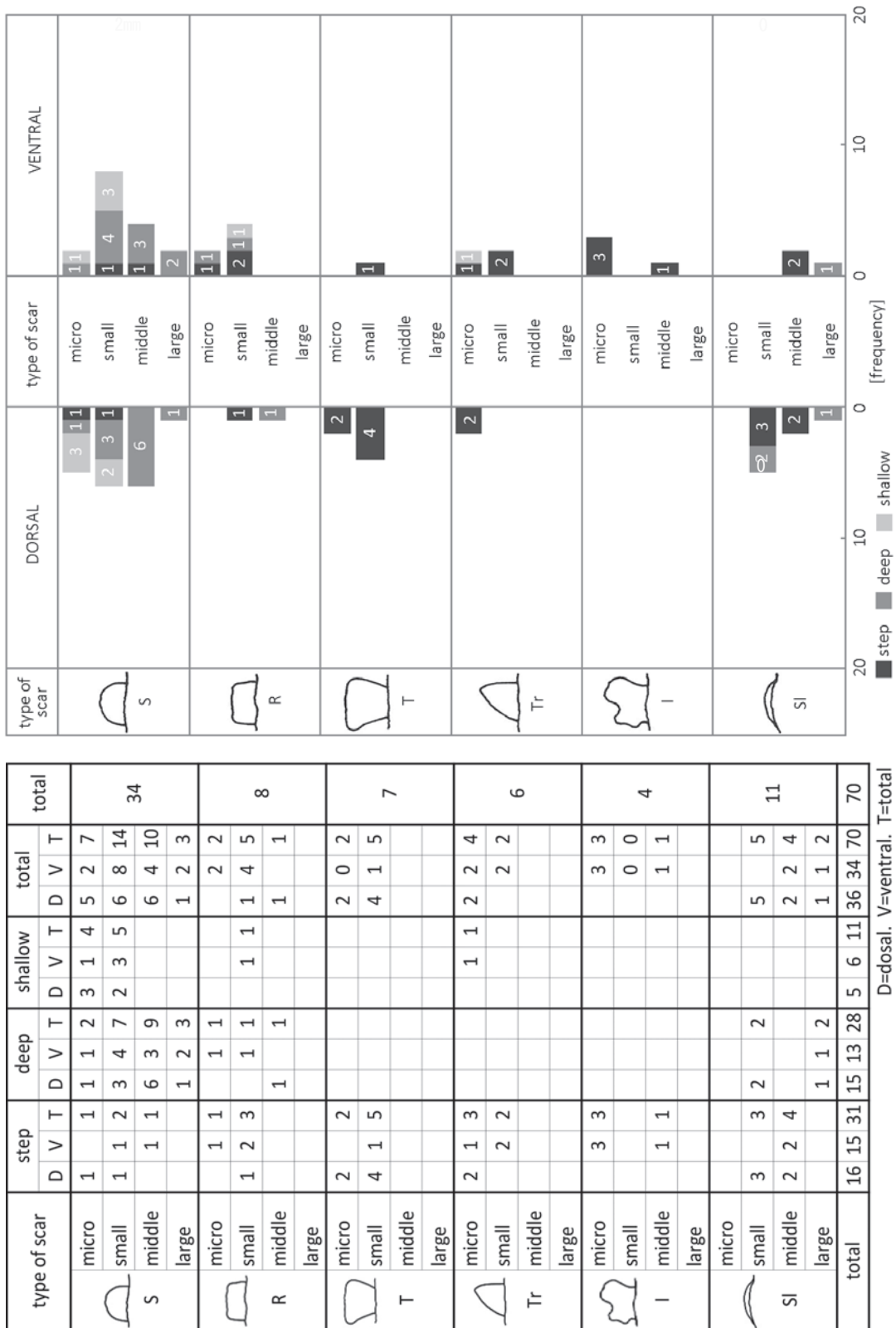


Figure 34. Characteristics of microflaking scars (hard worked materials)

SH68 antler sawing, 4300 strokes (dry) edge angle 50° 50° 55° edge width 45 mm

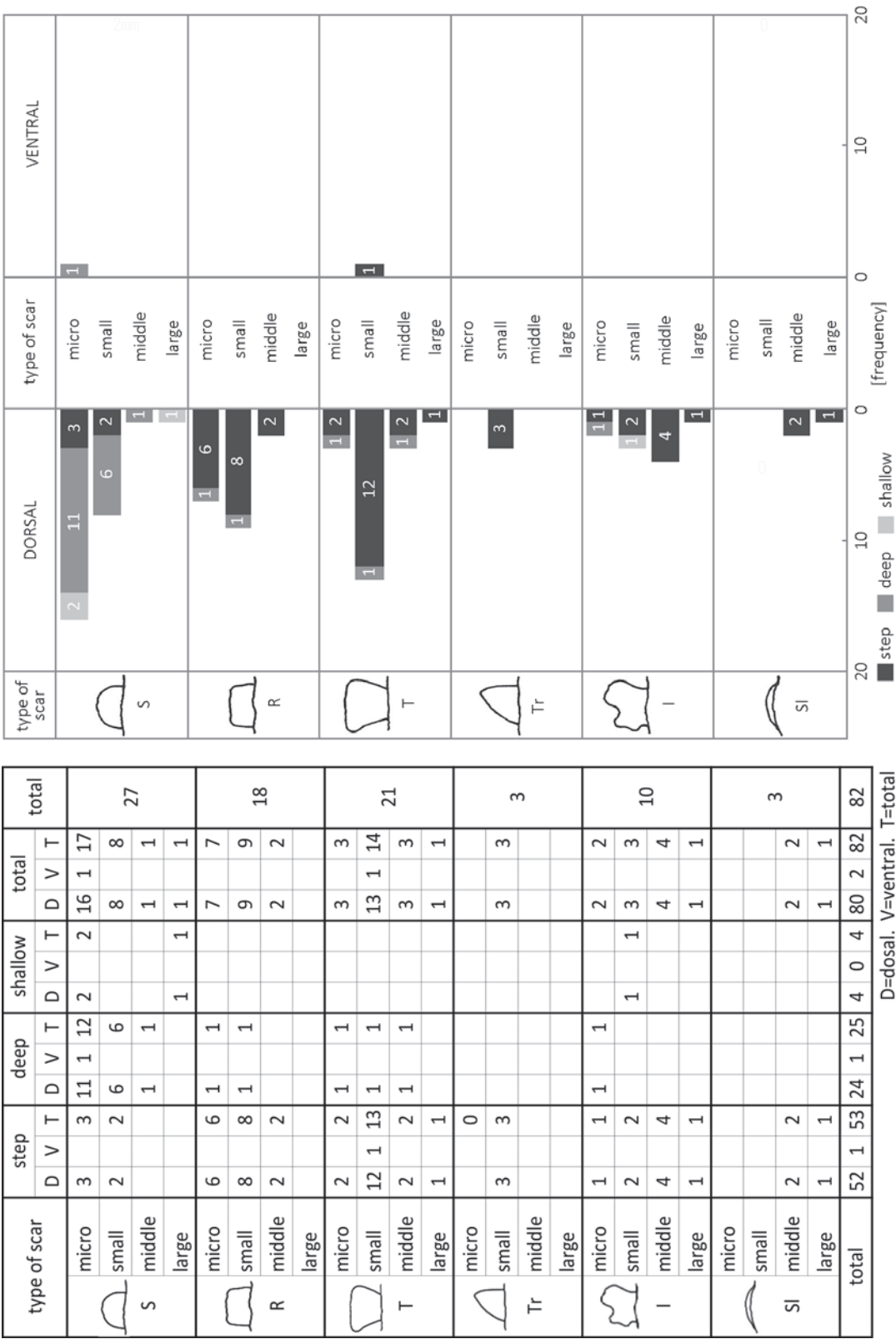
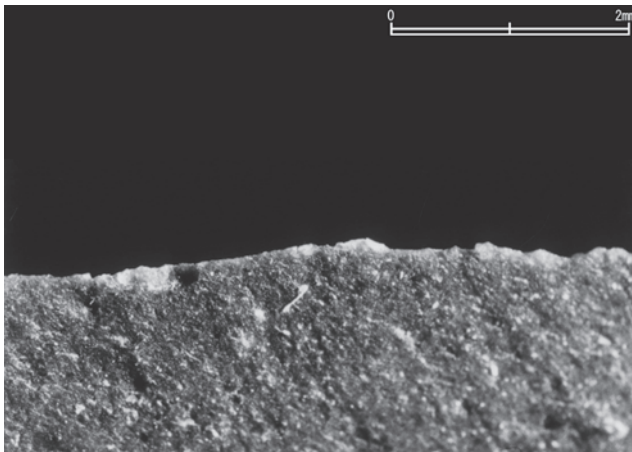
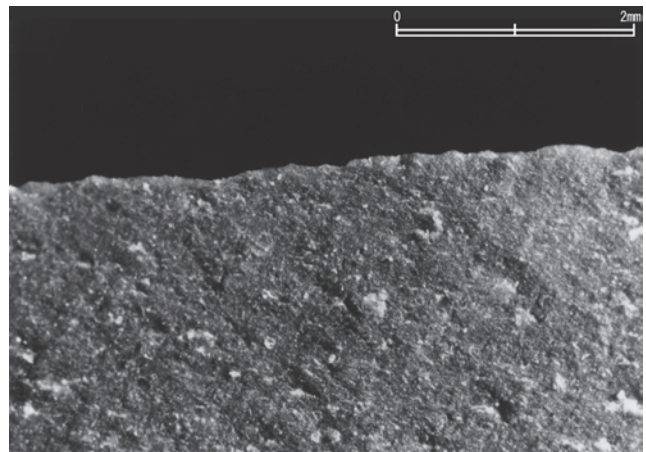


Figure 35. Characteristics of microflaking scars (hard worked materials)

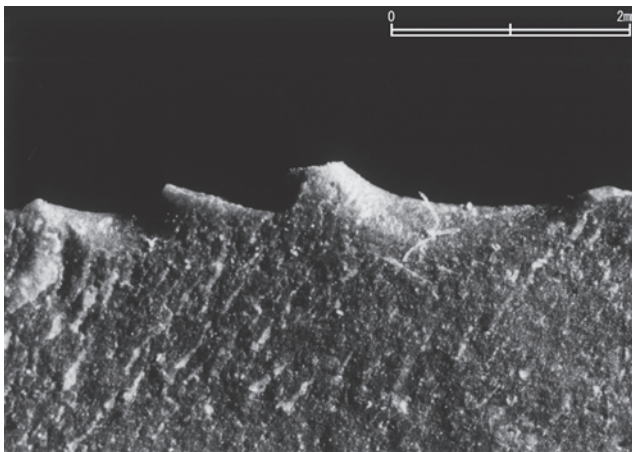
SH93 bone scraping, 1500 strokes (pig, boiled) edge angle 65° edge width 36 mm



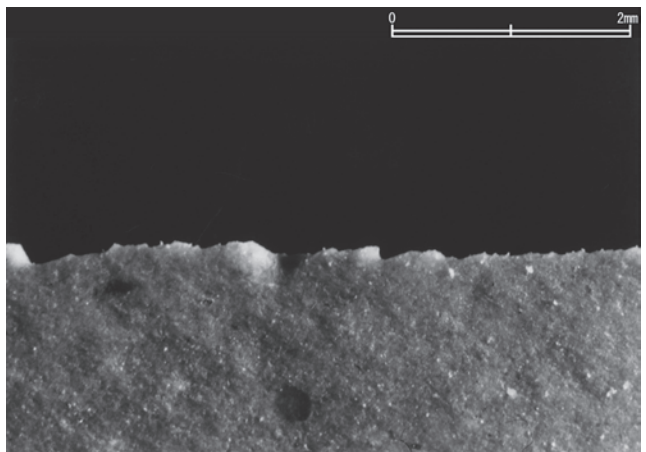
(1) 1.1-1. meat cut 800st (SH26d) 8x



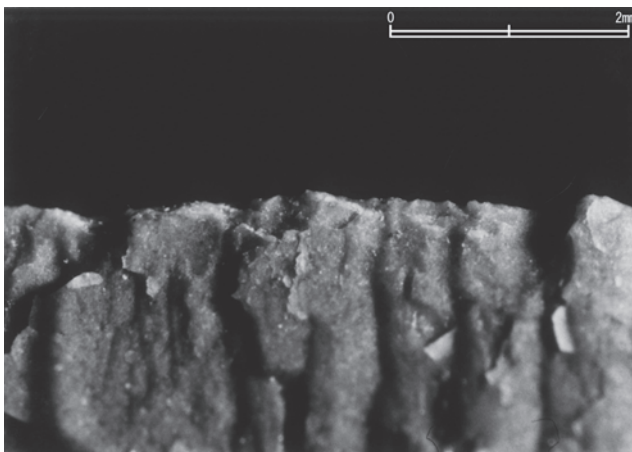
(2) 1.1-1. meat cut 800st (SH26v) 8x



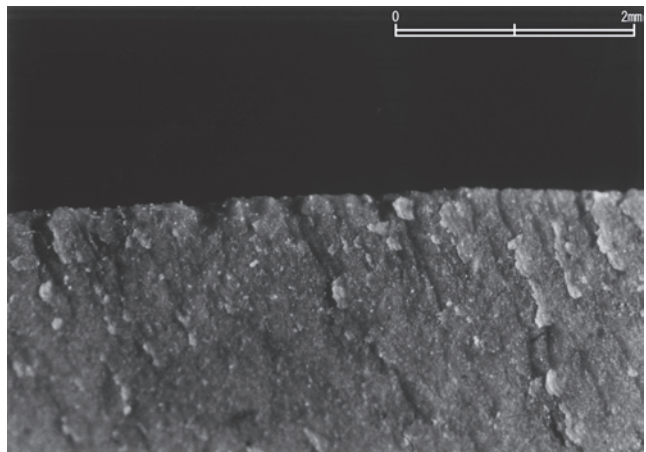
(3) 1.1-1. meat cut 800st (SH26v) 8x



(4) 1.2-1. meat cut 1300st (SH54d) 8x

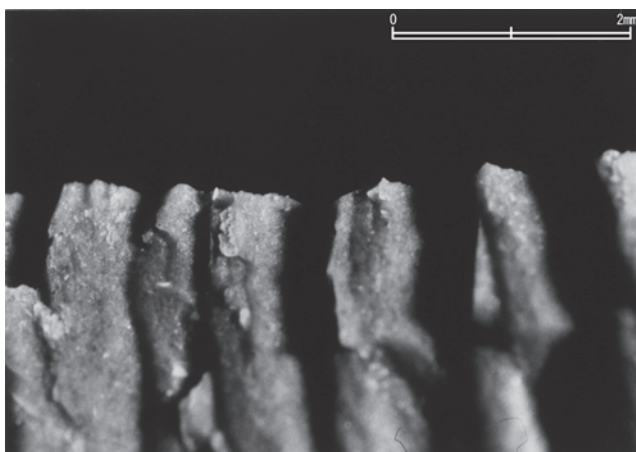


(5) 1.2-1. meat cut 1300st (SH54v) 8x

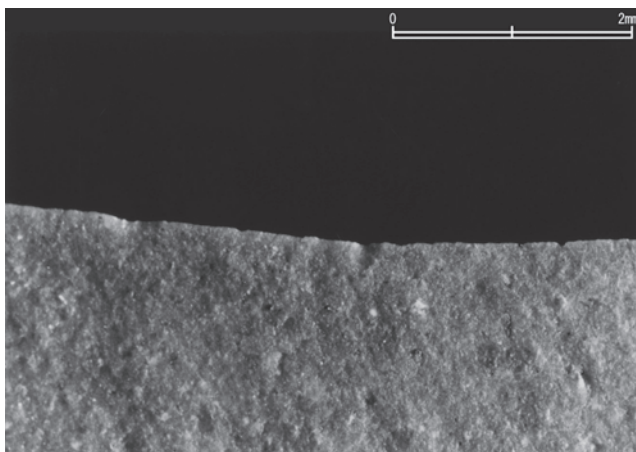


(6) 1.2-1. meat cut 1300st (SH54v) 8x

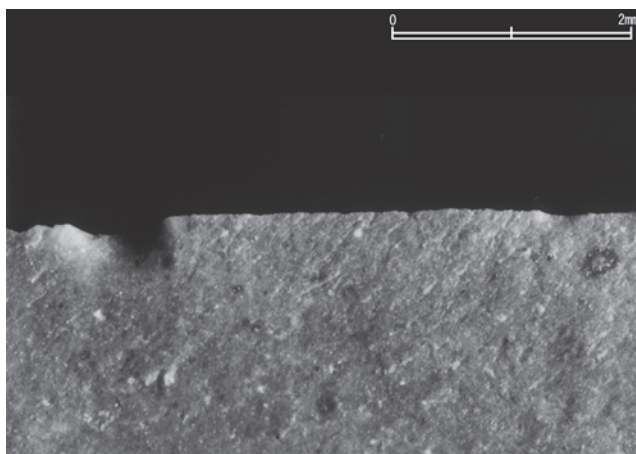
Figure 36. Experimental microflaking scars. (soft worked materials)



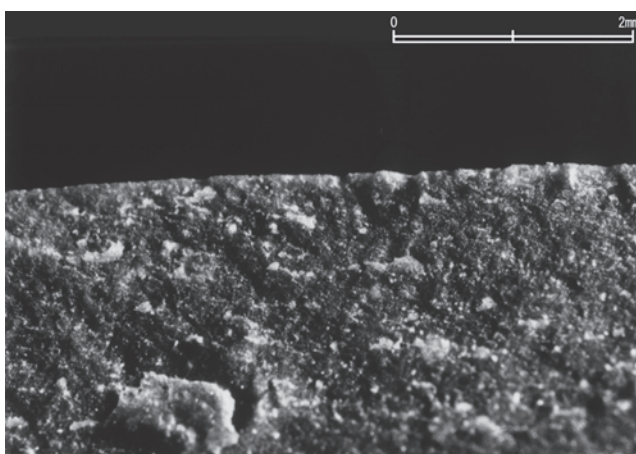
(1) 1.2-1. meat cut 1300st (SH54v) 8x



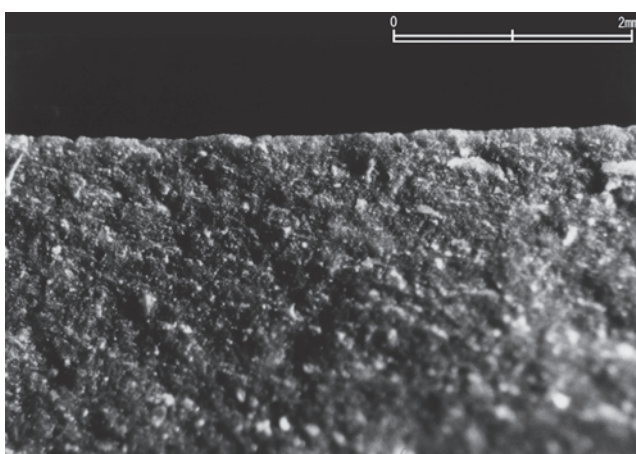
(2) 1.2-1. meat cut 1600st (SH55v) 8x



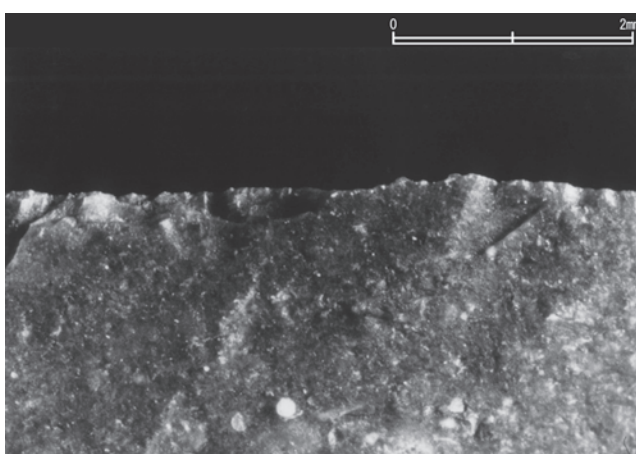
(3) 1.2-1. meat cut 1600st (SH55v) 8x



(4) 1.2-4. meat scrape 1100st (SH57d) 8x

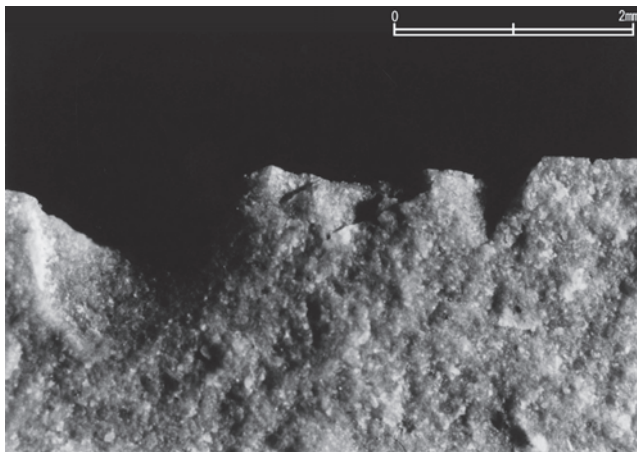


(5) 1.2-4. meat scrape 1100st (SH57d) 8x

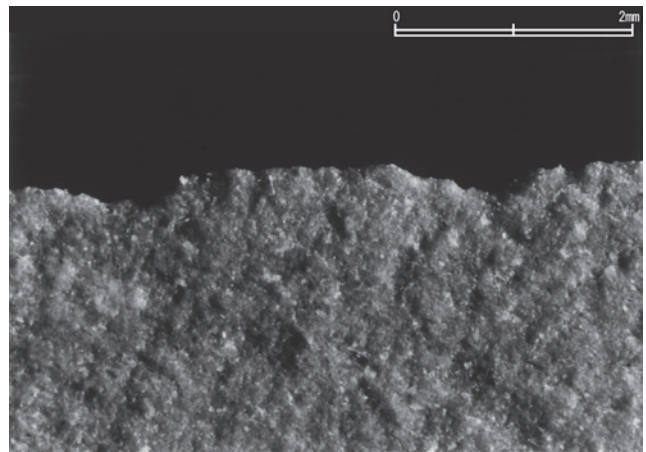


(6) 1.4-6. meat butcher (KSM5d) 8x

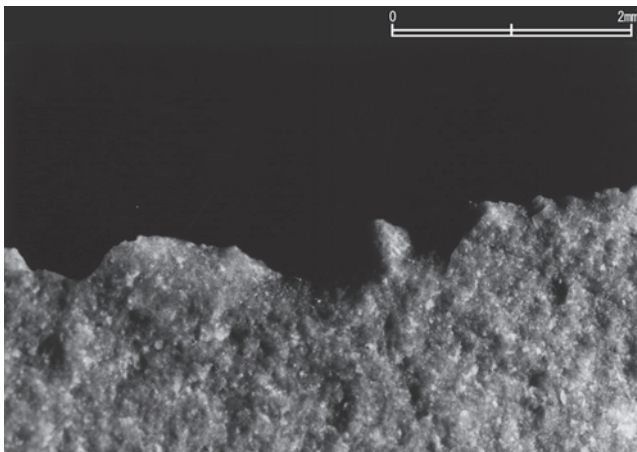
Figure 37. Experimental microflaking scars. (soft worked materials)



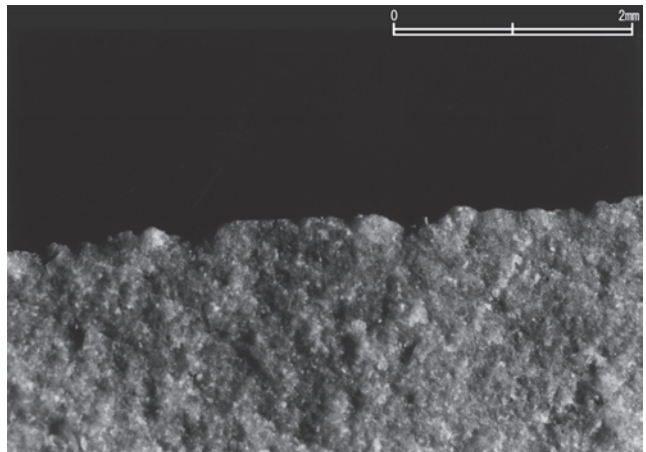
(1) 1.3-1. meat cut 500st (SH15d) 8x



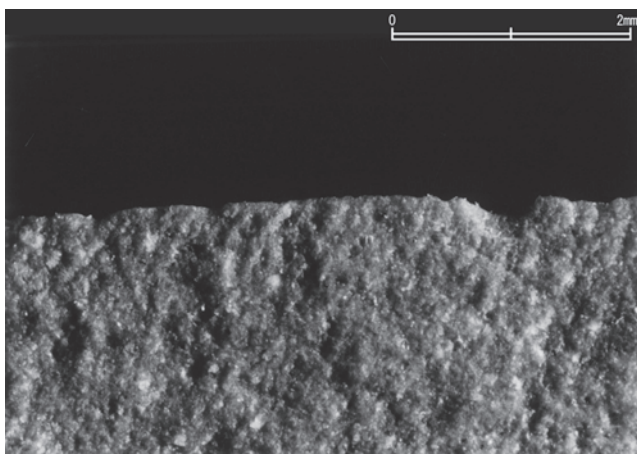
(2) 1.3-1. meat cut 500st (SH15d) 8x



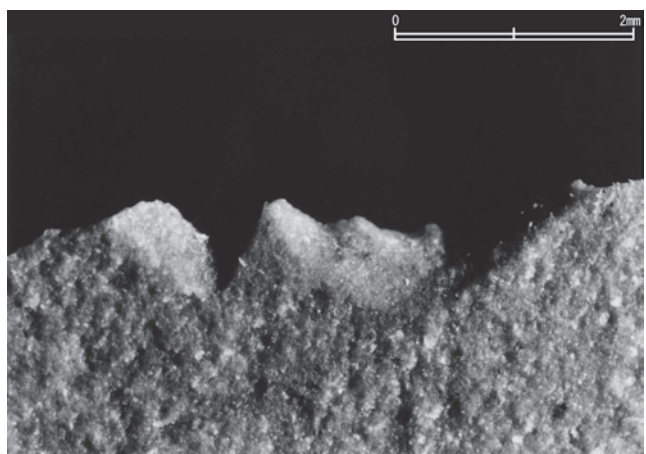
(3) 1.3-1. meat cut 500st (SH15d) 8x



(4) 1.2-1. meat cut 500st (SH15d) 8x

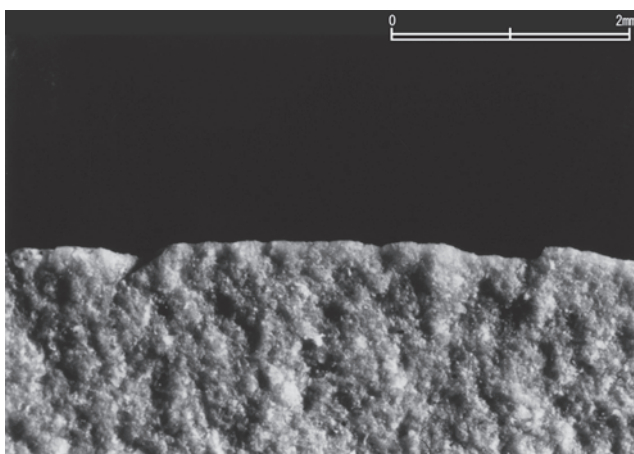


(5) 1.3-1. meat cut 500st (SH15v) 8x

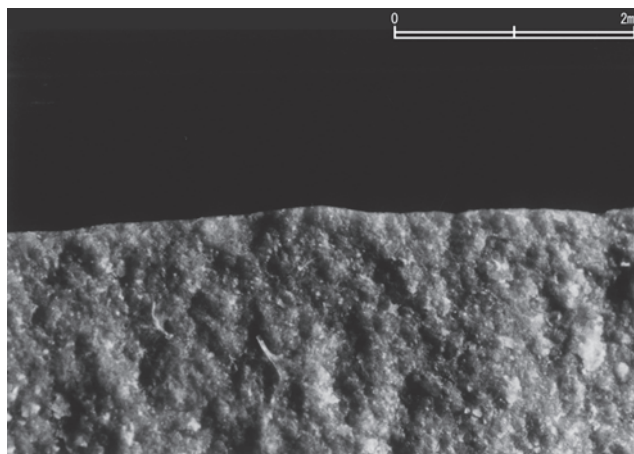


(6) 1.2-1. meat cut 500st (SH15v) 8x

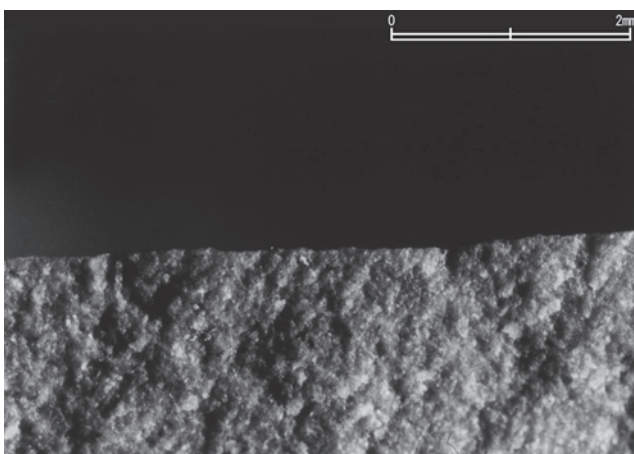
Figure 38. Experimental microflaking scars. (soft worked materials)



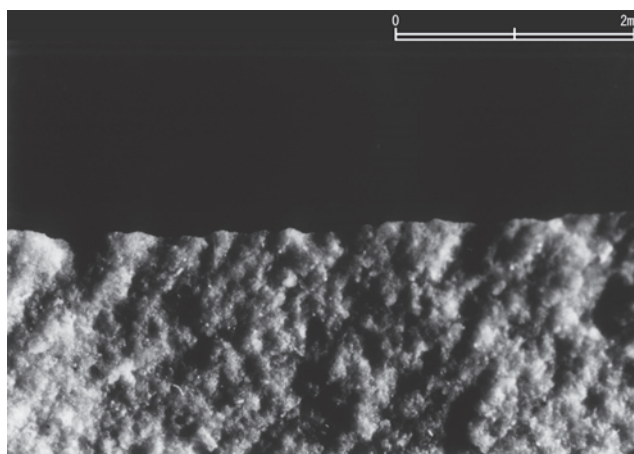
(1) 1.3-1. meat cut 500st (SH17d) 8x



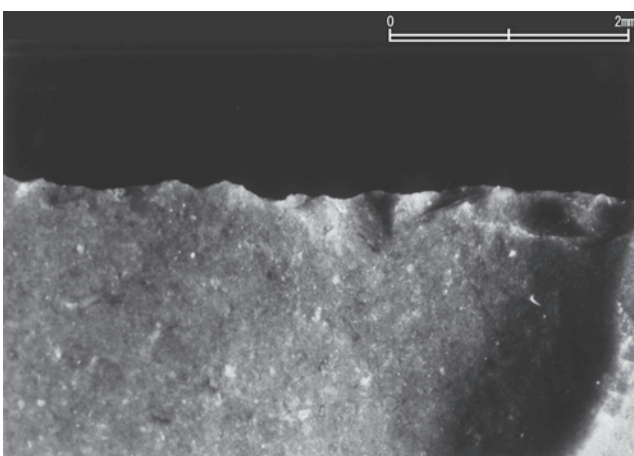
(2) 1.3-1. meat cut 1000st (SH17d) 8x



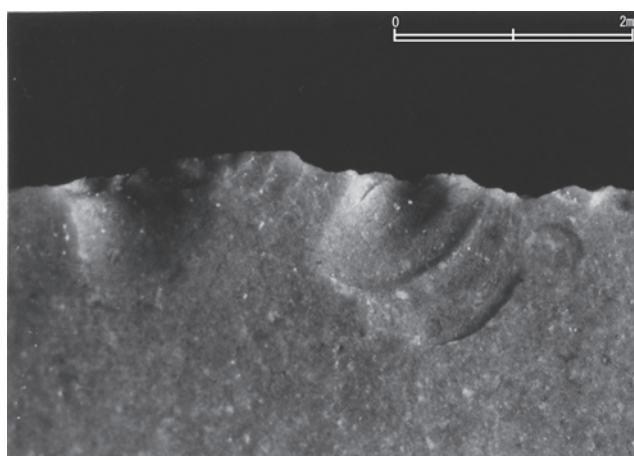
(3) 1.3-1. meat cut 1000st (SH17v) 8x



(4) 1.3-1. meat cut 1000st (SH17v) 8x

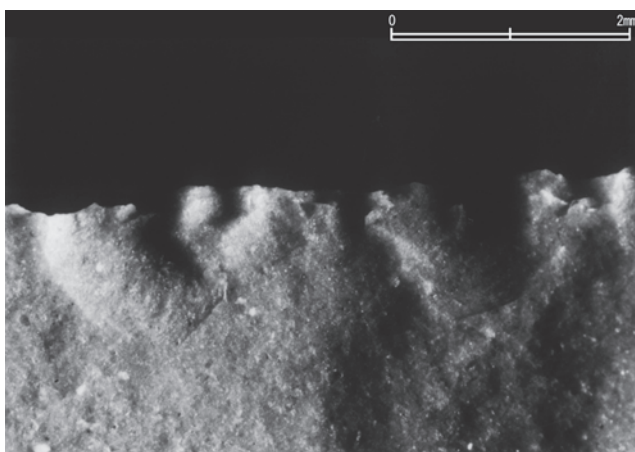


(5) 1.4-6. meat butcher (SH108d) 8x

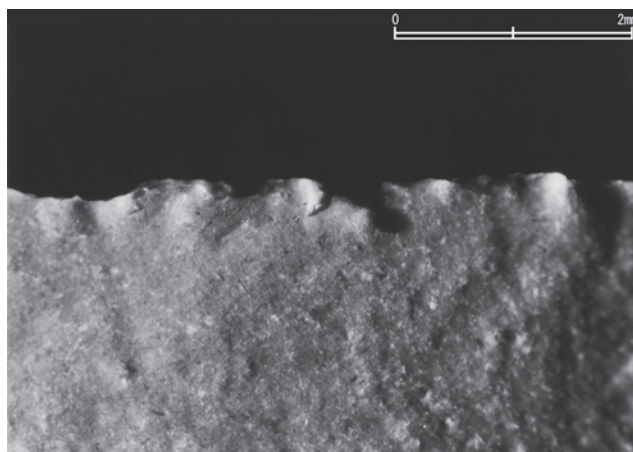


(6) 1.4-6. meat butcher (SH108d) 8x

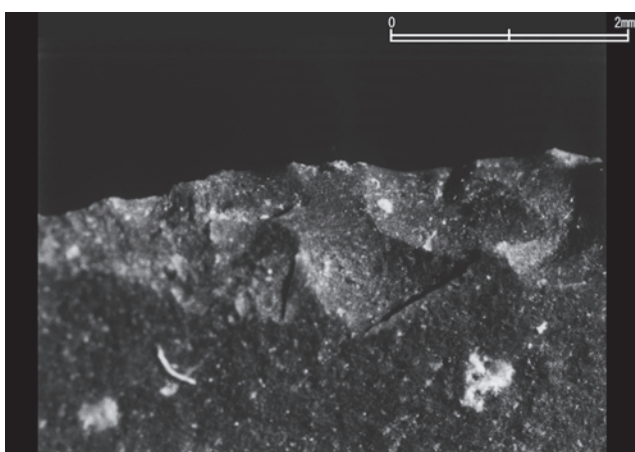
Figure 39. Experimental microflaking scars. (soft worked materials)



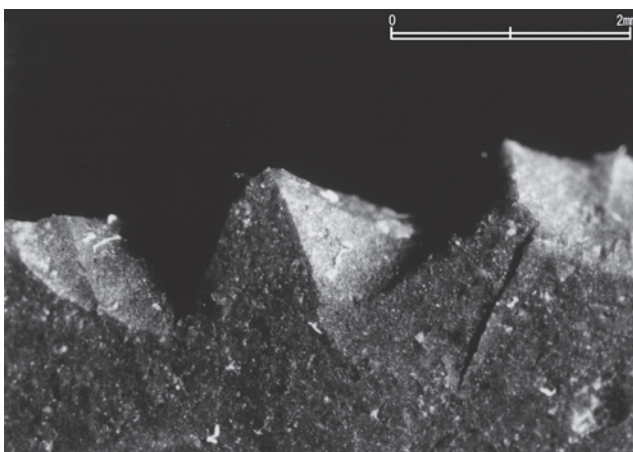
(1) 1.4-6. meat butcher (SH108v) 8x



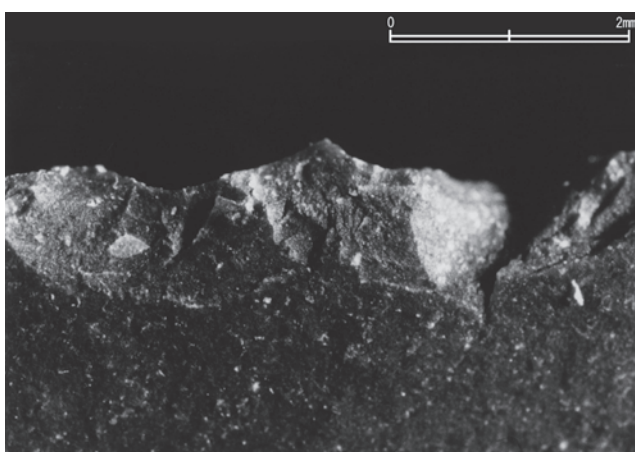
(2) 1.4-6. meat butcher (SH108v) 8x



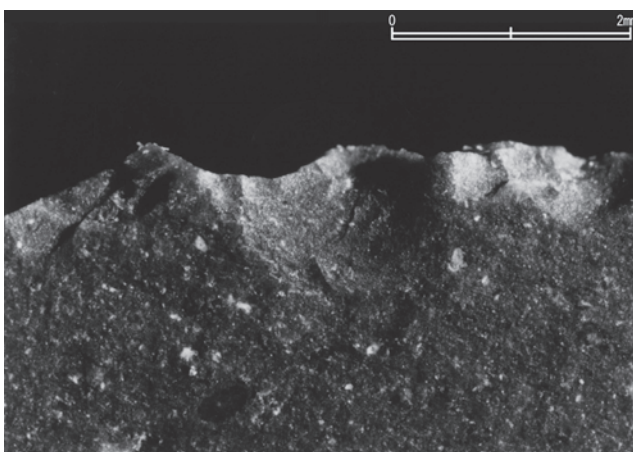
(3) 1.5-6. meat butcher 1020st (SH56d) 8x



(4) 1.5-6. meat butcher 1020st (SH56d) 8x

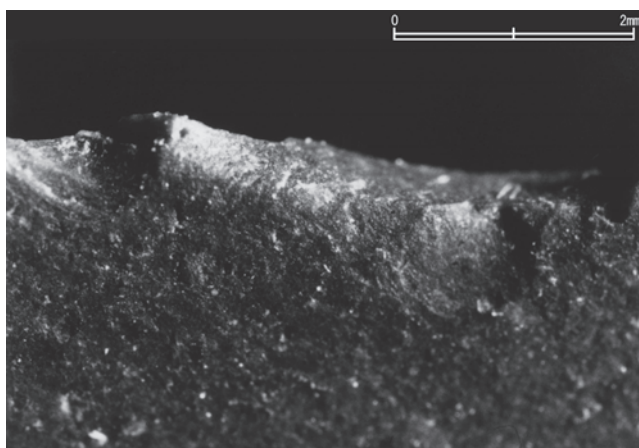


(5) 1.5-6. meat butcher 1020st (SH56d) 8x

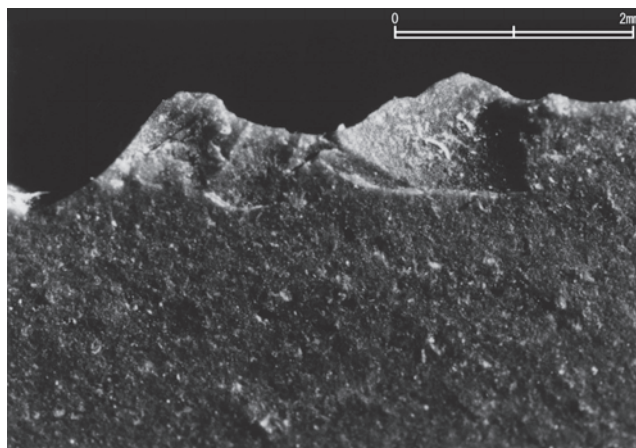


(6) 1.5-6. meat butcher 1020st (SH56d) 8x

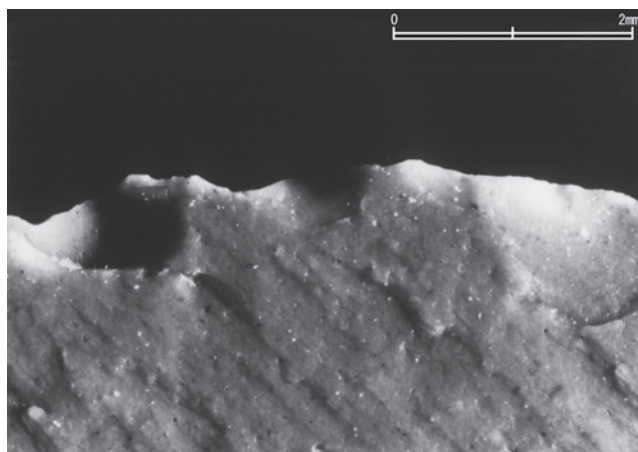
Figure 40. Experimental microflaking scars. (soft worked materials)



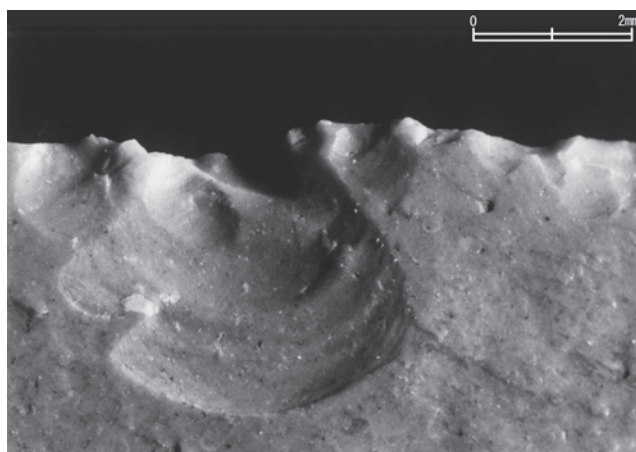
(1) 1.5-6. meat butcher 1020st (SH56v) 8x



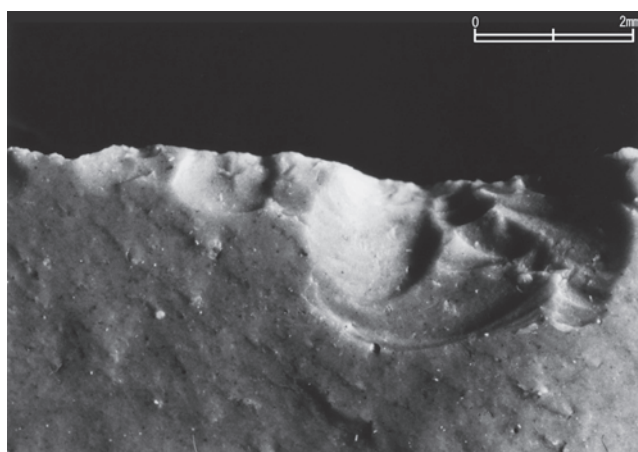
(2) 1.5-6. butcher 1020st (SH56v) 8x



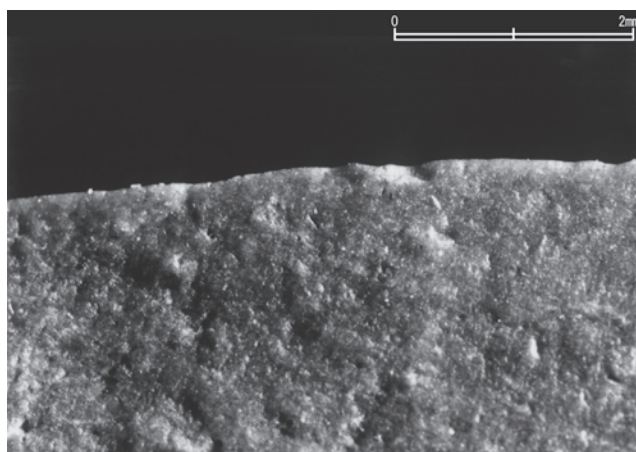
(3) 2.1-1. plant cut 1700st (SH20d) 8x



(4) 2.1-1. plant cut 1700st (SH20v) 5x

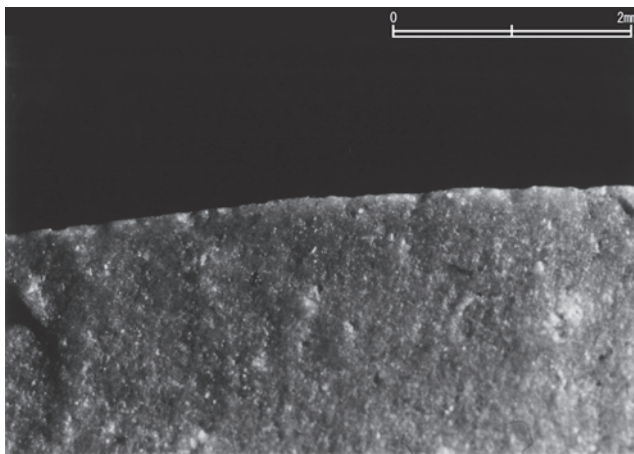


(5) 2.1-1. plant cut 1700st (SH20v) 5x

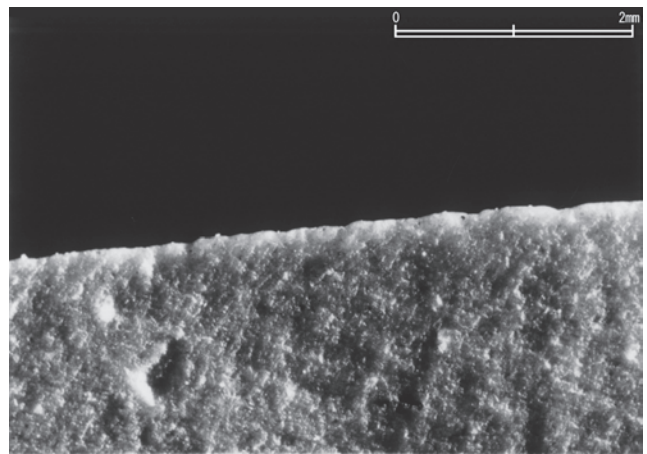


(6) 2.1-1. plant cut 2200st (SH140d) 8x

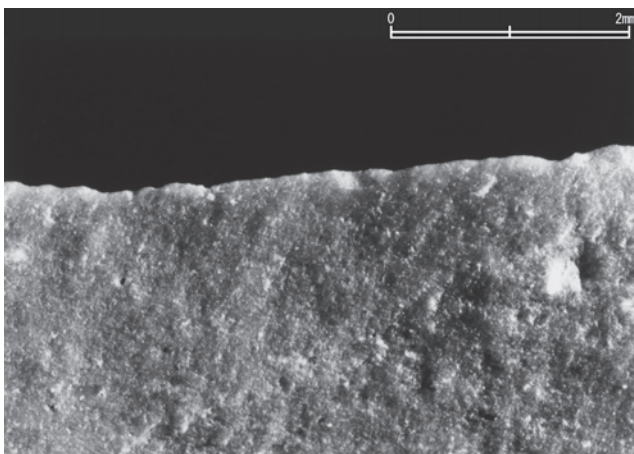
Figure 41. Experimental microflaking scars. (soft worked materials)



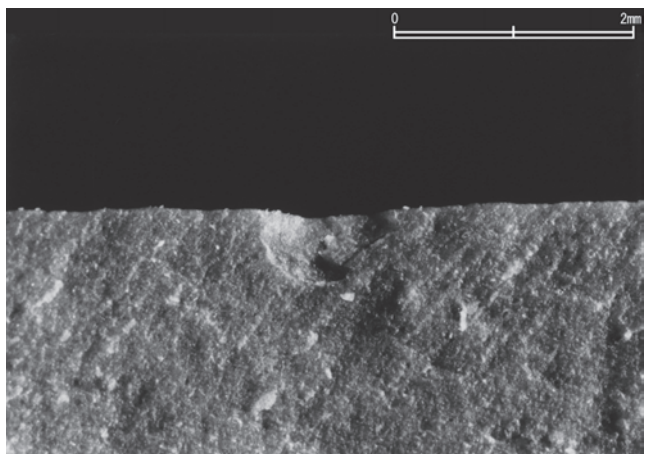
(1) 2.1-1. plant cut 2200st (SH140d) 8x



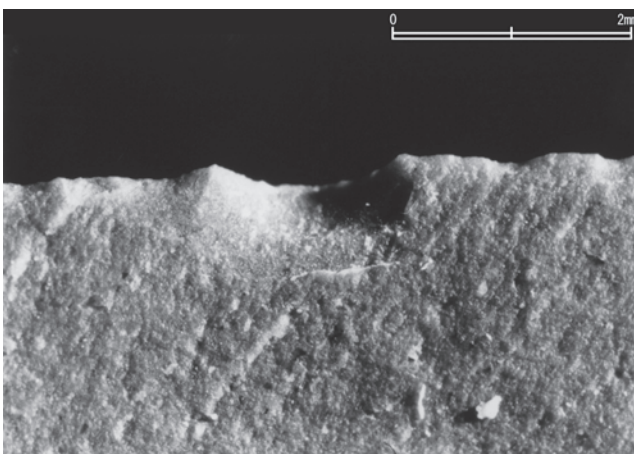
(2) 2.1-1. plant cut 2200st (SH140v) 8x



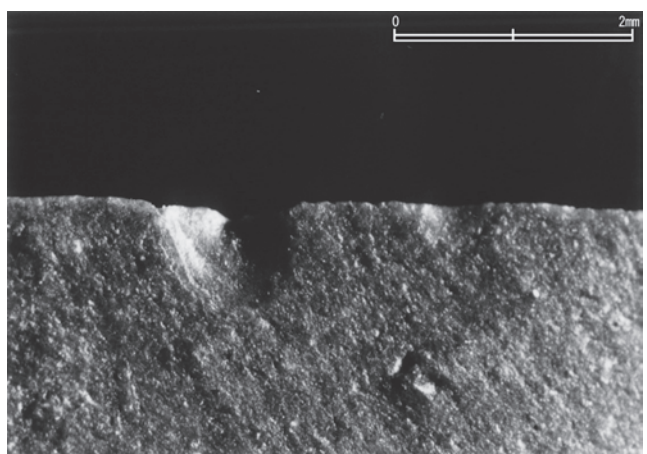
(3) 2.1-1. plant cut 2200st (SH140v) 8x



(4) 2.1-1. plant cut 2200st (SH140v) 8x

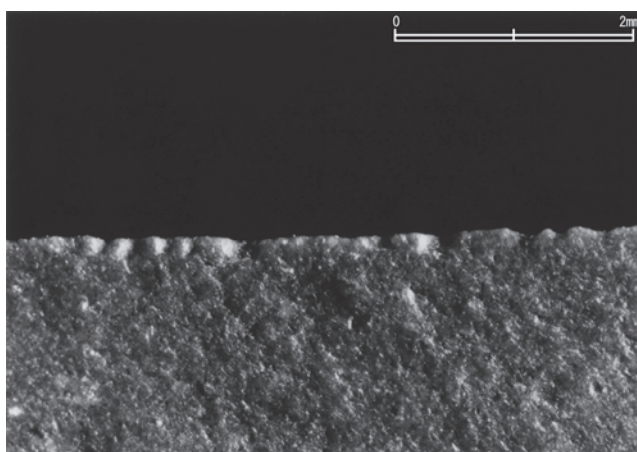


(5) 2.2-1. plant cut 2200st (SH140v) 8x

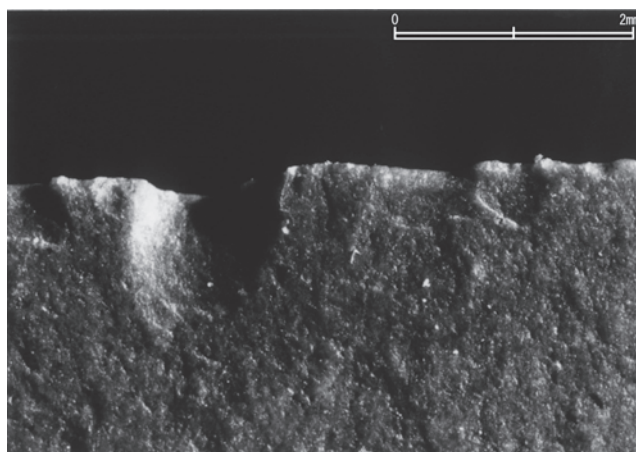


(6) 2.2-1. plant cut 15m (SH1d) 8x

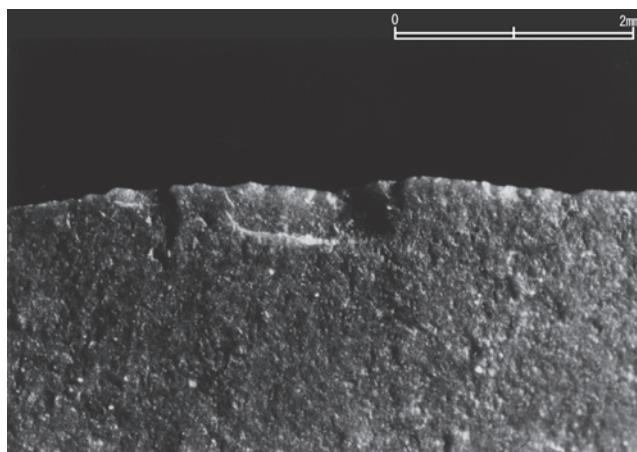
Figure 42. Experimental microflaking scars. (soft worked materials)



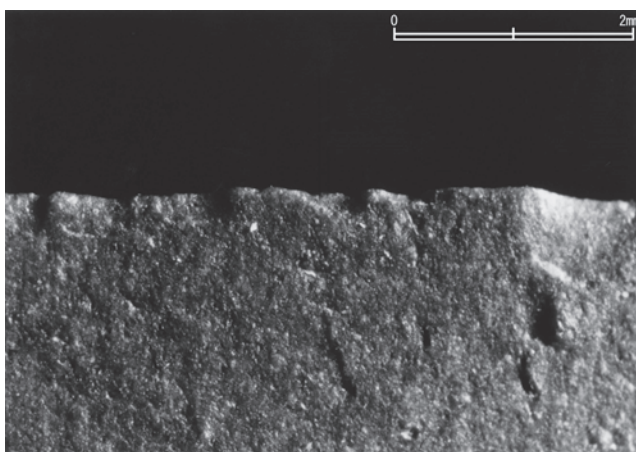
(1) 2.2-1. plant cut 15m (SH1d) 8x



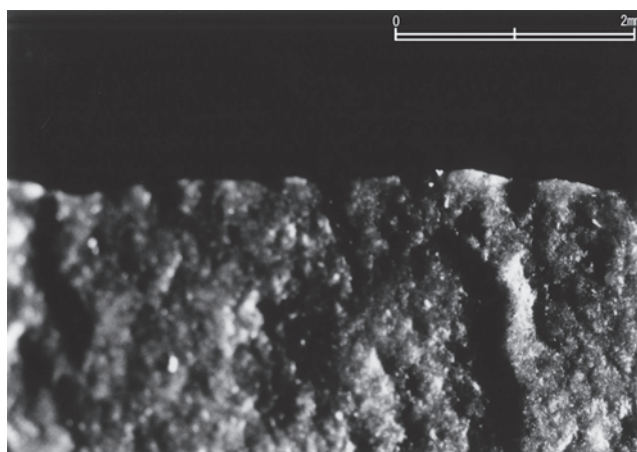
(2) 2.2-1. plant cut 15m (SH1v) 8x



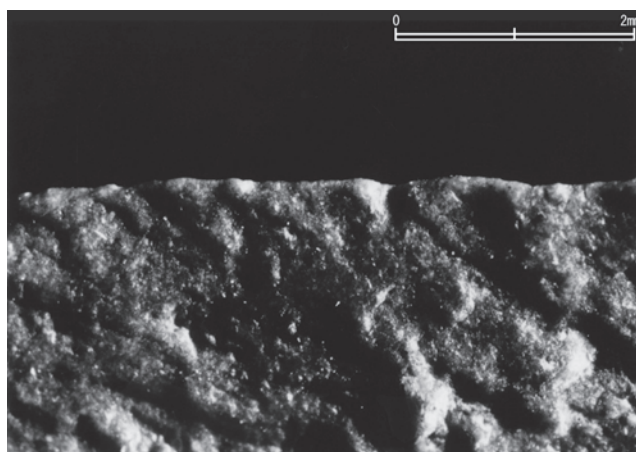
(3) 2.2-1. plant cut 15m (SH1v) 8x



(4) 2.2-1. plant cut 15m (SH1v) 8x

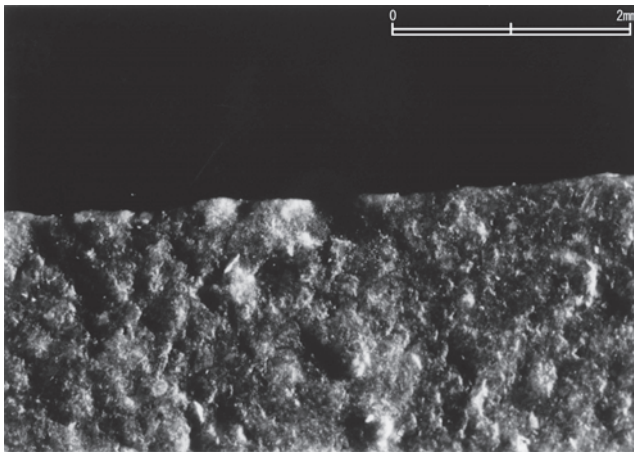


(5) 2.2-1. plant cut 25m (SH11d) 8x

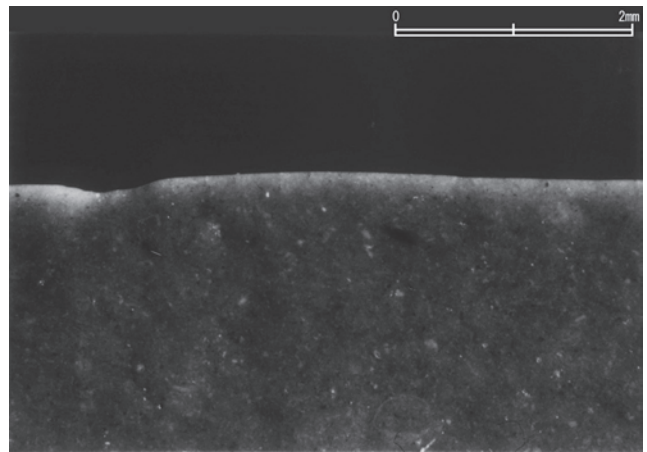


(6) 2.2-1. plant cut 25m (SH11d) 8x

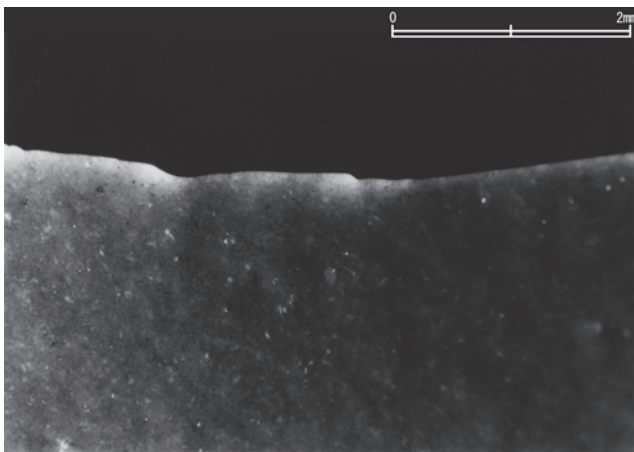
Figure 43. Experimental microflaking scars. (soft worked materials)



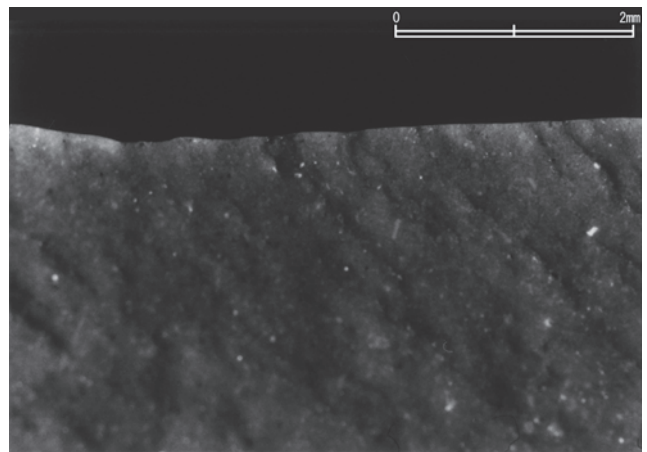
(1) 2.2-1. plant cut 25m (SH11v) 8x



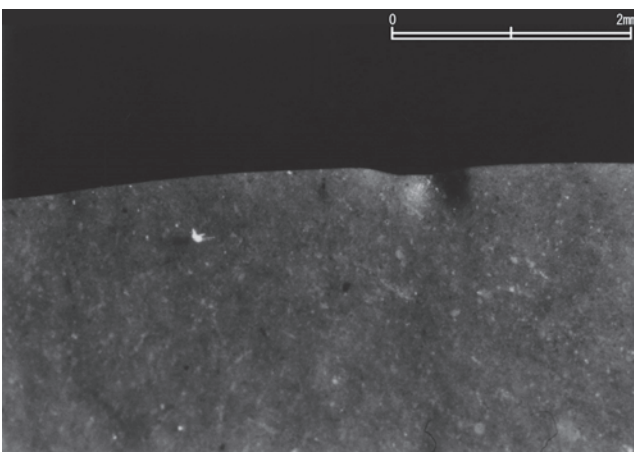
(2) 2.3-1. plant cut 3000st (SH43d) 8x



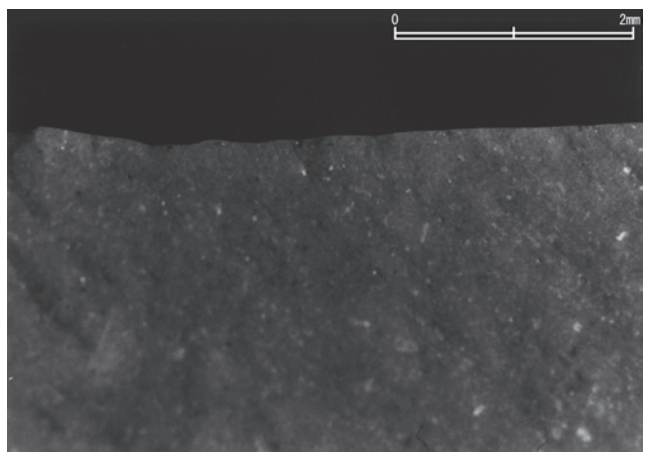
(3) 2.3-1. plant cut 3000st (SH43d) 8x



(4) 2.3-1. plant cut 3000st (SH43v) 8x

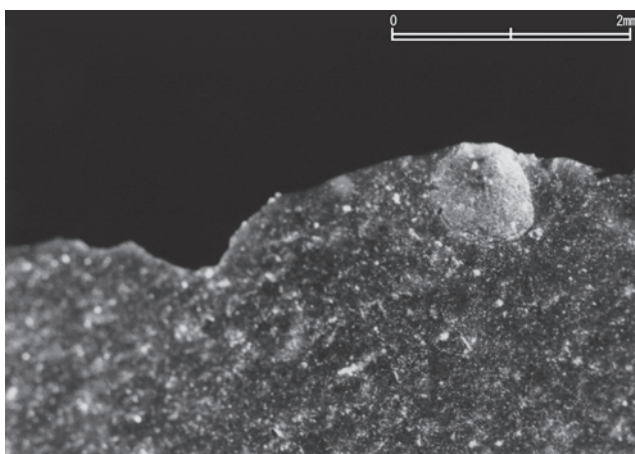


(5) 2.3-1. plant cut 3000st (SH43v) 8x

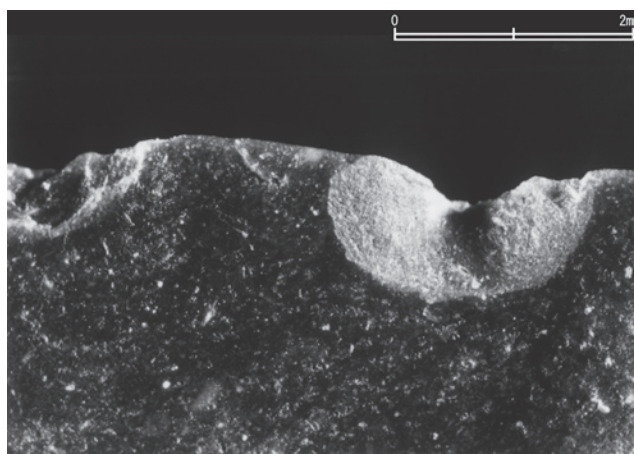


(6) 2.3-1. plant cut 3000st (SH43v) 8x

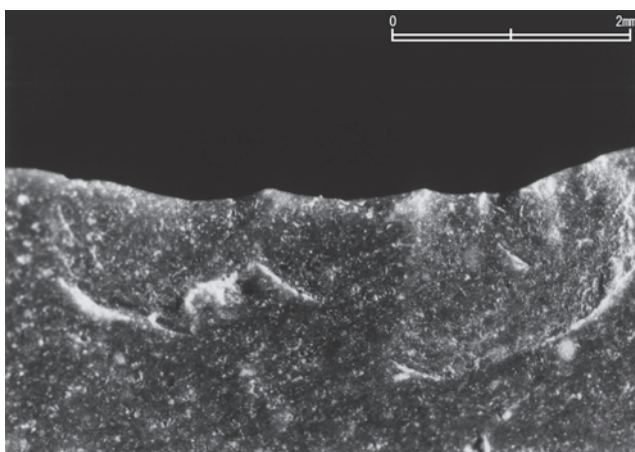
Figure 44. Experimental microflaking scars. (soft worked materials)



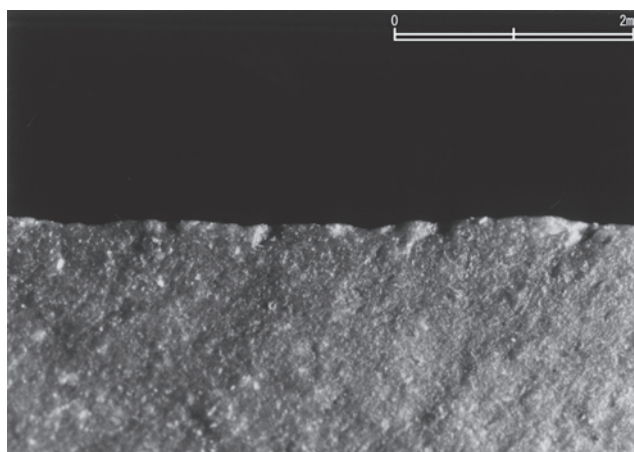
(1) 2.3-1. plant cut 3000st (SH45d) 8x



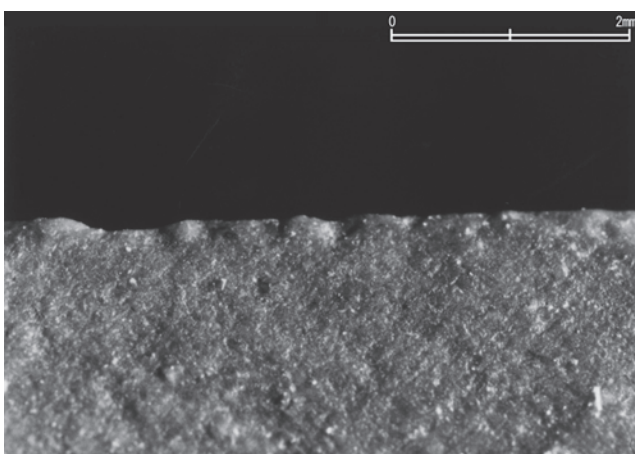
(2) 2.3-1. plant cut 3000st (SH45v) 8x



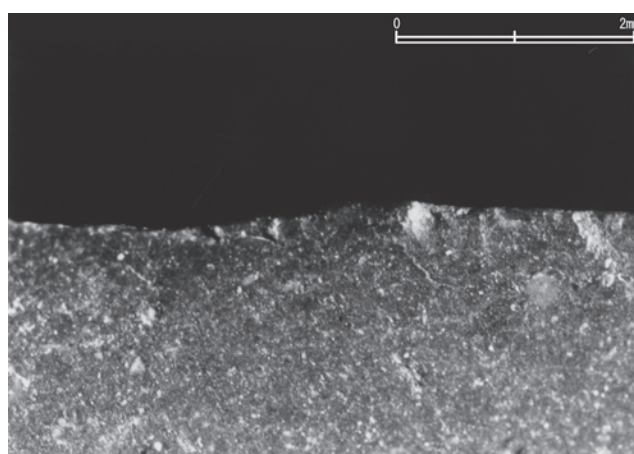
(3) 2.3-1. plant cut 3000st (SH45v) 8x



(4) 2.4-1. plant cut 2650st (SH42d) 8x

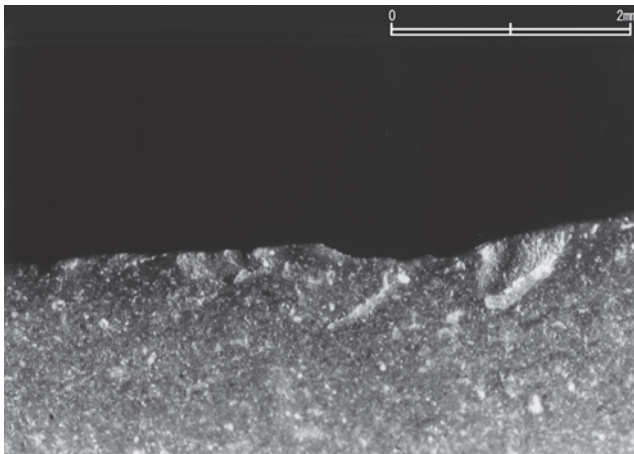


(5) 2.4-1. plant cut 2650st (SH42v) 8x

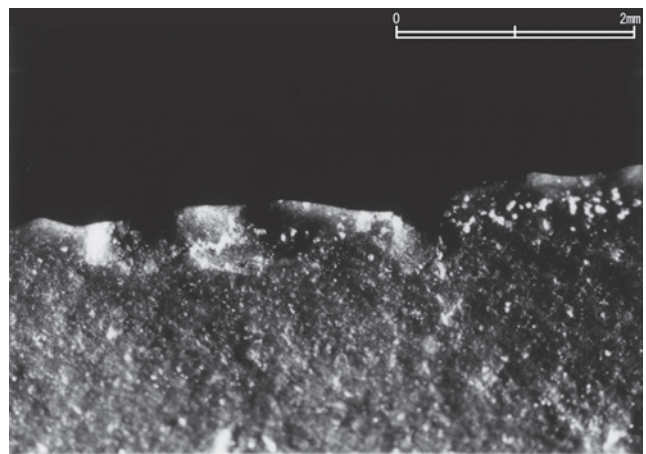


(6) 2.4-1. plant cut 3000st (SH40d) 8x

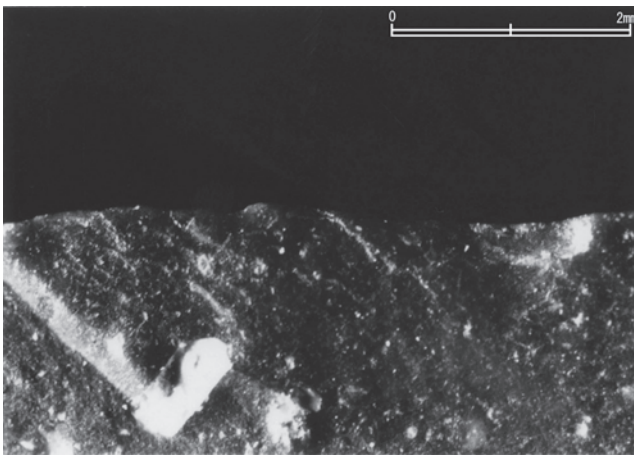
Figure 45. Experimental microflaking scars. (soft worked materials)



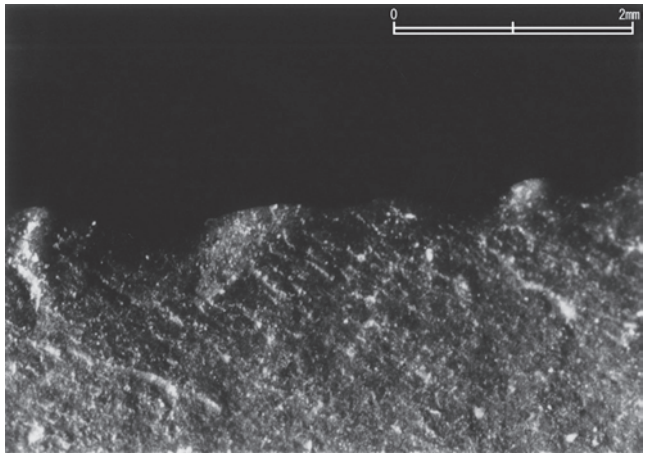
(1) 2.4-1. plant cut 3000st (SH40d) 8x



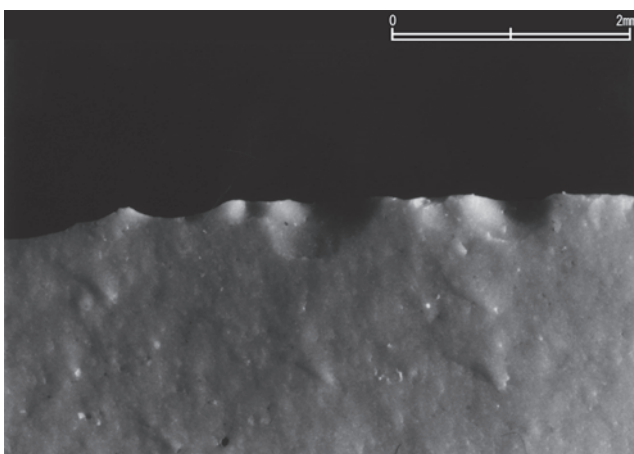
(2) 2.4-1. plant cut 3000st (SH40d) 8x



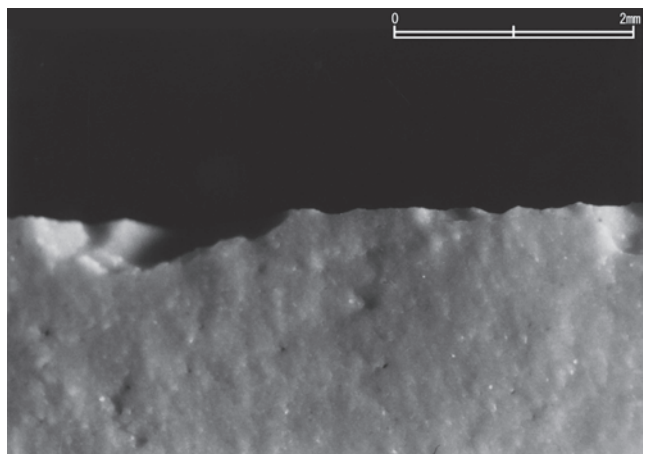
(3) 2.4-1. plant cut 3000st (SH40v) 8x



(4) 2.4-1. plant cut 3000st (SH40v) 8x

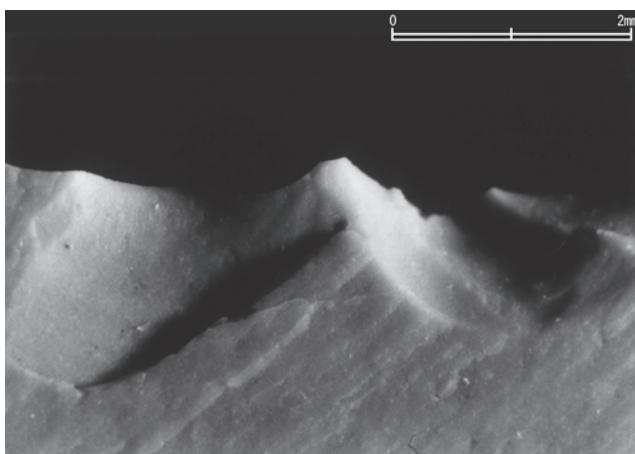


(5) 2.5-1. plant cut 800st (SH66d) 8x

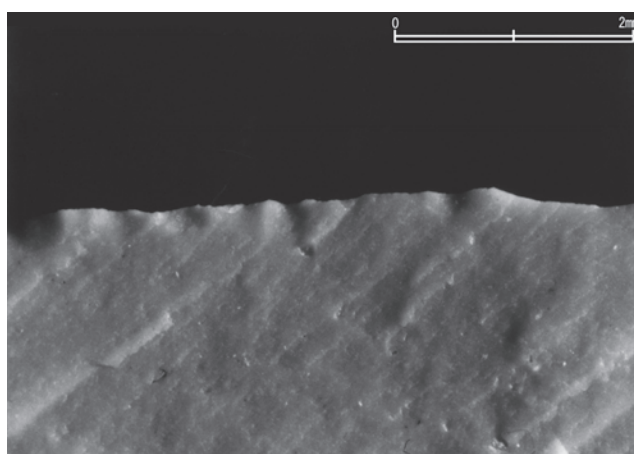


(6) 2.5-1. plant cut 800st (SH66d) 8x

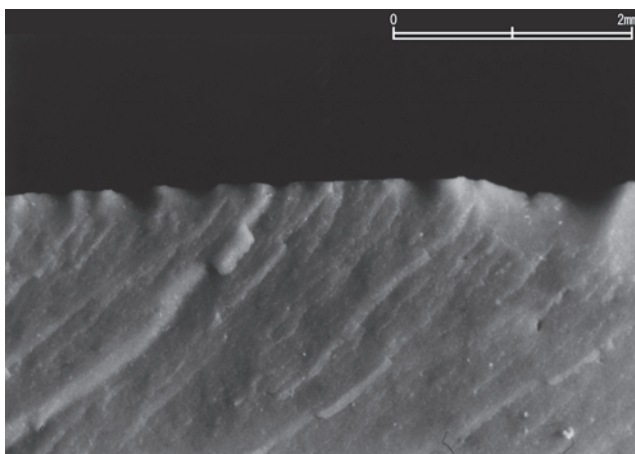
Figure 46. Experimental microflaking scars. (soft worked materials)



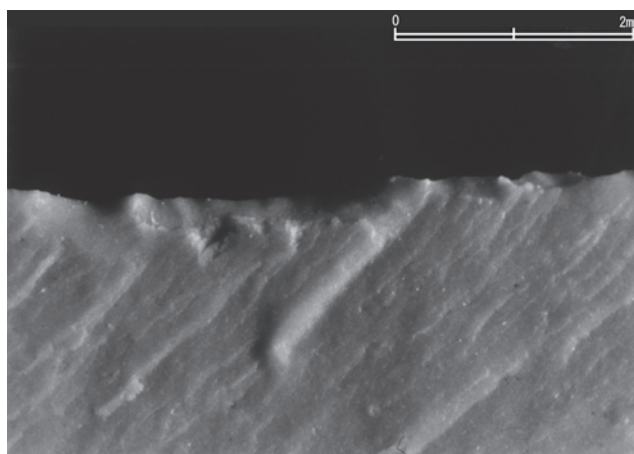
(1) 2.5-1. plant cut 800st (SH66v) 8x



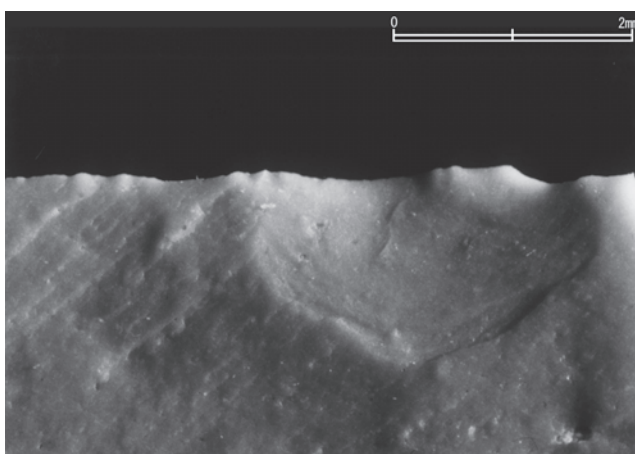
(2) 2.5-1. plant cut 800st (SH66v) 8x



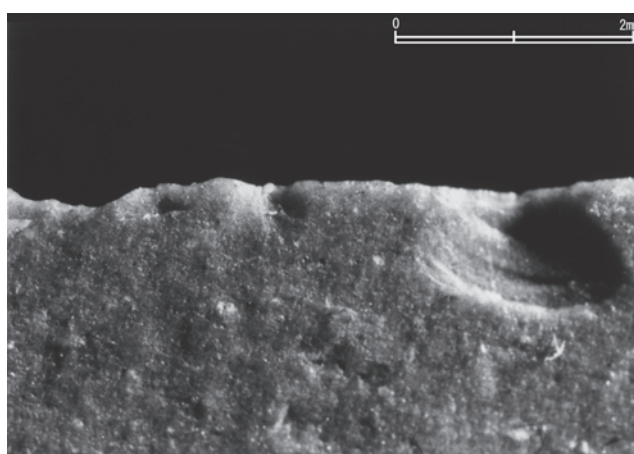
(3) 2.5-1. plant cut 800st (SH66v) 8x



(4) 2.5-1. plant cut 800st (SH66v) 8x

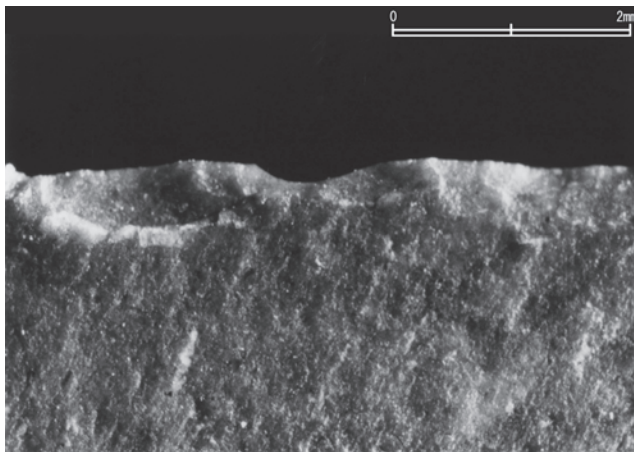


(5) 2.5-1. plant cut 800st (SH66v) 8x

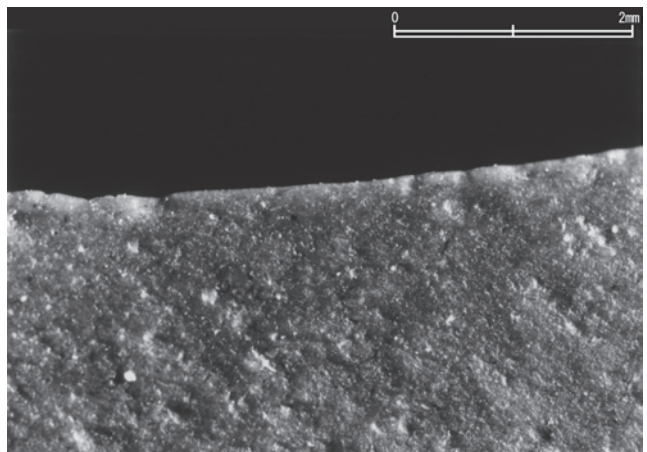


(6) 2.5-1. plant cut 2200st (SH141d) 8x

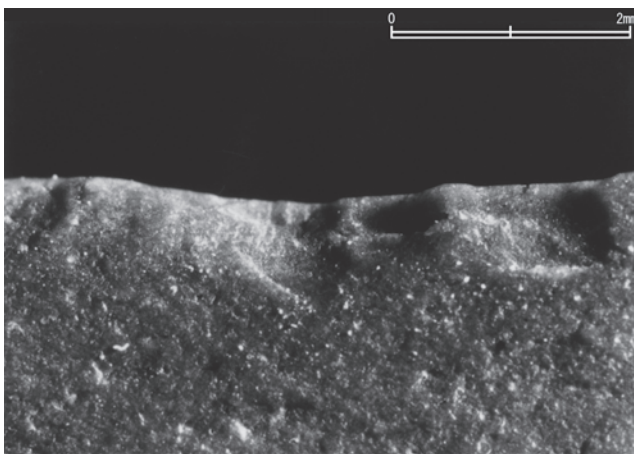
Figure 47. Experimental microflaking scars. (soft worked materials)



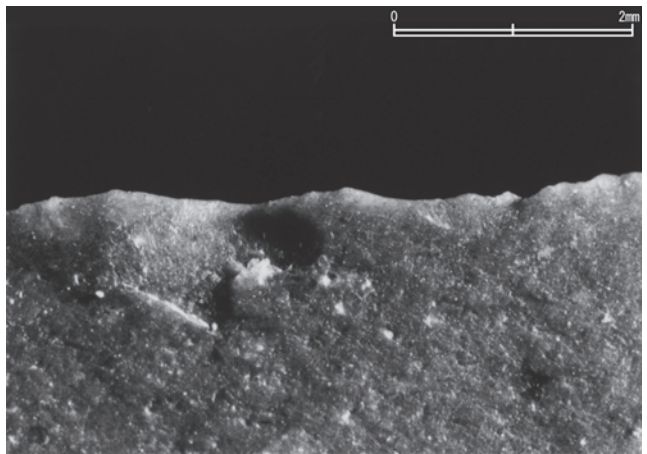
(1) 2.5-1. plant cut 2200st (SH141d) 8x



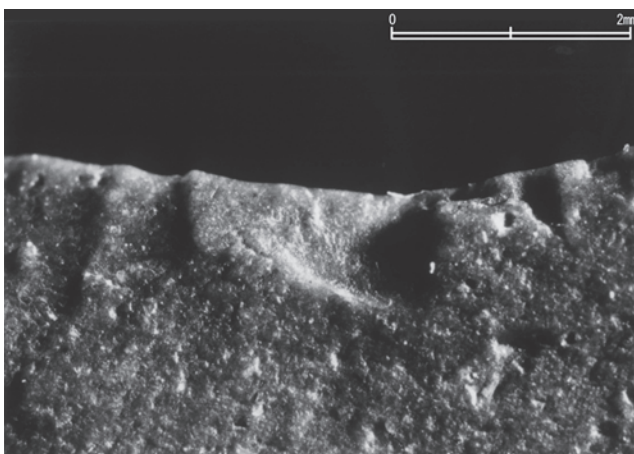
(2) 2.5-1. plant cut 2200st (SH141v) 8x



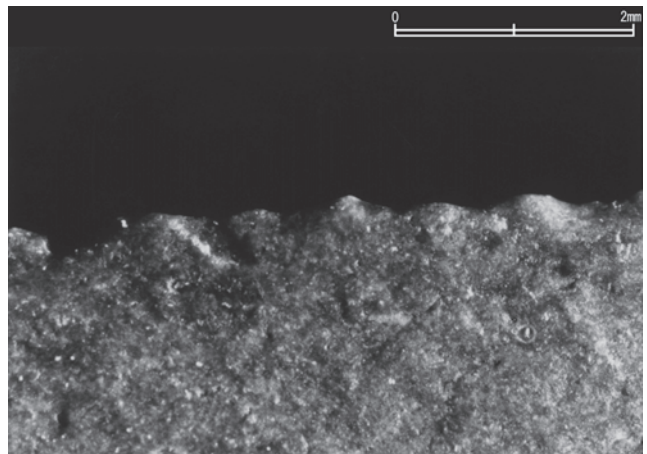
(3) 2.4-1. plant cut 2200st (SH141v) 8x



(4) 2.5-1. plant cut 2200st (SH141v) 8x

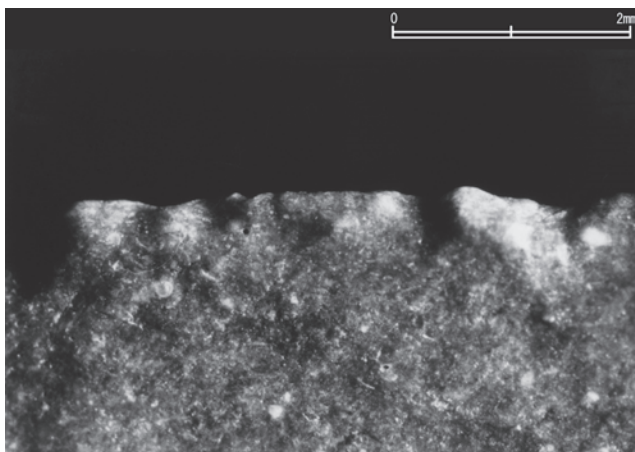


(5) 2.5-1. plant cut 2200st (SH141v) 8x

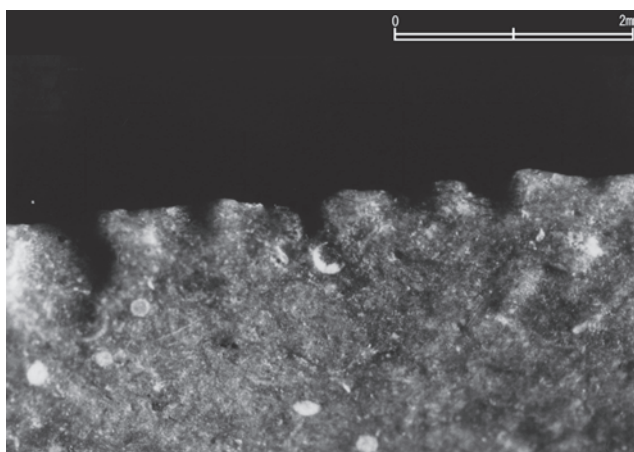


(6) 3.1-4. hide scrape 800st (SH124d) 8x

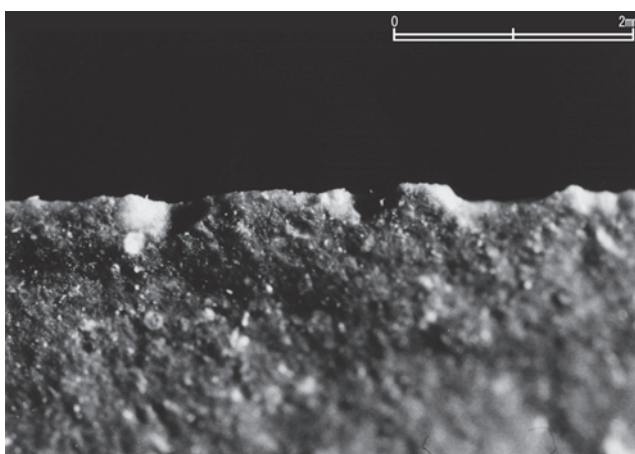
Figure 48. Experimental microflaking scars. (soft worked materials)



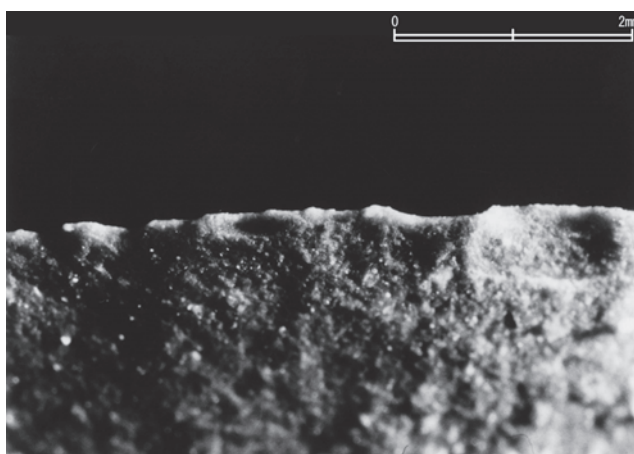
(1) 3.1-4. hide scrape 800st (SH124v) 8x



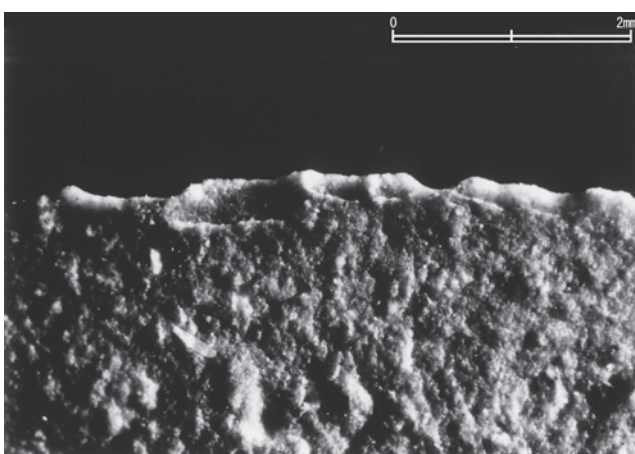
(2) 3.1-4. hide scrape 800st (SH124v) 8x



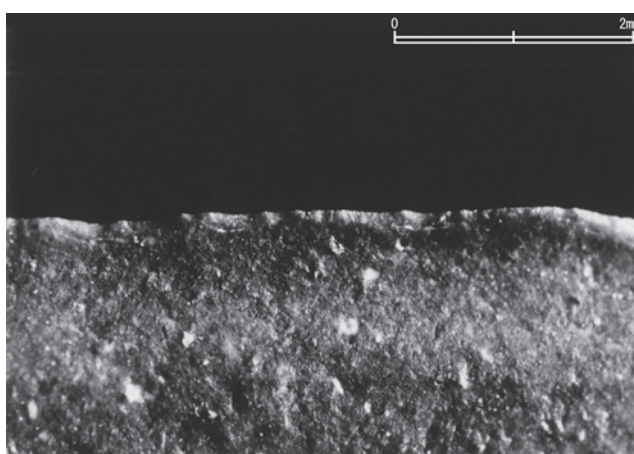
(3) 3.1-4. hide scrape 2000st (SH120A) 8x



(4) 3.1-4. hide scrape 2000st (SH120A) 8x

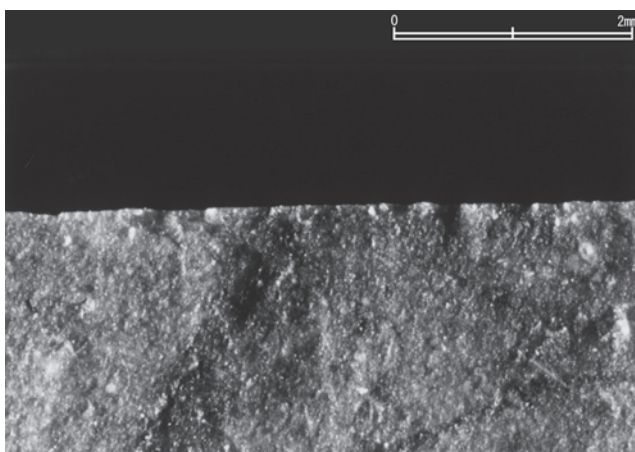


(5) 3.1-4. hide scrape 2000st (SH120A) 8x

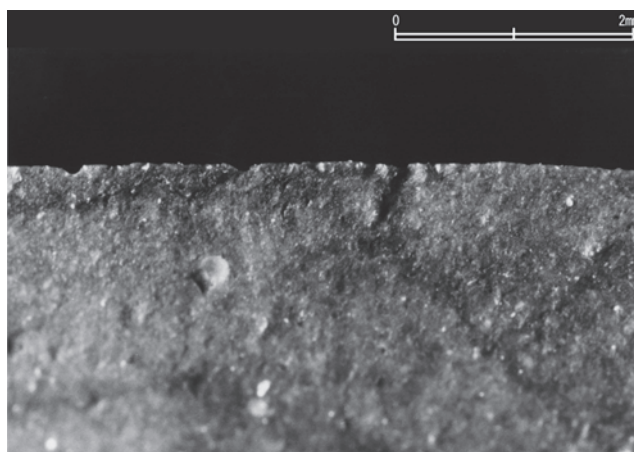


(6) 3.1-4. hide scrape 2000st (SH120A) 8x

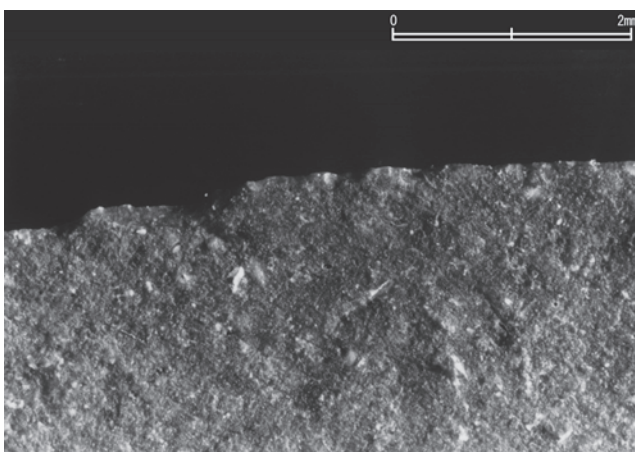
Figure 49. Experimental microflaking scars. (soft worked materials)



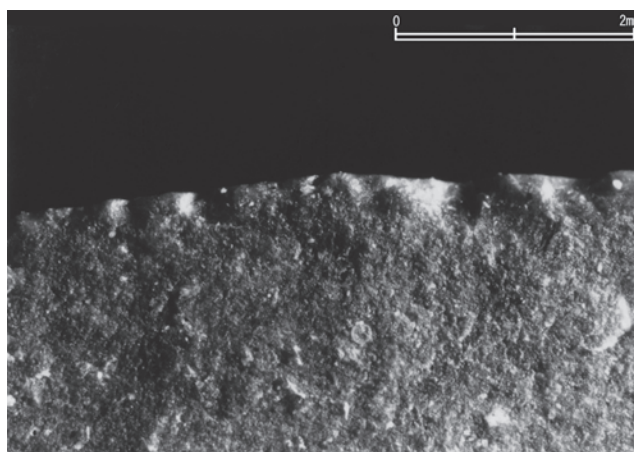
(1) 3.1-4. hide scrape 2000st (SH121d) 8x



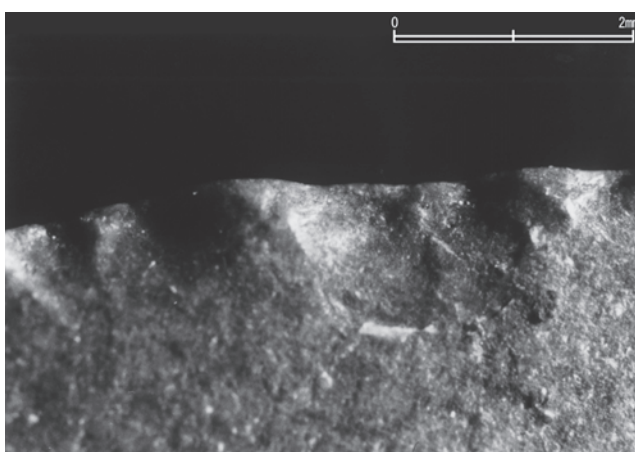
(2) 3.1-4. hide scrape 2000st (SH121v) 8x



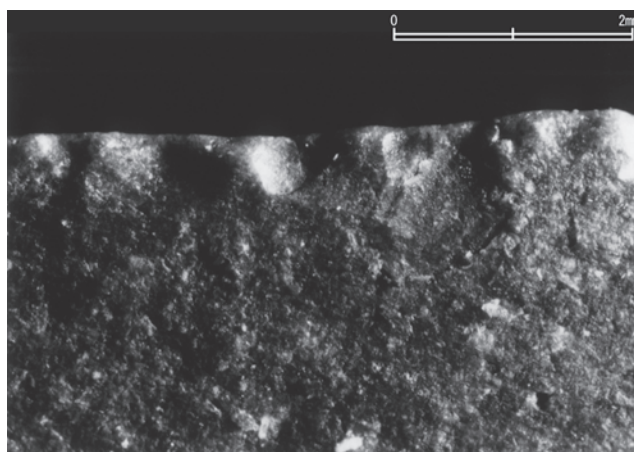
(3) 3.1-4. hide scrape 2000st (SH122v) 8x



(4) 3.1-4. hide scrape 2000st (SH123d) 8x

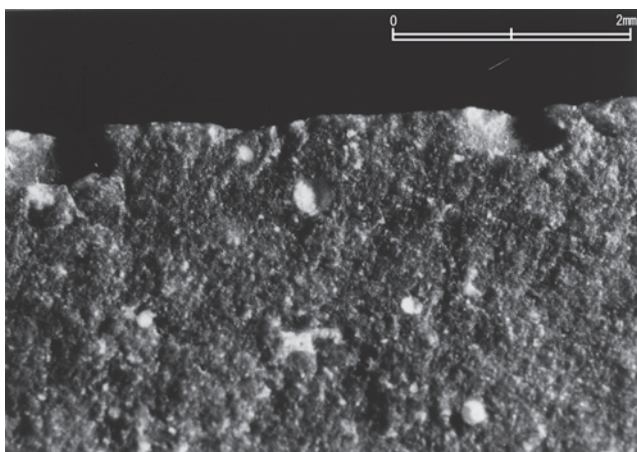


(5) 3.1-4. hide scrape 2000st (SH123d) 8x

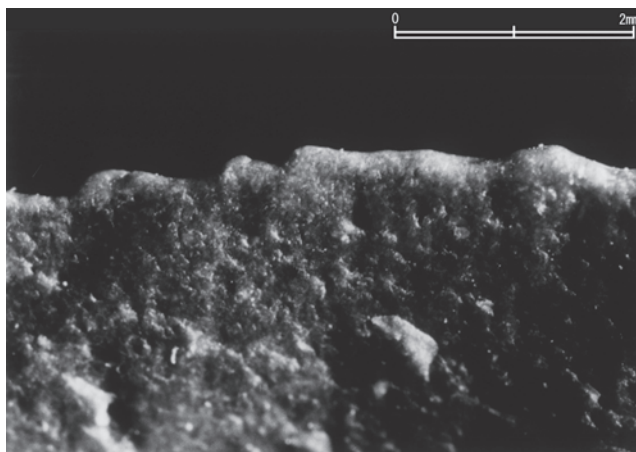


(6) 3.1-4. hide scrape 2000st (SH123d) 8x

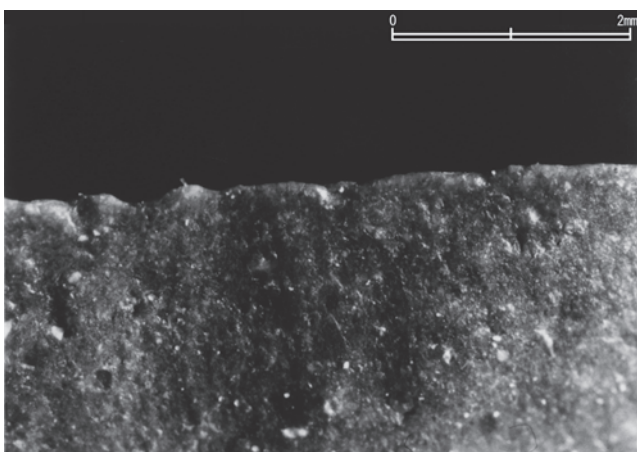
Figure 50. Experimental microflaking scars. (soft worked materials)



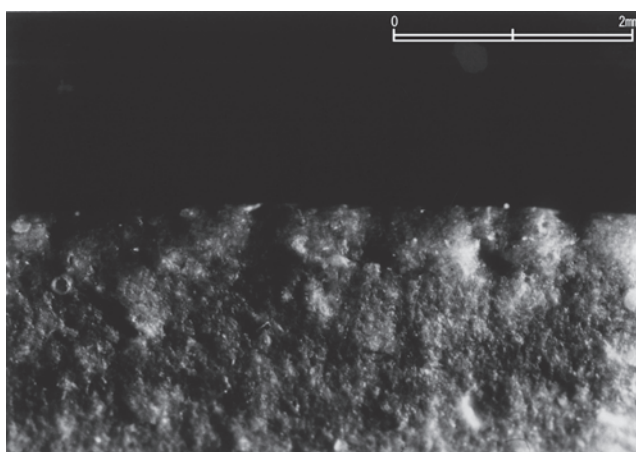
(1) 3.1-4. hide scrape 2000st (SH123d) 8x



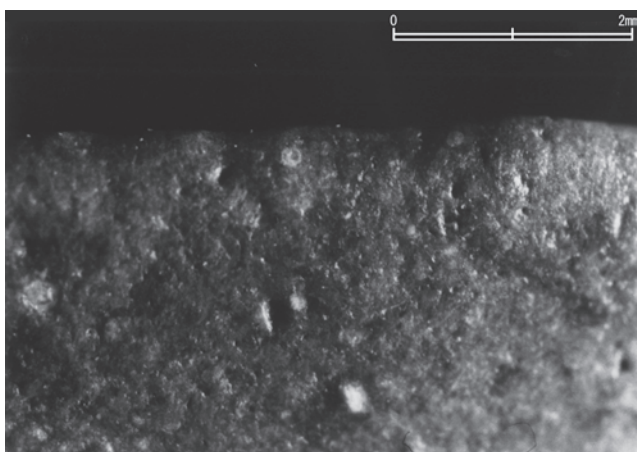
(2) 3.1-4. hide scrape 2000st (SH123v) 8x



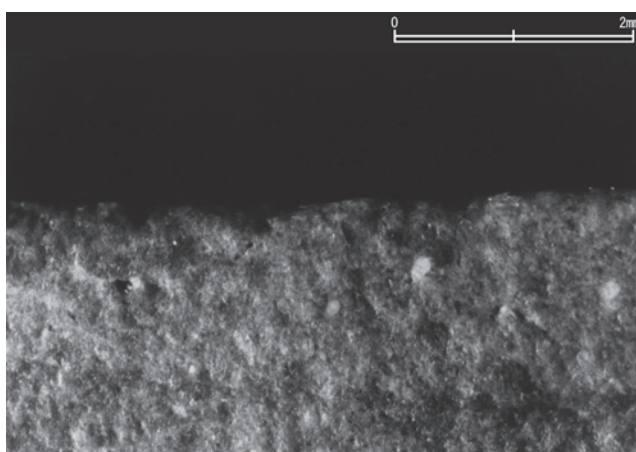
(3) 3.1-4. hide scrape 2000st (SH123v) 8x



(4) 3.1-4. hide scrape 2000st (SH125A) 8x

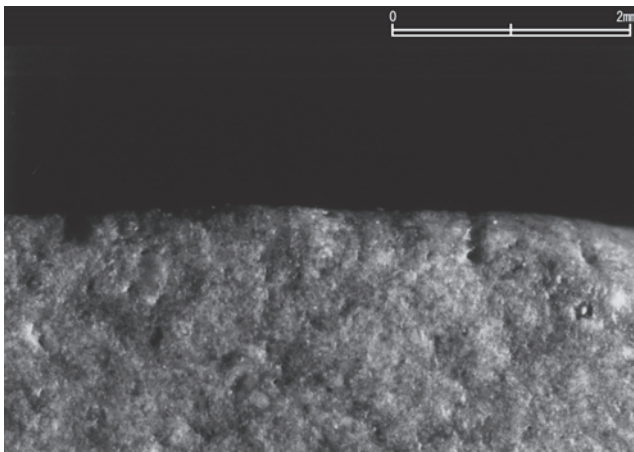


(5) 3.1-4. hide scrape 2000st (SH125B) 8x

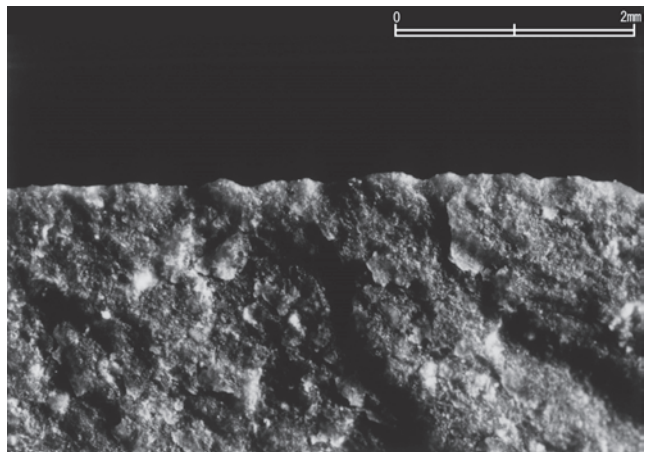


(6) 3.1-4. hide scrape 2000st (SH126d) 8x

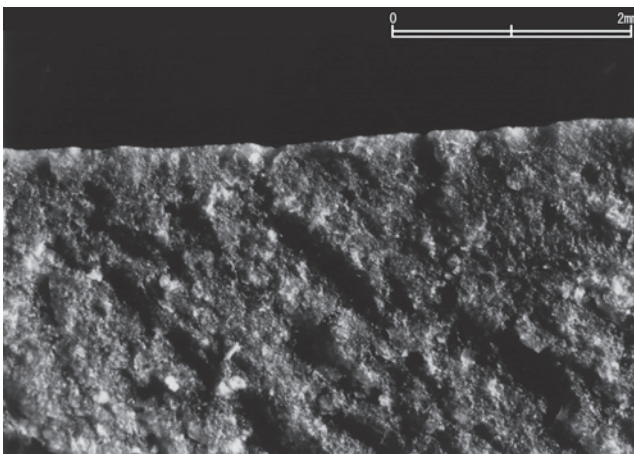
Figure 51. Experimental microflaking scars. (soft worked materials)



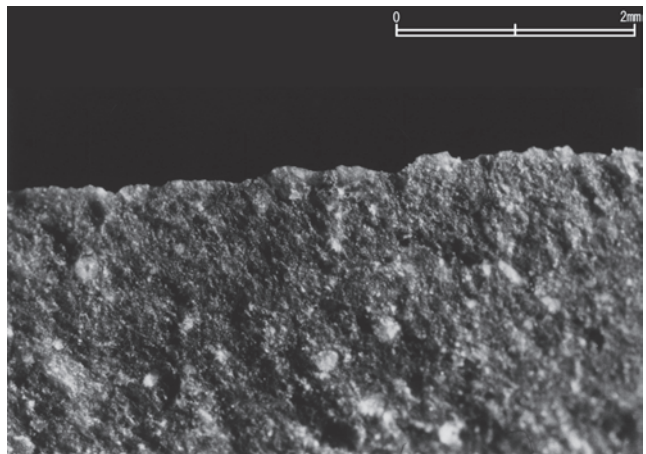
(1) 3.1-4. hide scrape 2000st (SH126v) 8x



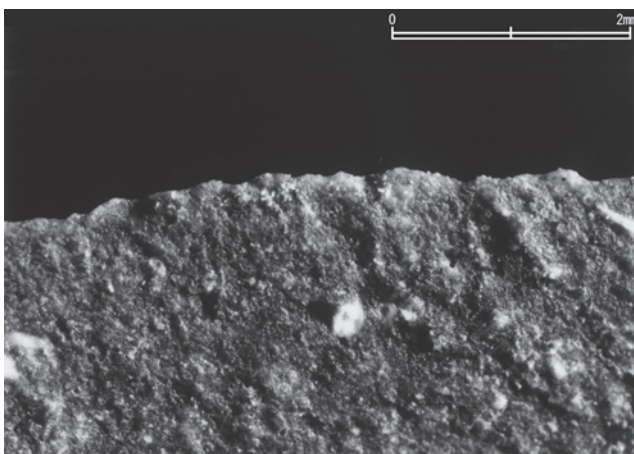
(2) 3.2-4. hide scrape 2000st (SH128d) 8x



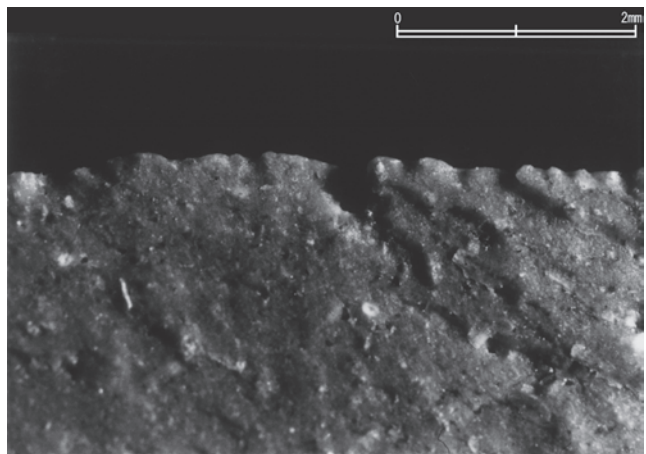
(3) 3.2-4. hide scrape 2000st (SH128d) 8x



(4) 3.2-4. hide scrape 2000st (SH128v) 8x

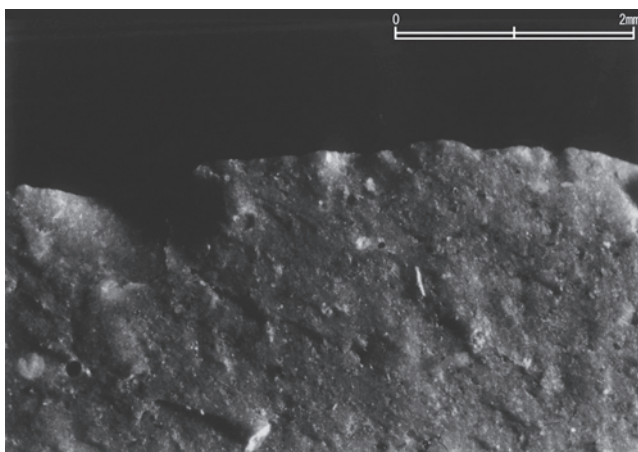


(5) 3.2-4. hide scrape 2000st (SH128v) 8x

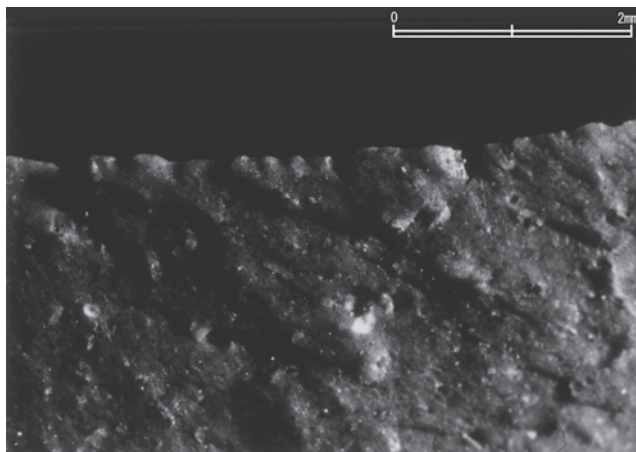


(6) 3.2-4. hide scrape 4000st (SH129v) 8x

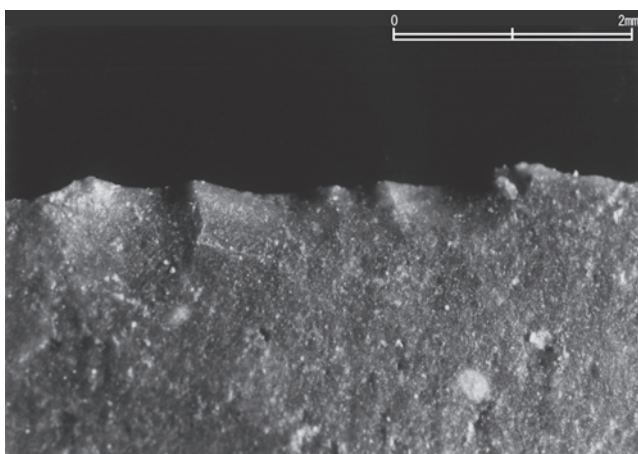
Figure 52. Experimental microflaking scars. (soft worked materials)



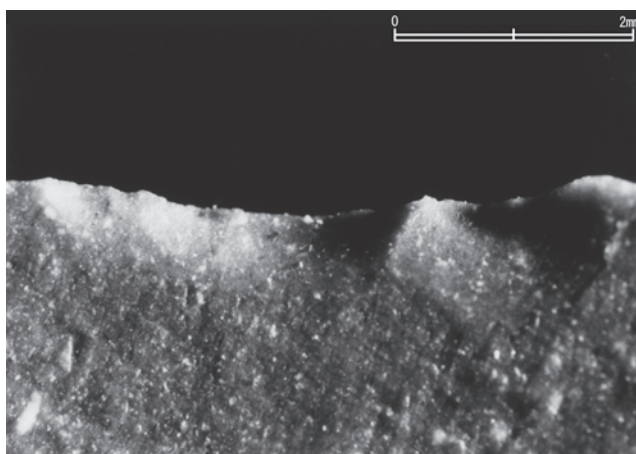
(1) 3.2-4. hide scrape 4000st (SH129v) 8x



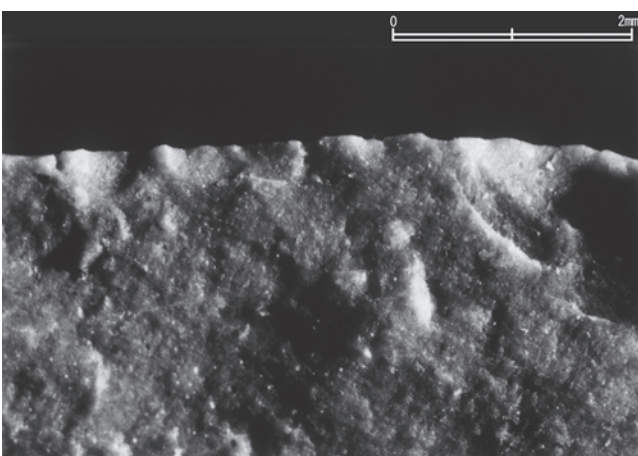
(2) 3.2-4. hide scrape 4000st (SH129v) 8x



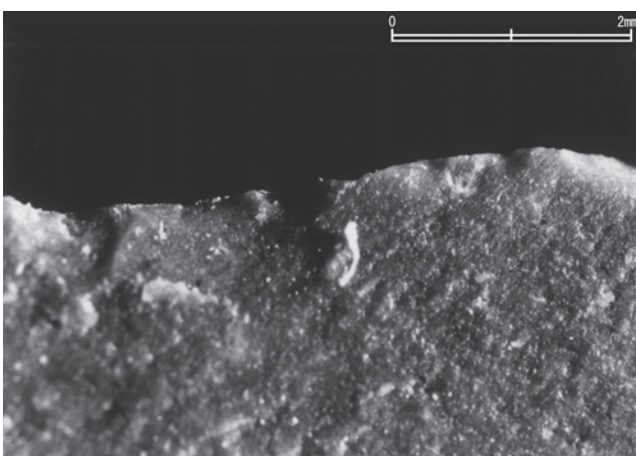
(3) 3.3-2. hide saw 5000st (SH76d) 8x



(4) 3.3-2. hide saw 5000st (SH76d) 8x

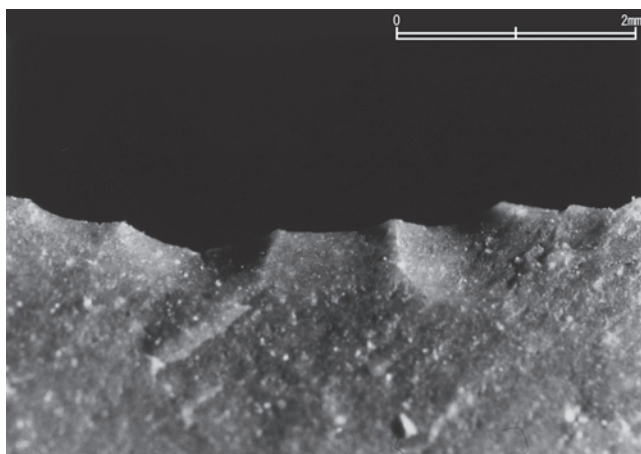


(5) 3.3-2. hide saw 5000st (SH76d) 8x

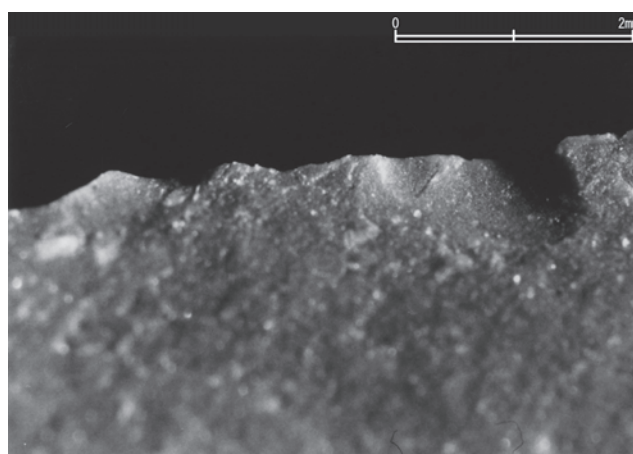


(6) 3.3-2. hide saw 5000st (SH76v) 8x

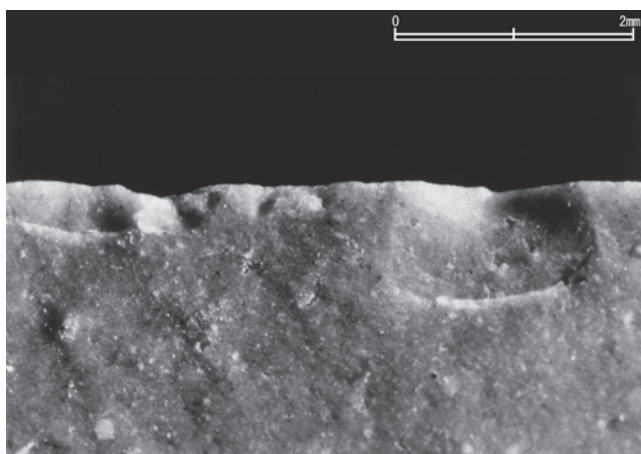
Figure 53. Experimental microflaking scars. (soft worked materials)



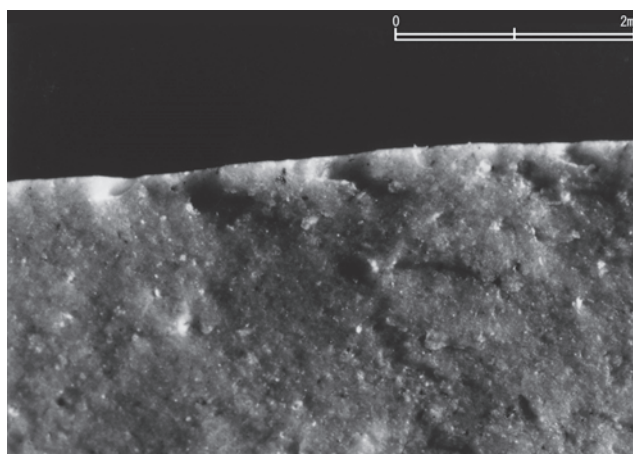
(1) 3.3-2. hide saw 5000st (SH76v) 8x



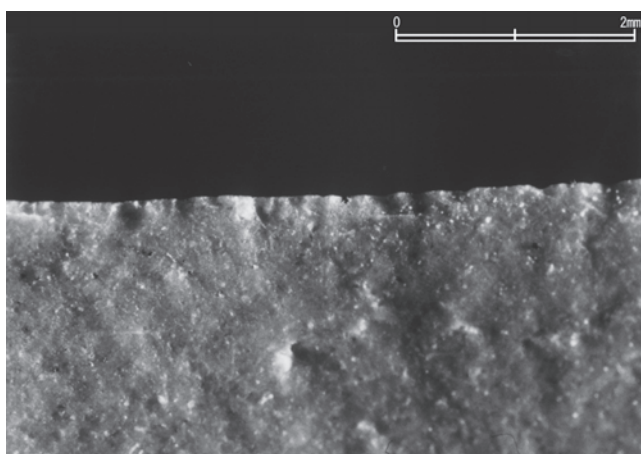
(2) 3.3-2. hide saw 5000st (SH76v) 8x



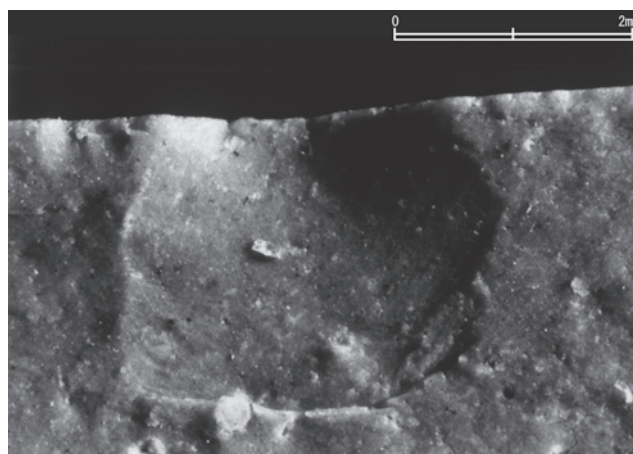
(3) 3.3-4. hide scrape 1000st (SH146d) 8x



(4) 3.2-4. hide scrape 1000st (SH146d) 8x

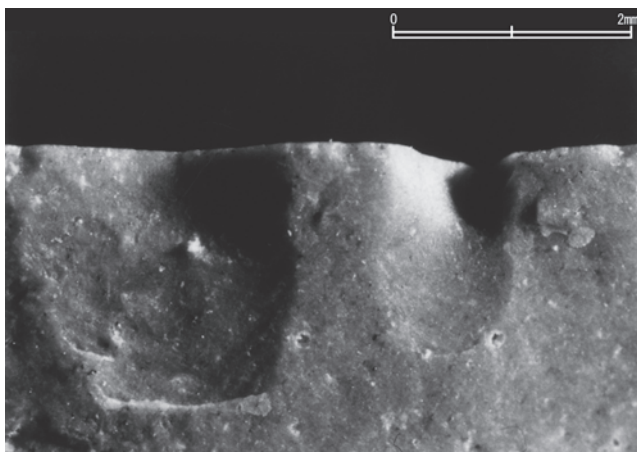


(5) 3.3-4. hide scrape 1000st (SH146d) 8x

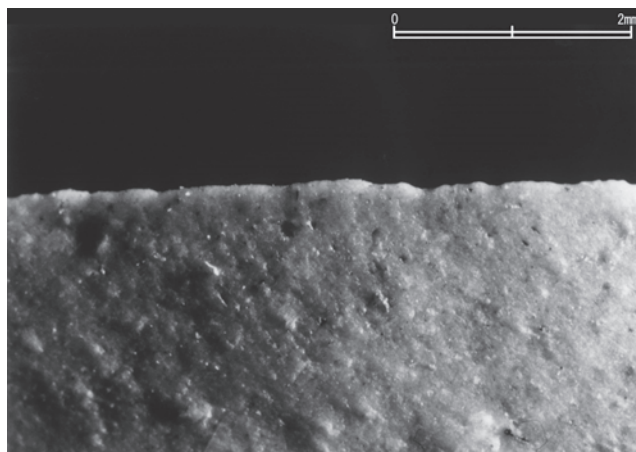


(6) 3.3-4. hide scrape 1000st (SH146d) 8x

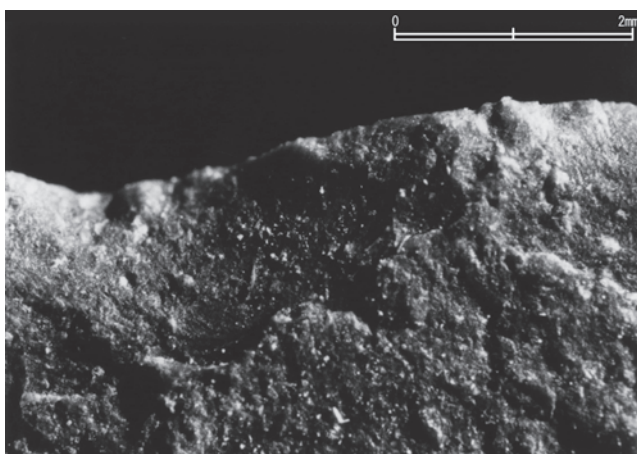
Figure 54. Experimental microflaking scars. (soft worked materials)



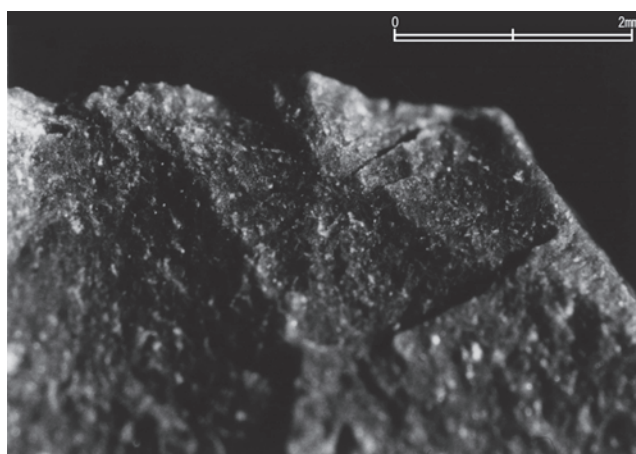
(1) 3.3-4. hide scrape 1000st (SH146v) 8x



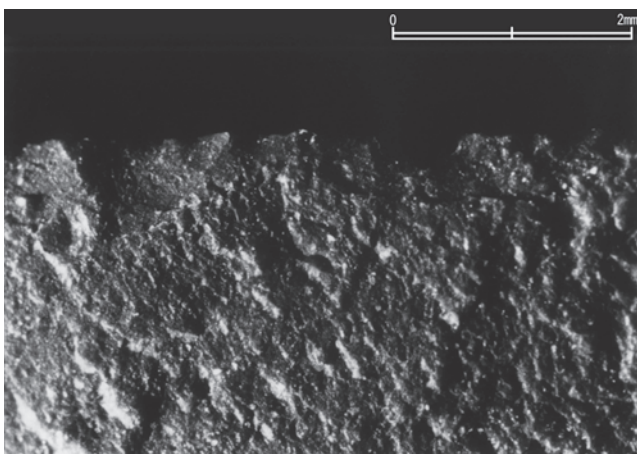
(2) 3.3-4. hide scrape 1000st (SH146v) 8x



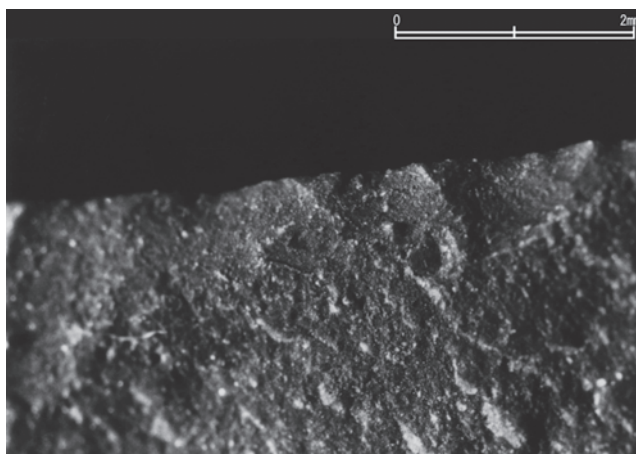
(3) 3.3-4. hide scrape 1500st (SH130A) 8x



(4) 3.3-4. hide scrape 1500st (SH130A) 8x

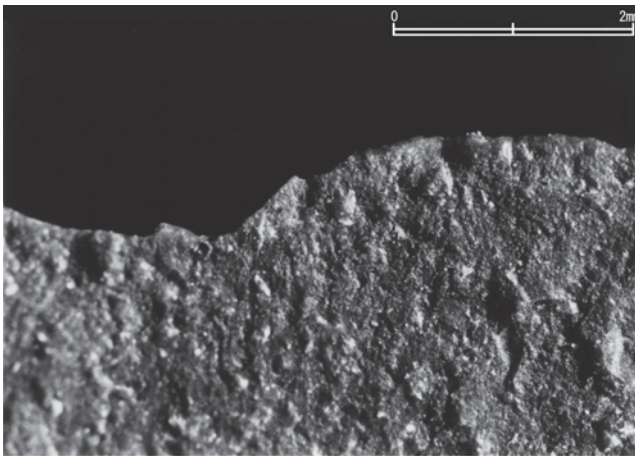


(5) 3.3-4. hide scrape 1500st (SH130A) 8x

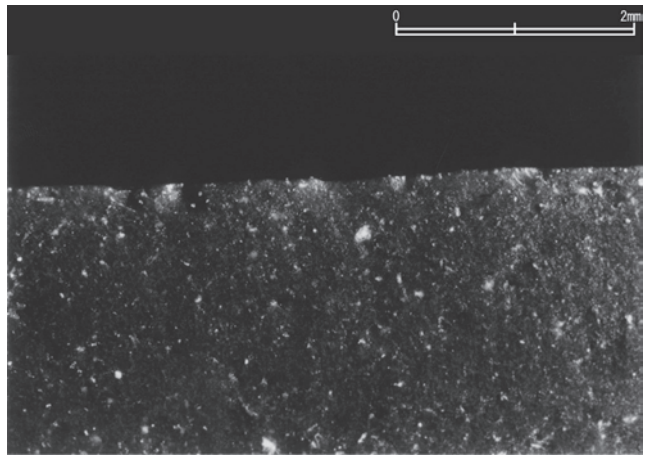


(6) 3.3-4. hide scrape 1500st (SH130A) 8x

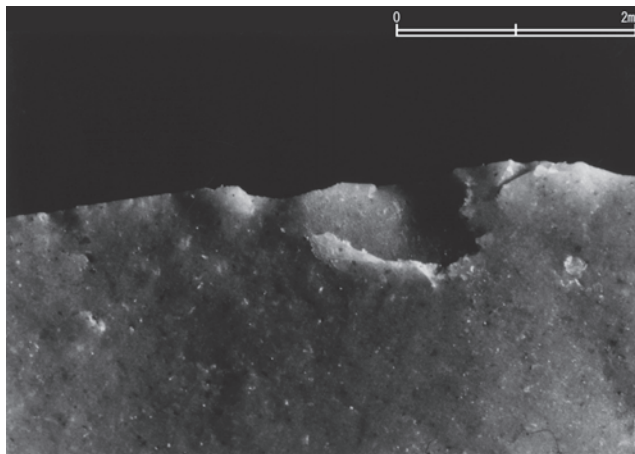
Figure 55. Experimental microflaking scars. (soft worked materials)



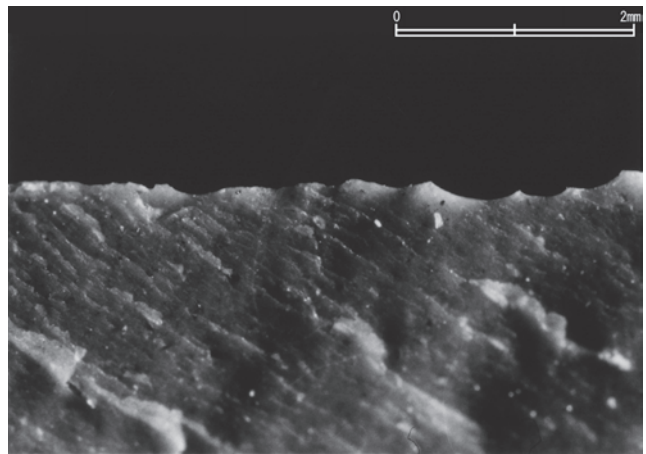
(1) 3.3-4. hide scrape 1500st (SH130B) 8x



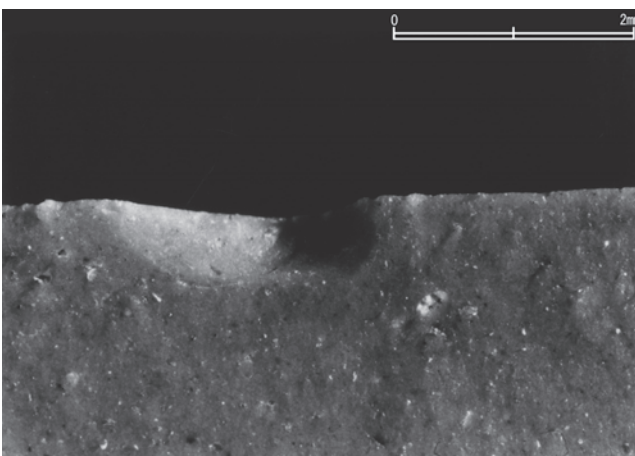
(2) 3.3-4. hide scrape 1500st (SH131) 8x



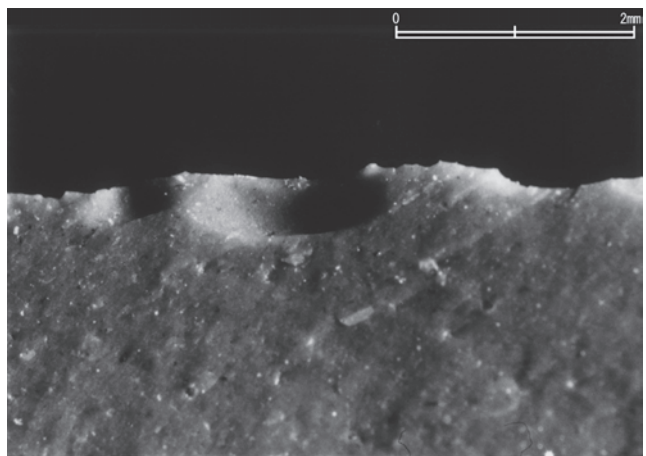
(3) 3.3-5. hide chop 306st (SH148d) 8x



(4) 3.3-5. hide chop 306st (SH148d) 8x

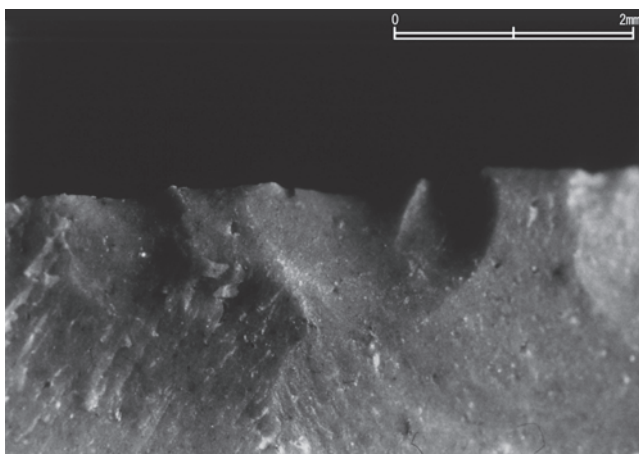


(5) 3.3-5. hide chop 306st (SH148d) 8x

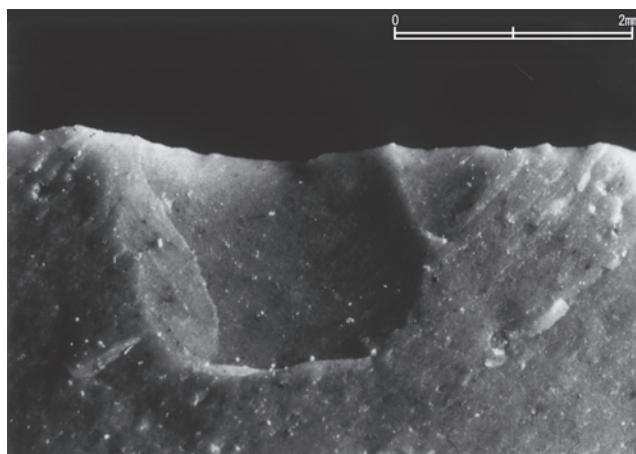


(6) 3.3-5. hide chop 306st (SH148v) 8x

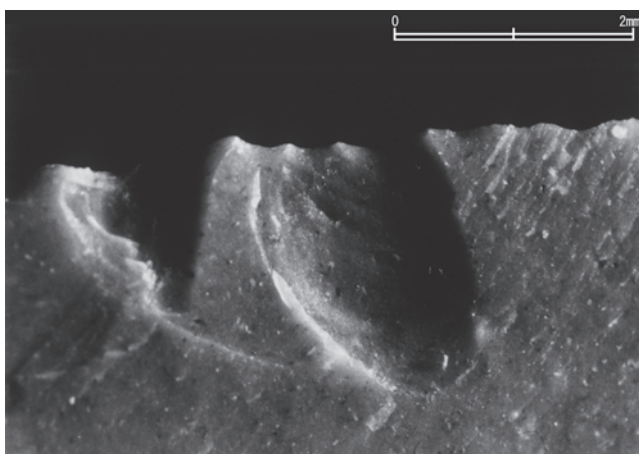
Figure 56. Experimental microflaking scars. (soft worked materials)



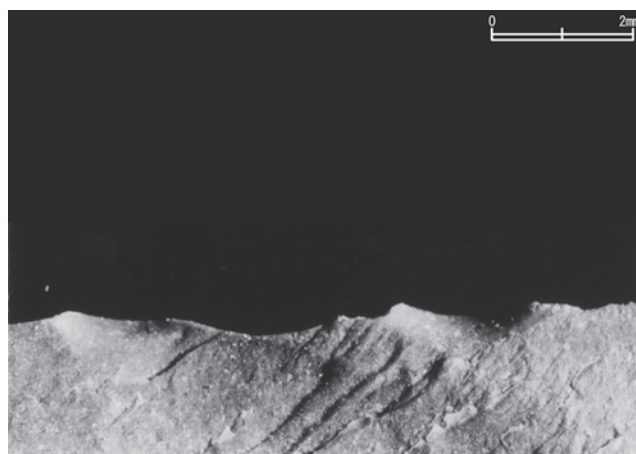
(1) 3.3-5. hide chop 306st (SH148v) 8x



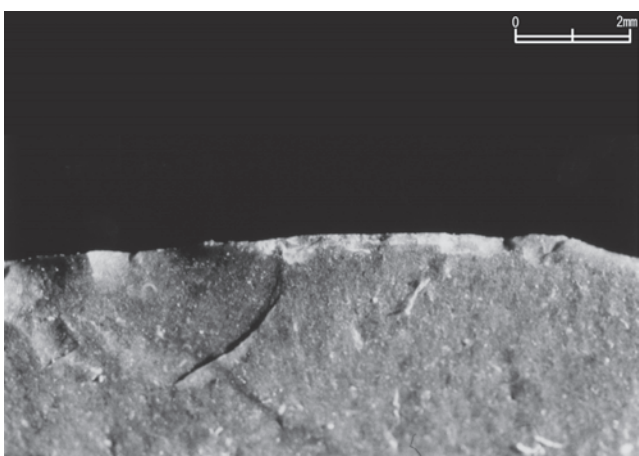
(2) 3.3-5. hide chop 306st (SH148v) 8x



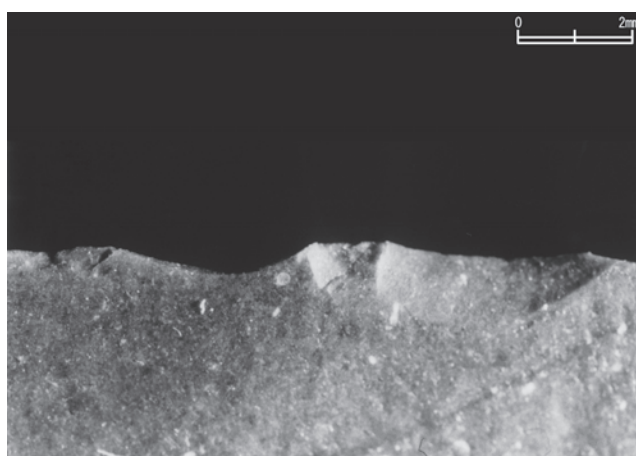
(3) 3.3-5. hide chop 306st (SH148v) 8x



(4) 4.1-2. wood saw 1000st (SH115d) 4x

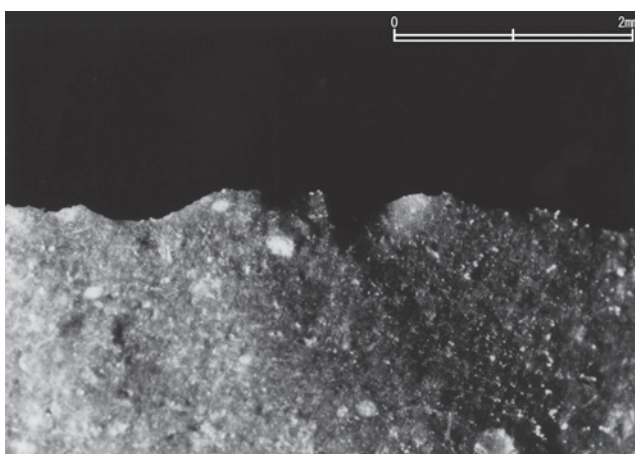


(5) 4.1-2. wood saw 1000st (SH115v) 3x

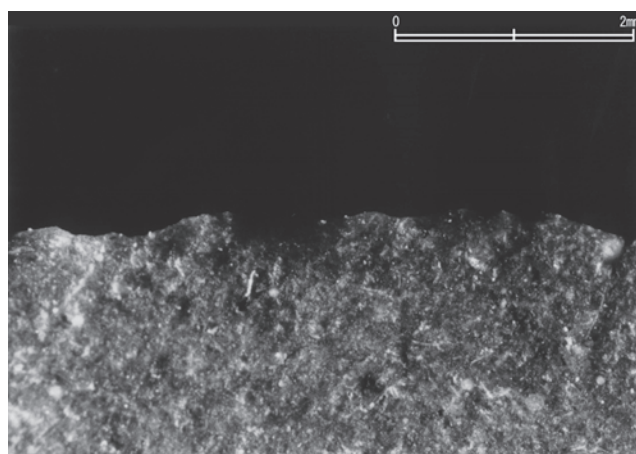


(6) 4.1-2. wood saw 1000st (SH115v) 3x

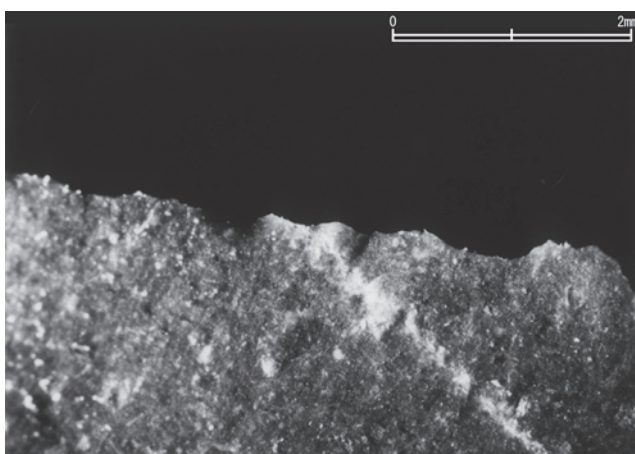
Figure 57. Experimental microflaking scars. (soft to medium worked materials)



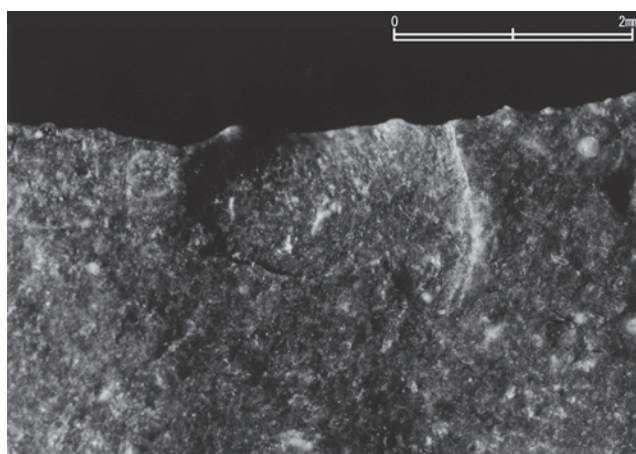
(1) 4.1-3. wood whittle 1000st (SH114v) 8x



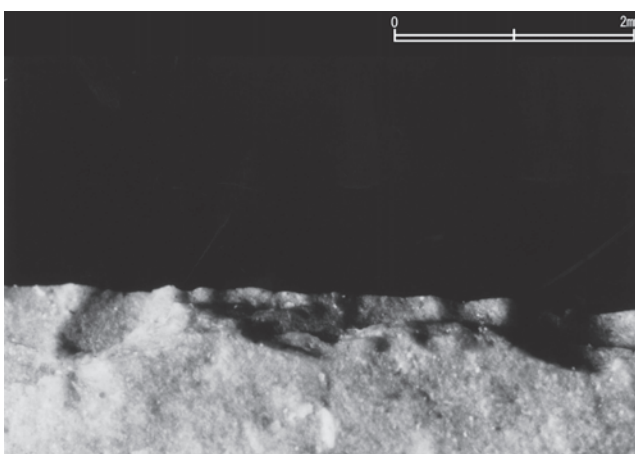
(2) 4.1-3. wood whittle 1000st (SH114v) 8x



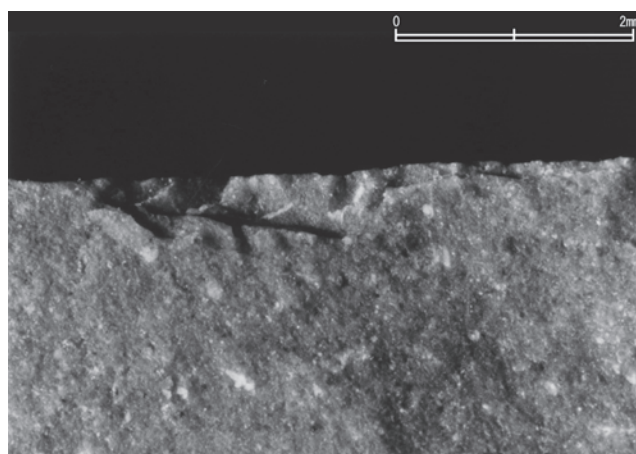
(3) 4.1-3. wood whittle 1000st (SH114v) 8x



(4) 4.1-3. wood whittle 1000st (SH114v) 8x

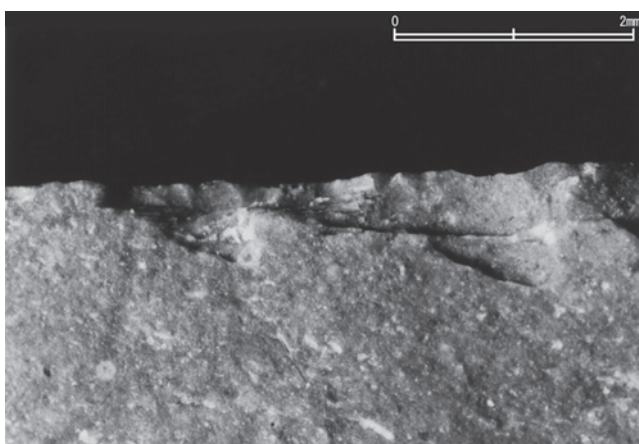


(5) 4.1-4. wood scrape 1000st (SH111d) 8x

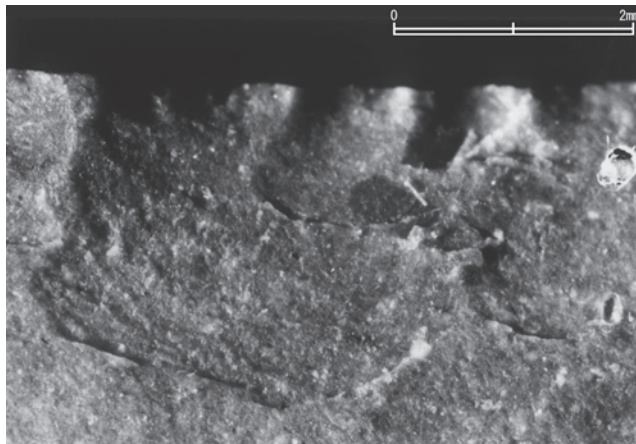


(6) 4.1-4. wood scrape 1000st (SH111d) 8x

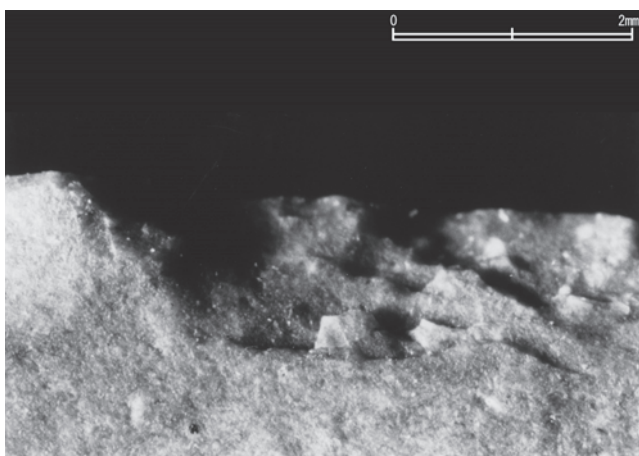
Figure 58. Experimental microflaking scars. (medium worked materials)



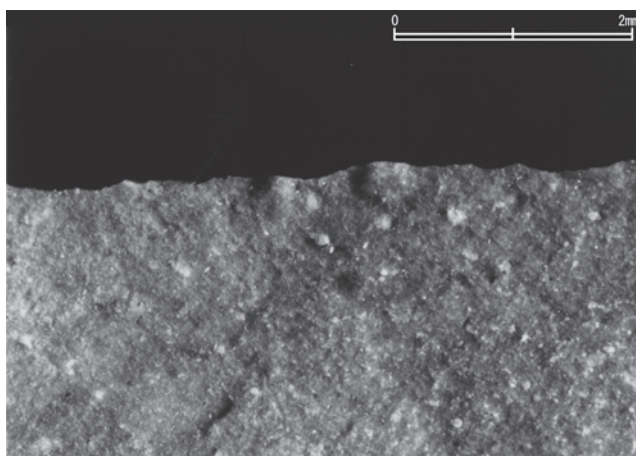
(1) 4.1-4. wood scrape 1000st (SH111d) 8x



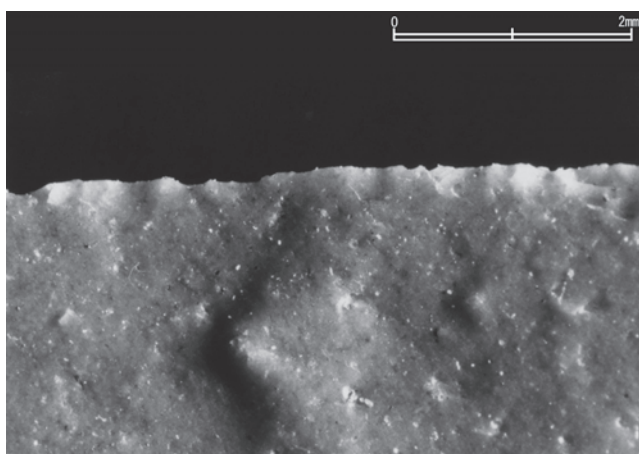
(2) 4.1-4. wood scrape 1000st (SH111d) 8x



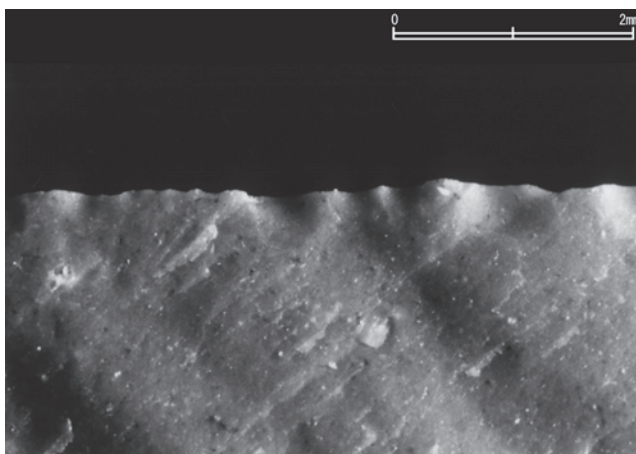
(3) 4.1-4. wood scrape 1000st (SH111d) 8x



(4) 4.1-4. wood scrape 1000st (SH111v) 8x

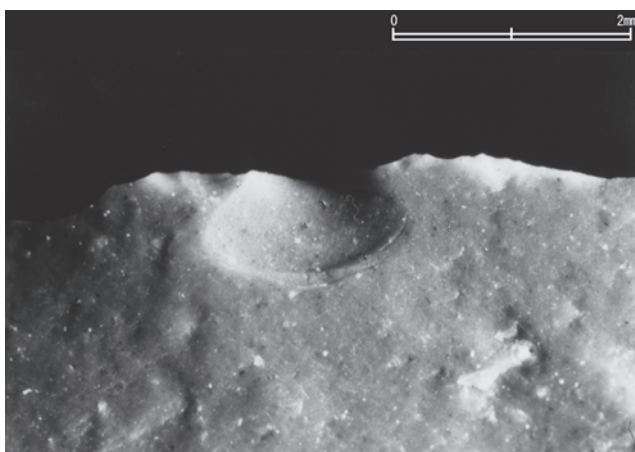


(5) 4.2-3. wood whittle (KSM20d) 8x

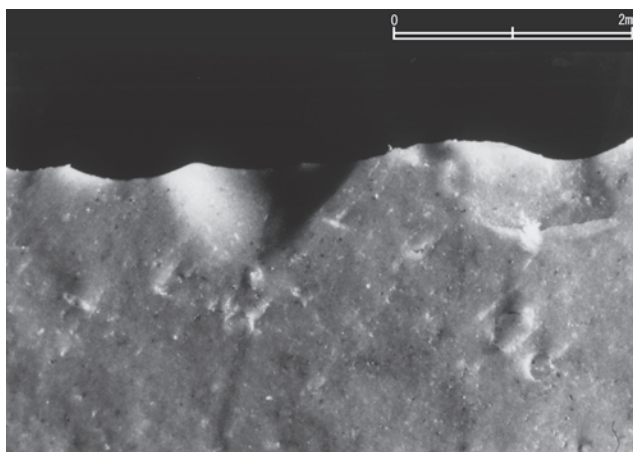


(6) 4.2-3. wood whittle (KSM20d) 8x

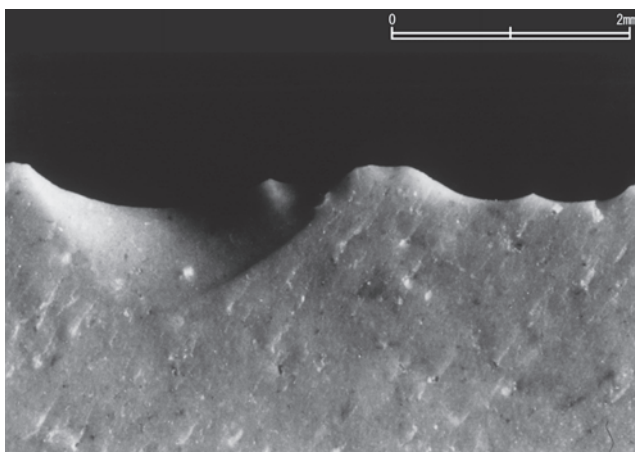
Figure 59. Experimental microflaking scars. (medium worked materials)



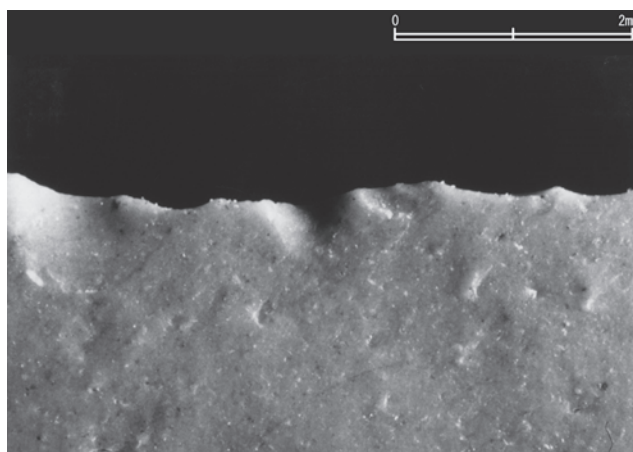
(1) 4.2-3. wood whittle 1000st (SH96d) 8x



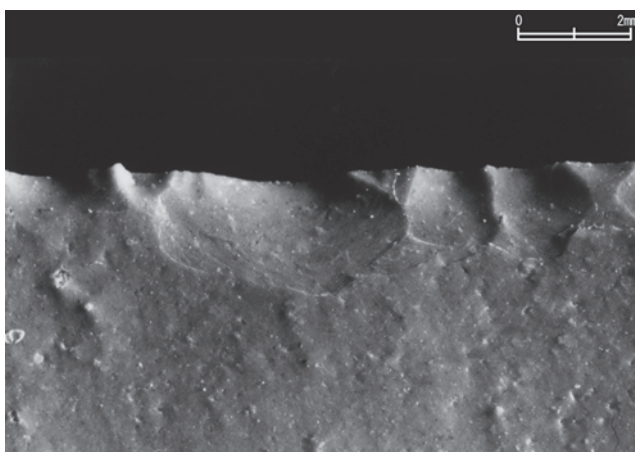
(2) 4.2-3. wood whittle 1000st (SH96v) 8x



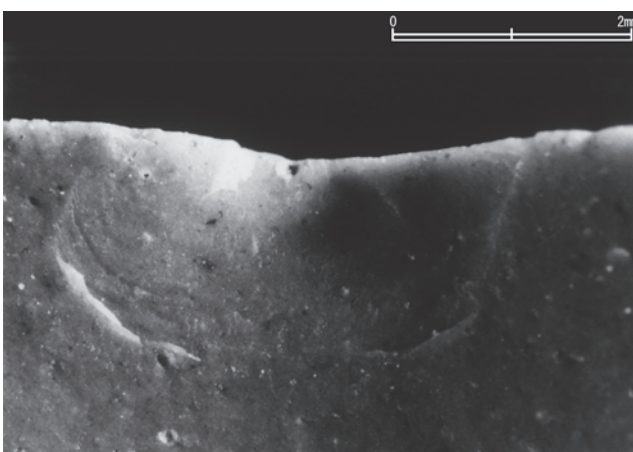
(3) 4.2-3. wood whittle 1000st (SH96v) 8x



(4) 4.2-3. wood whittle 1000st (SH96v) 8x

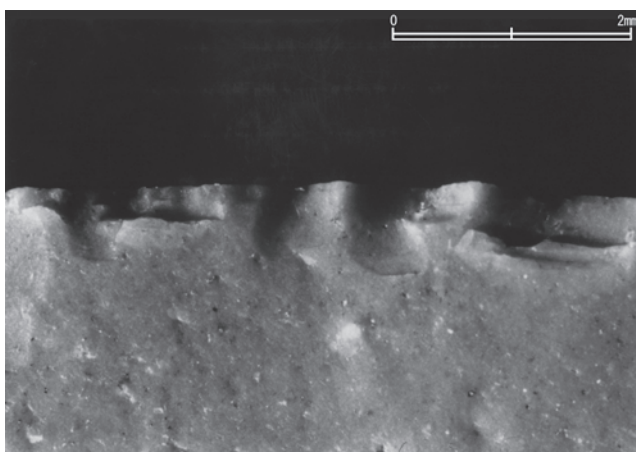


(5) 4.2-4. wood scrape 500st (SH150d) 3.5x

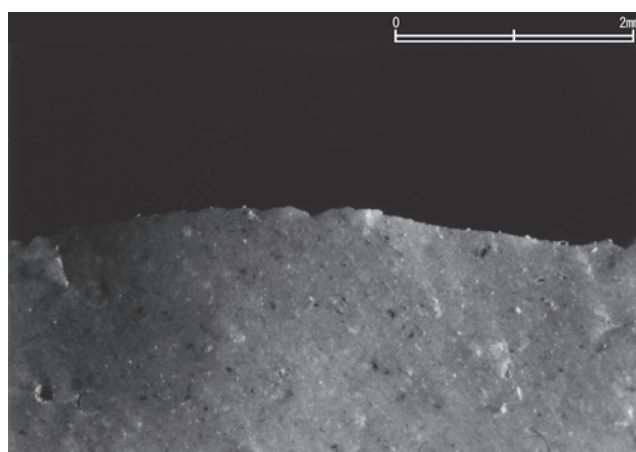


(6) 4.2-4. wood scrape 1000st (SH151d) 8x

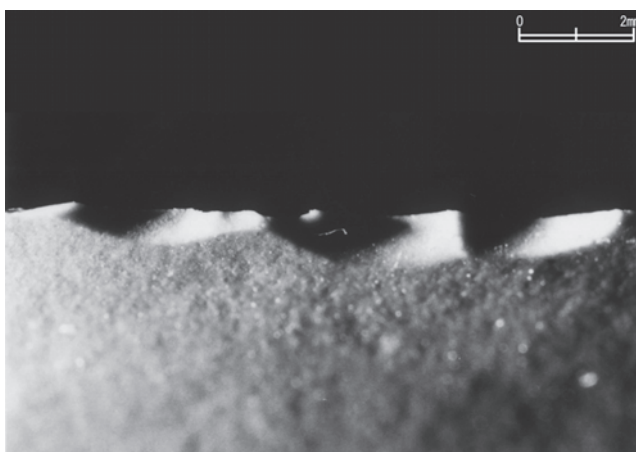
Figure 60. Experimental microflaking scars. (medium worked materials)



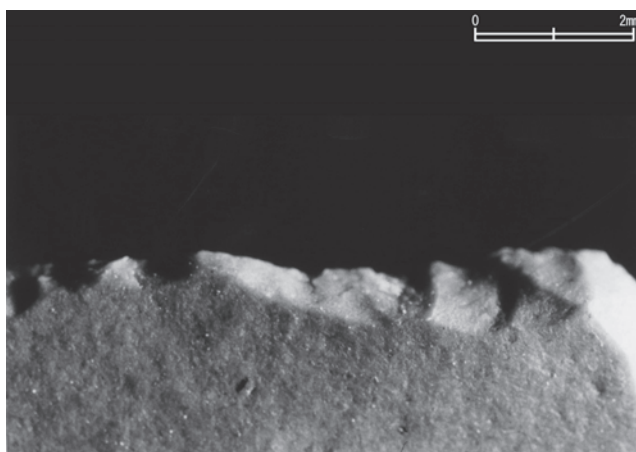
(1) 4.2-4. wood scrape 1000st (SH151d) 8x



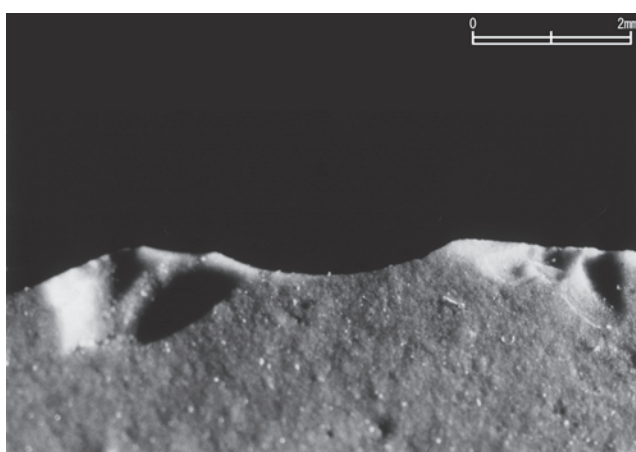
(2) 4.2-4. wood scrape 1000st (SH151d) 8x



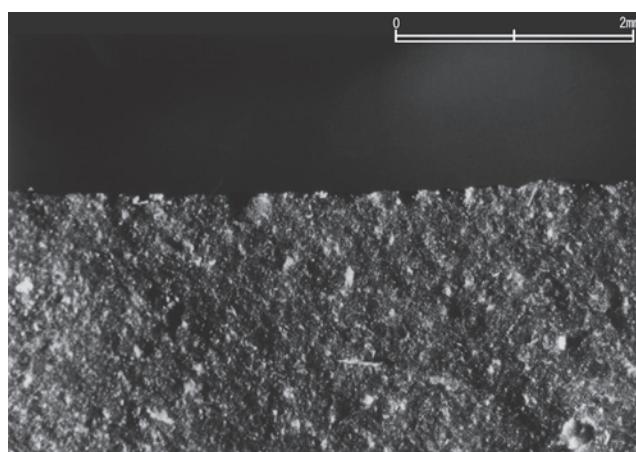
(3) 4.3-2. wood saw 2000st (SH44d) 3x



(4) 4.3-2. wood saw 2000st (SH44v) 5x

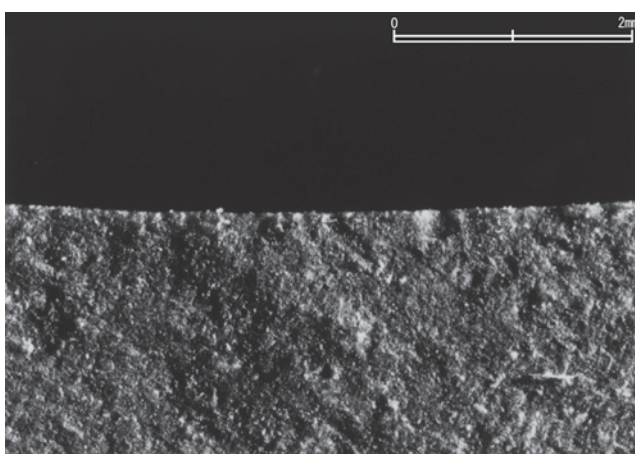


(5) 4.3-2. wood saw 2000st (SH44v) 5x

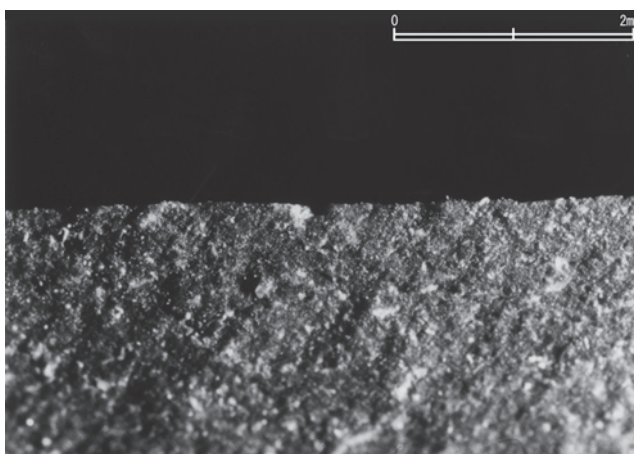


(6) 4.3-3. wood whittle 1500st (SH46d) 8x

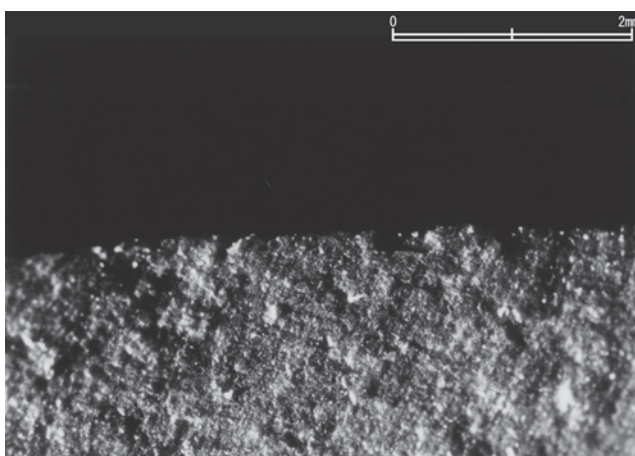
Figure 61. Experimental microflaking scars. (medium worked materials)



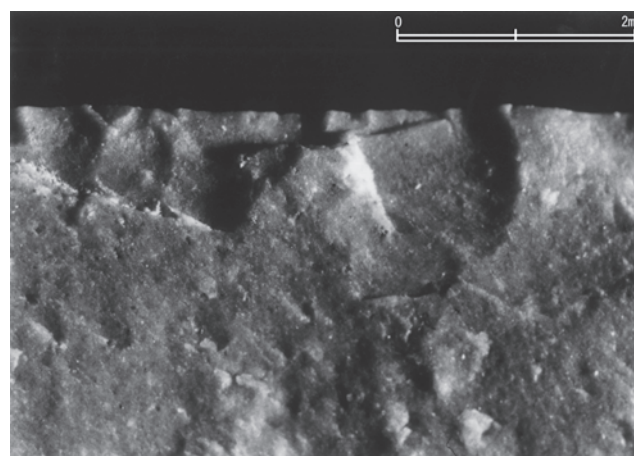
(1) 4.3-3. wood whittle 1500st (SH46d) 8x



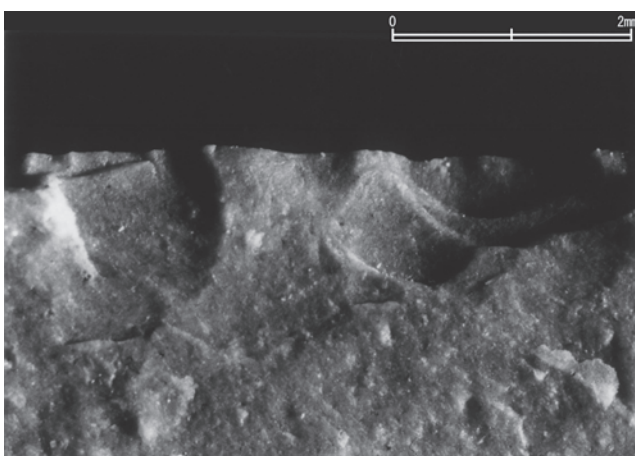
(2) 4.3-3. wood whittle 1500st (SH46v) 8x



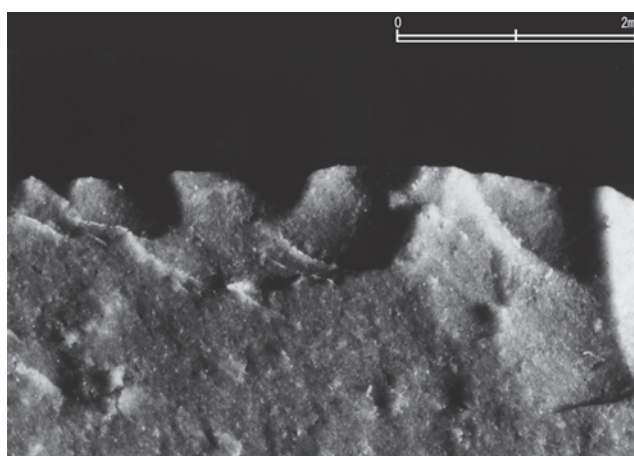
(3) 4.3-3. wood whittle 1500st (SH46v) 8x



(4) 4.3-3. wood whittle 2000st (SH100v) 8x

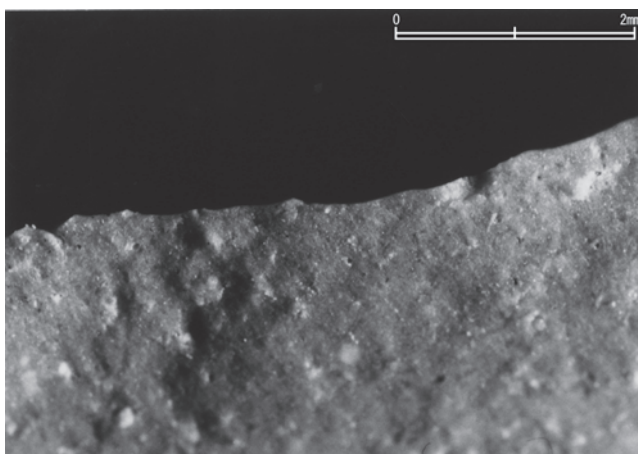


(5) 4.3-3. wood whittle 2000st (SH100d) 8x

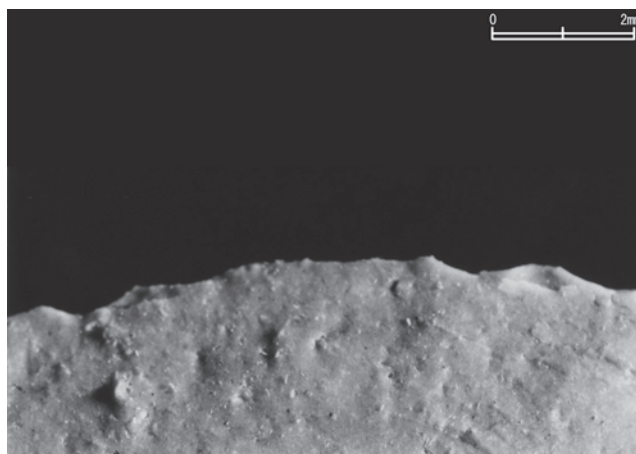


(6) 4.3-3. wood whittle 2000st (SH100d) 8x

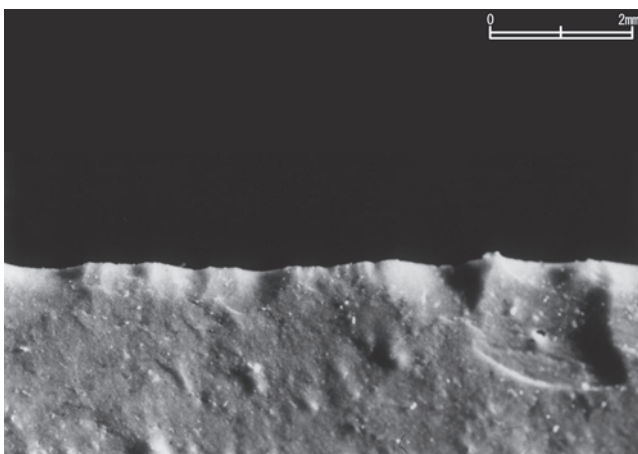
Figure 62. Experimental microflaking scars. (medium worked materials)



(1) 4.3-3. wood whittle 2000st (SH100v) 8x



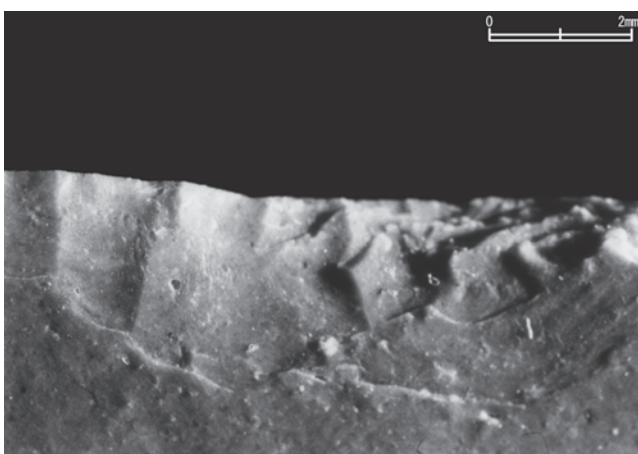
(2) 4.3-4. wood scrape 300st (SH90d) 4x



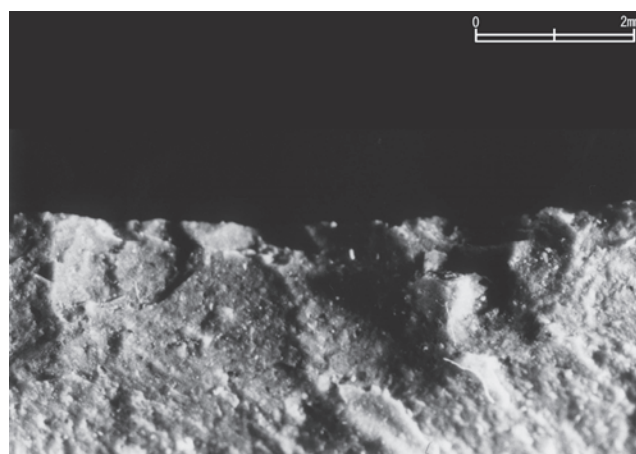
(3) 4.3-4. wood scrape 300st (SH90v) 4x



(4) 4.3-4. wood scrape 300st (SH90v) 4x

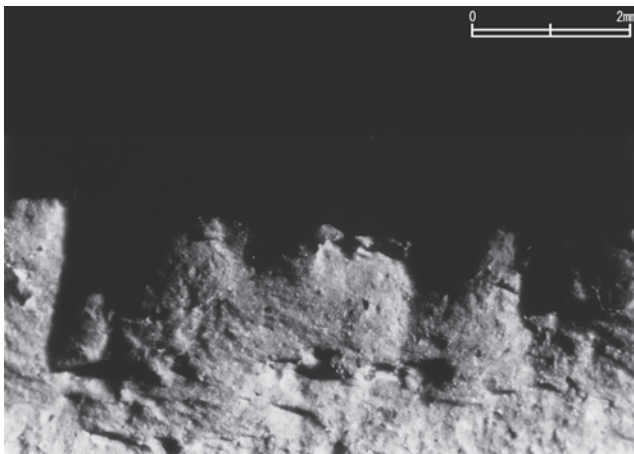


(5) 4.3-4. wood scrape 300st (SH90v) 4x

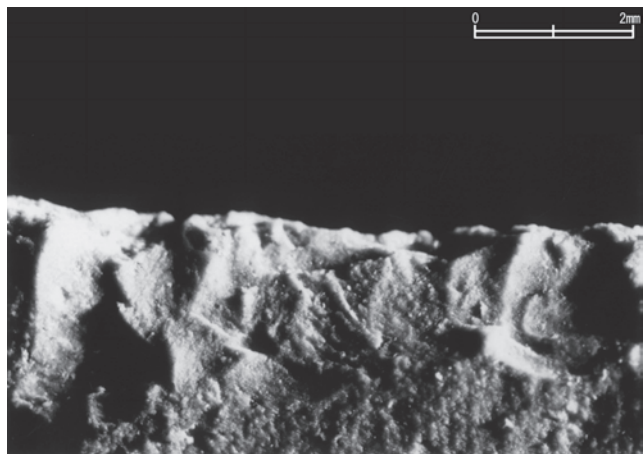


(6) 4.3-4. wood scrape 500st (SH120Bd) 5x

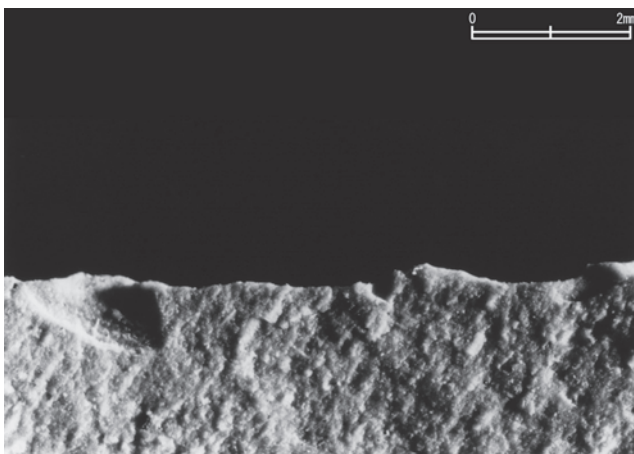
Figure 63. Experimental microflaking scars. (medium worked materials)



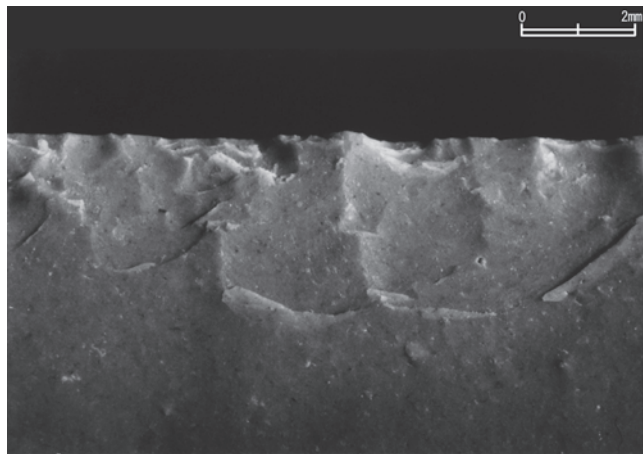
(1) 4.3-4. wood scrape 500st (SH120Bd) 5x



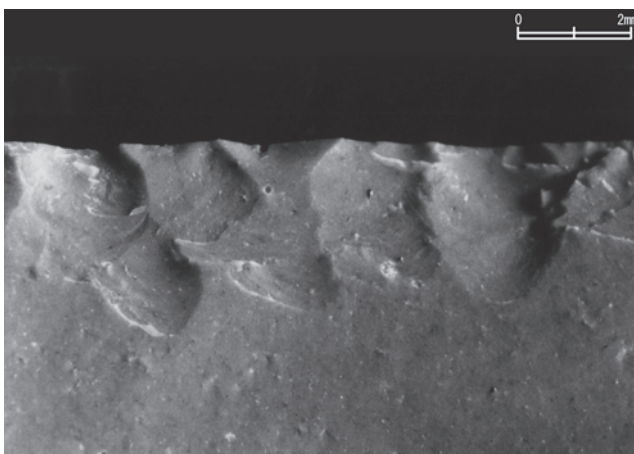
(2) 4.3-4. wood scrape 500st (SH120Bd) 5x



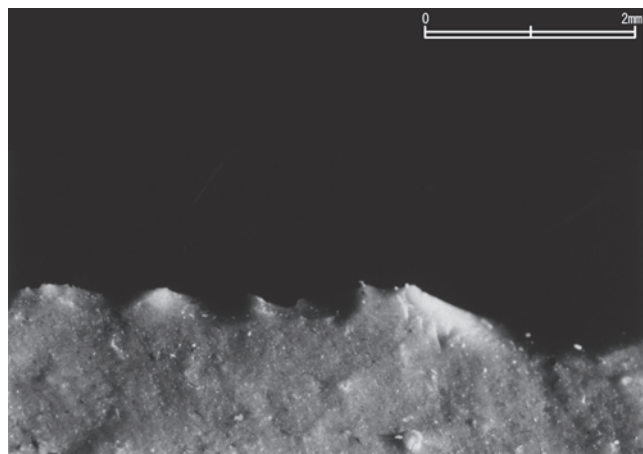
(3) 4.3-4. wood scrape 500st (SH120Bv) 5x



(4) 4.3-4. wood scrape 500st (SH149d) 3.5x

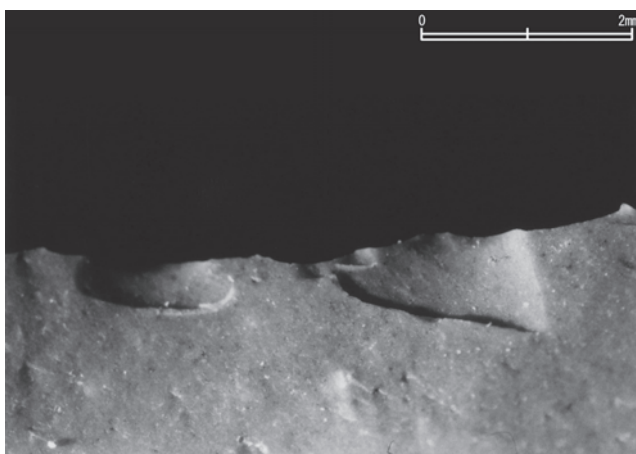


(5) 4.3-4. wood scrape 500st (SH149d) 3.5x

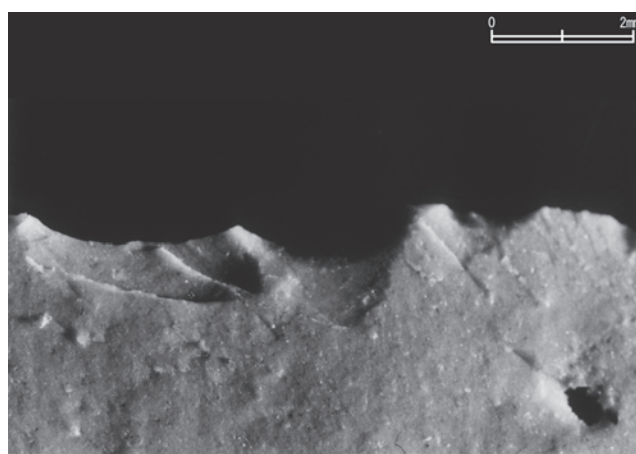


(6) 4.3-5. wood chop 200st (SH14d) 6x

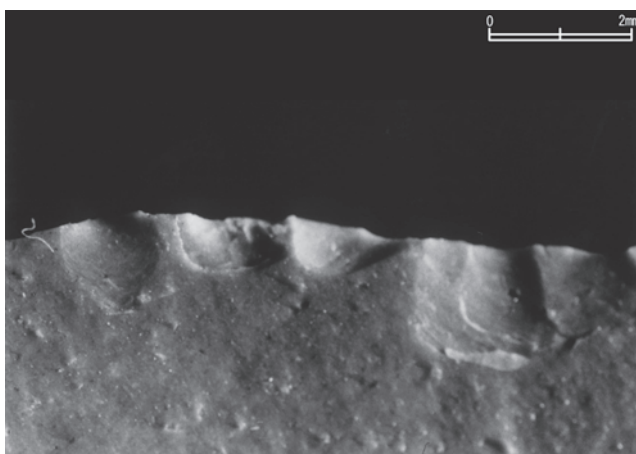
Figure 64. Experimental microflaking scars. (medium worked materials)



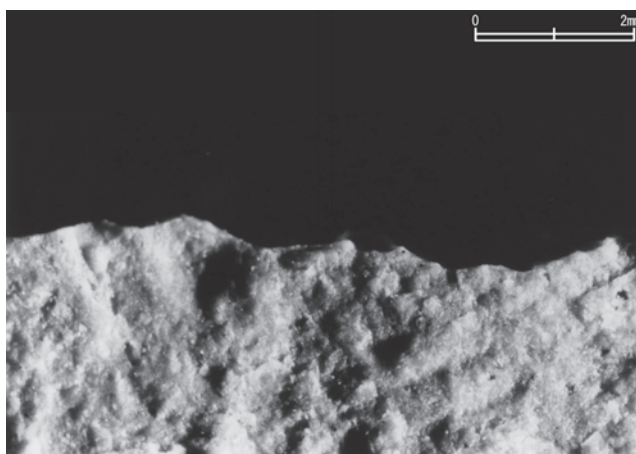
(1) 4. 3-5. wood chop 200st (SH14v) 6x



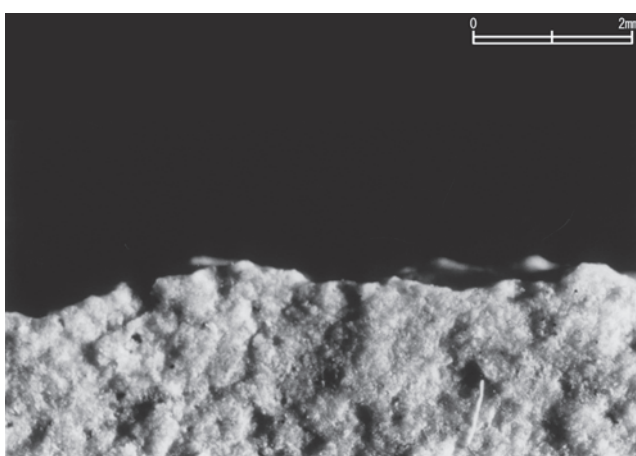
(2) 4. 3-5. wood chop 200st (SH14v) 4x



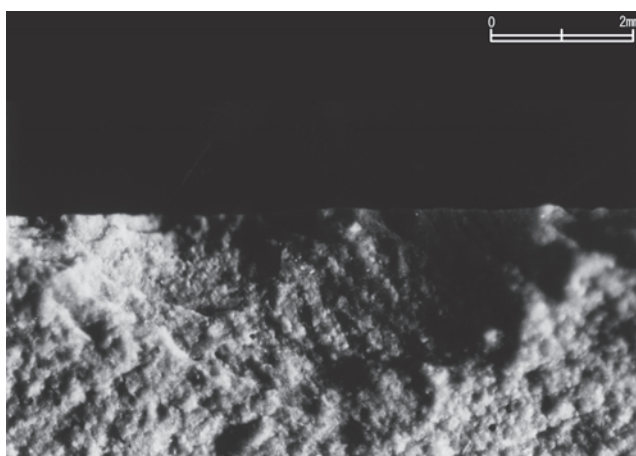
(3) 4. 3-5. wood chop 200st (SH14v) 4x



(4) 4. 3-5. wood chop 700st (SH152d) 5x

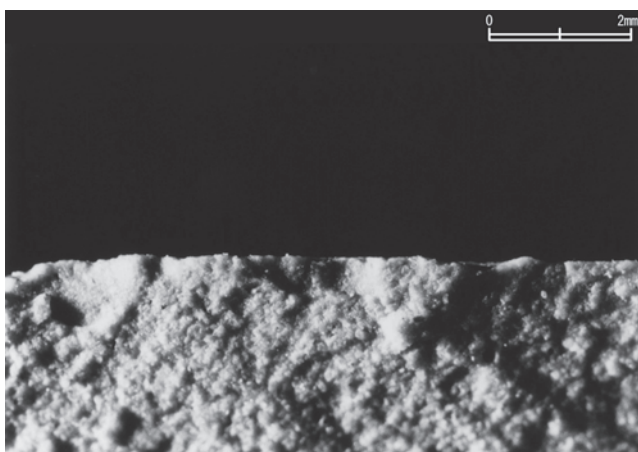


(5) 4. 3-5. wood chop 700st (SH152v) 5x

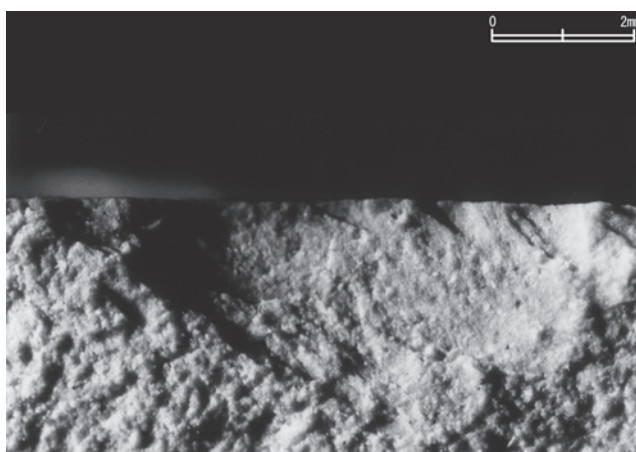


(6) 4. 3-5. wood chop 700st (SH152v) 4x

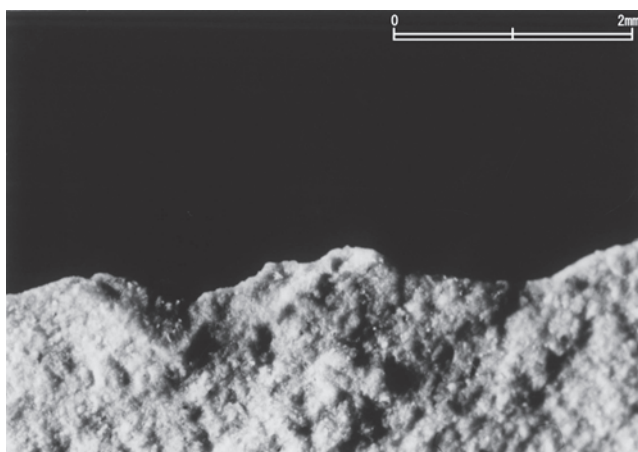
Figure 65. Experimental microflaking scars. (medium worked materials)



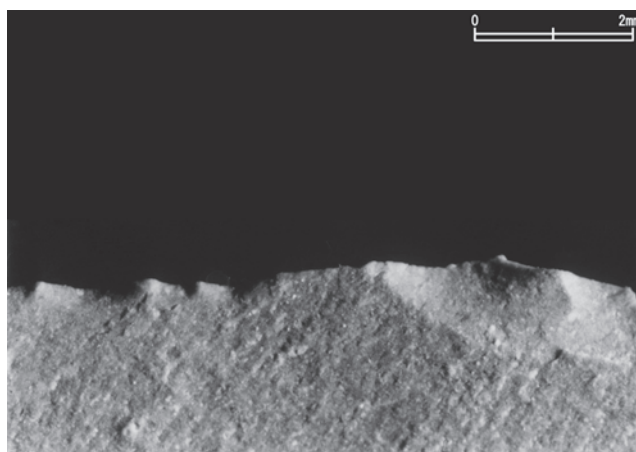
(1) 4.3-5. wood chop 700st (SH152v) 4x



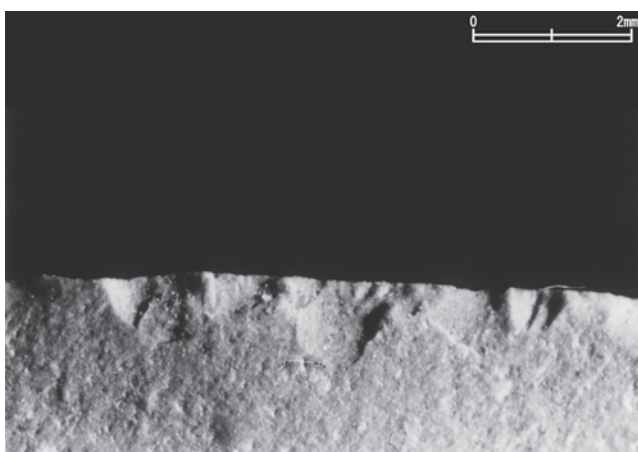
(2) 4.3-5. wood chop 700st (SH152v) 4x



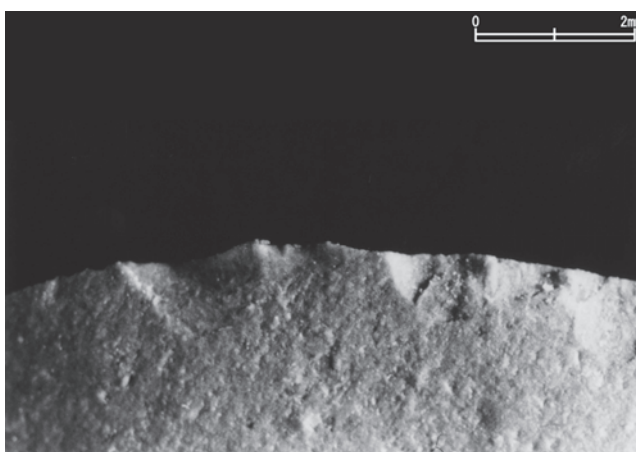
(3) 4.4-1. wood cut 1000st (SH9d) 8x



(4) 4.4-1. wood cut 1000st (SH9v) 5x

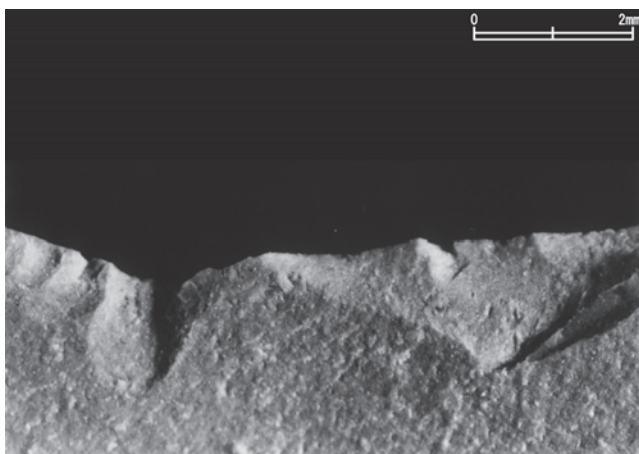


(5) 4.4-1. wood cut 1000st (SH9v) 5x

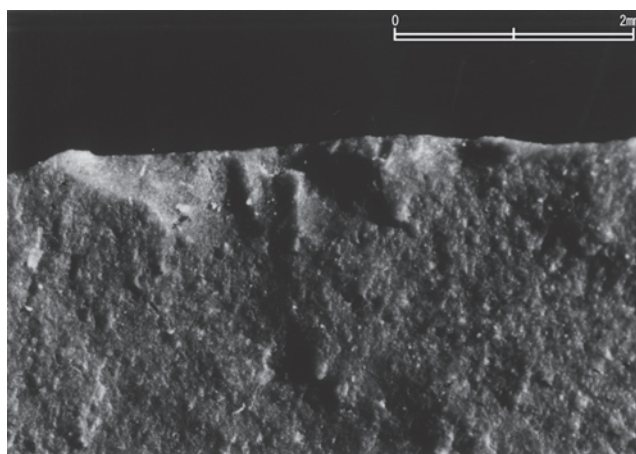


(6) 4.4-1. wood cut 1000st (SH9v) 5x

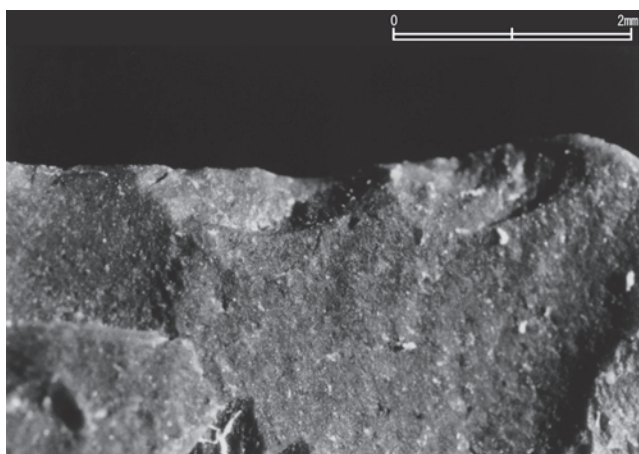
Figure 66. Experimental microflaking scars. (medium worked materials)



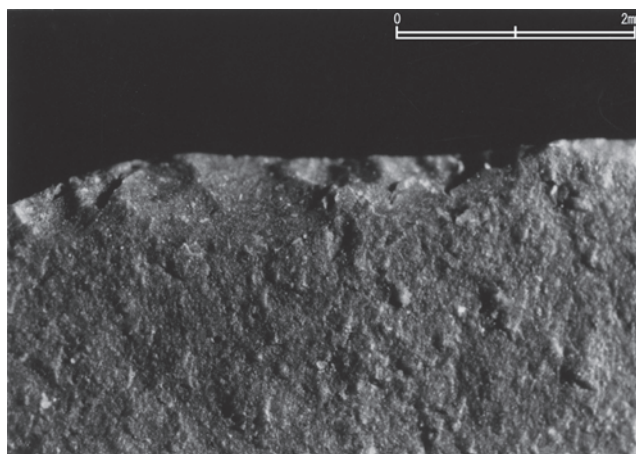
(1) 4. 4-1. wood cut 1000st (SH9v) 5x



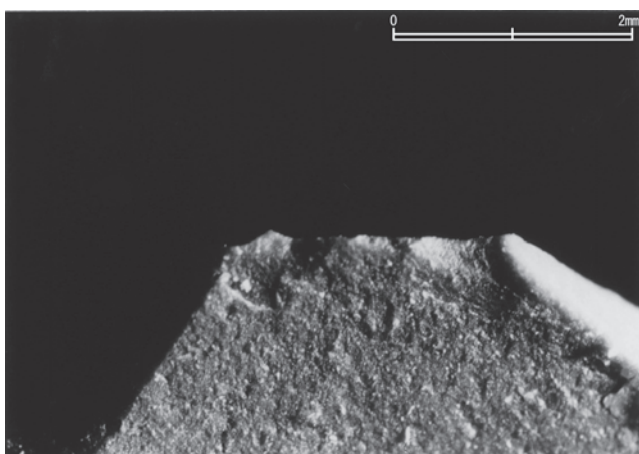
(2) 4. 4-1. wood cut 1400st (SH7d) 8x



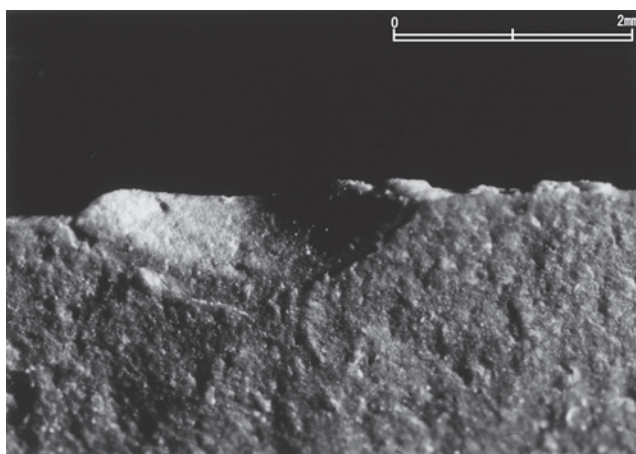
(3) 4. 4-1. wood cut 1400st (SH7d) 8x



(4) 4. 4-1. wood cut 1400st (SH7d) 8x

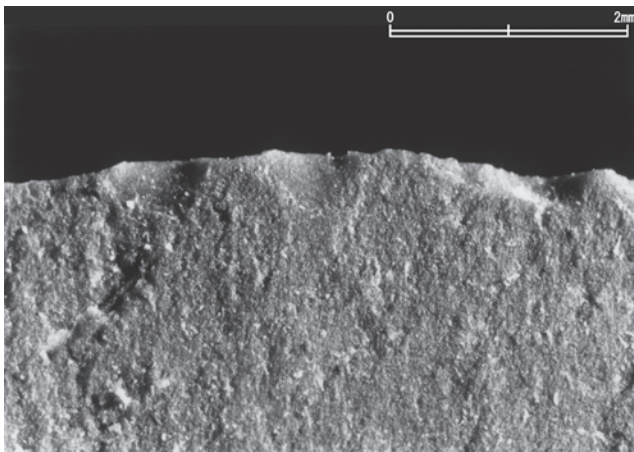


(5) 4. 4-1. wood cut 1400st (SH7v) 8x

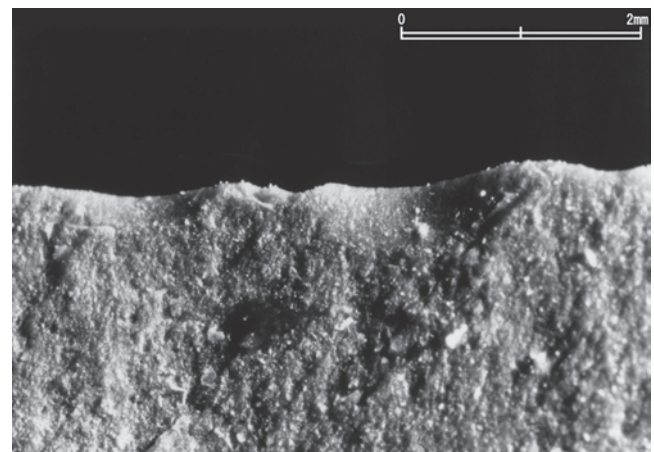


(6) 4. 4-1. wood cut 1400st (SH7v) 8x

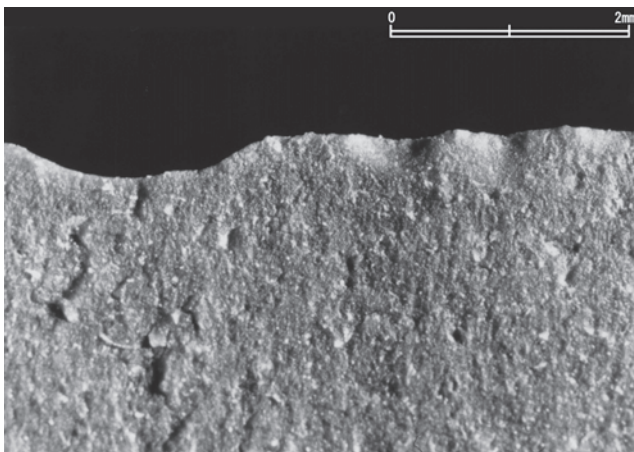
Figure 67. Experimental microflaking scars. (medium worked materials)



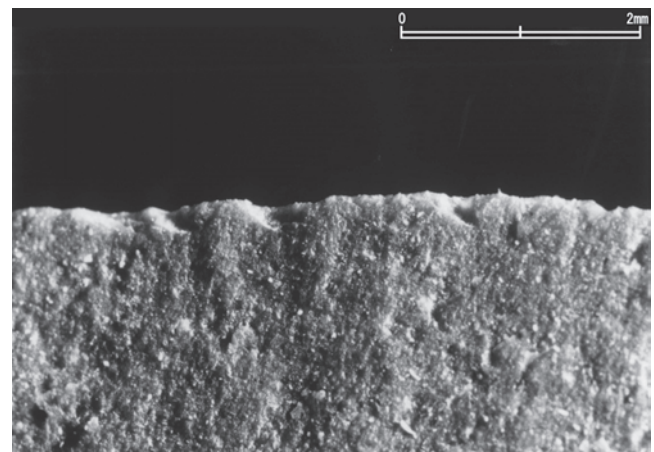
(1) 4. 4-1. wood cut 2000st (SH10d) 8x



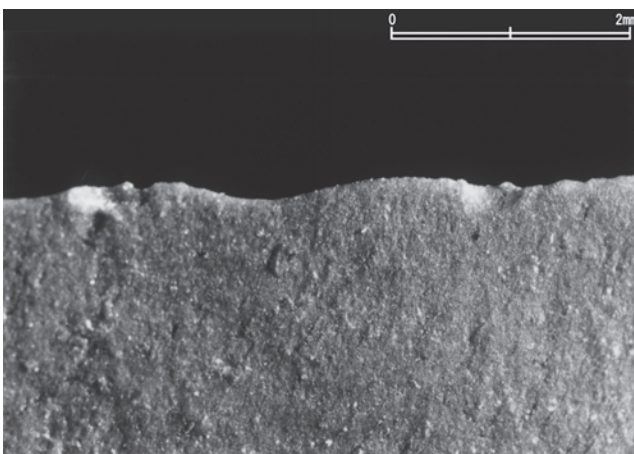
(2) 4. 4-1. wood cut 2000st (SH10d) 8x



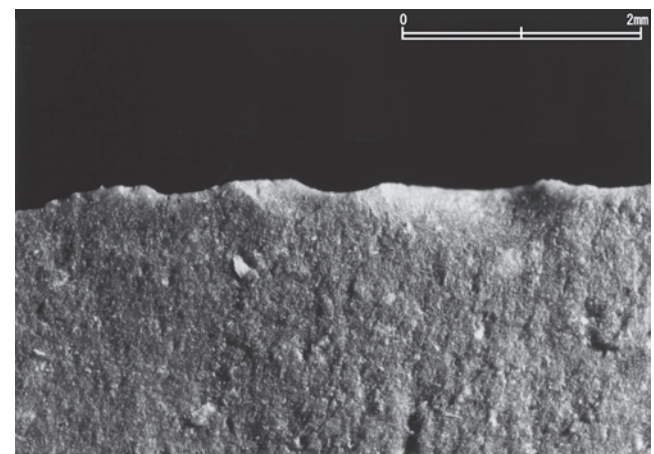
(3) 4. 4-1. wood cut 2000st (SH10d) 8x



(4) 4. 4-1. wood cut 2000st (SH10d) 8x

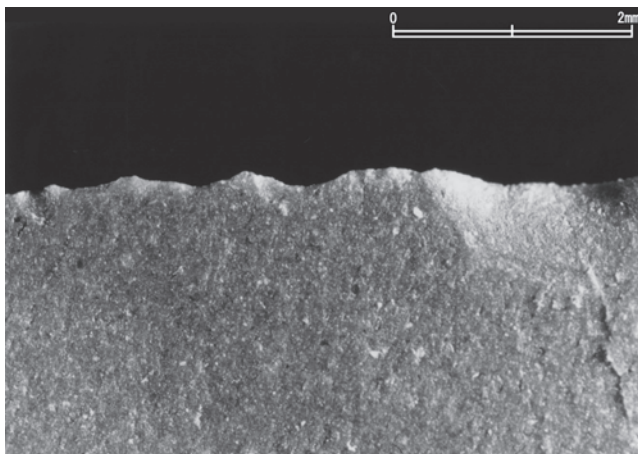


(5) 4. 4-1. wood cut 2000st (SH10v) 8x

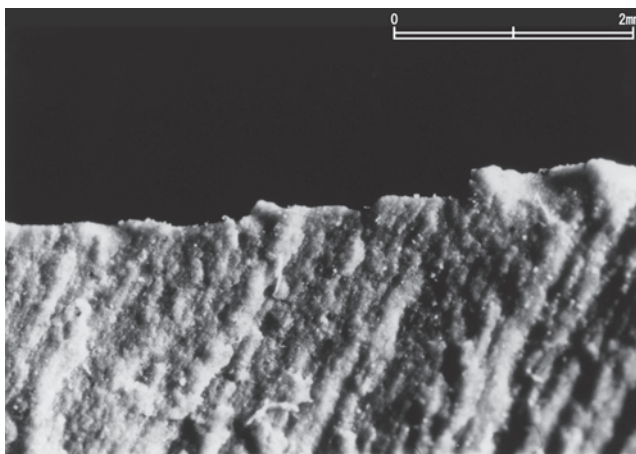


(6) 4. 4-1. wood cut 2000st (SH10v) 8x

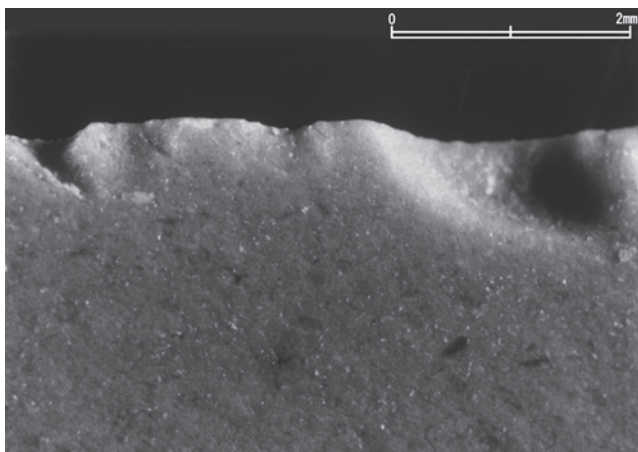
Figure 68. Experimental microflaking scars. (medium worked materials)



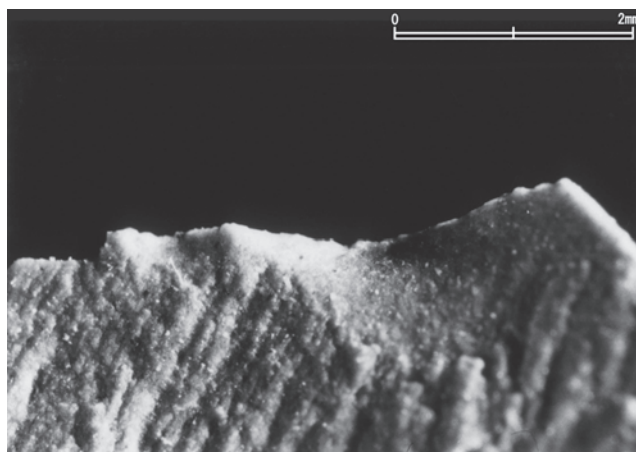
(1) 4.4-1. wood cut 2000st (SH10v) 8x



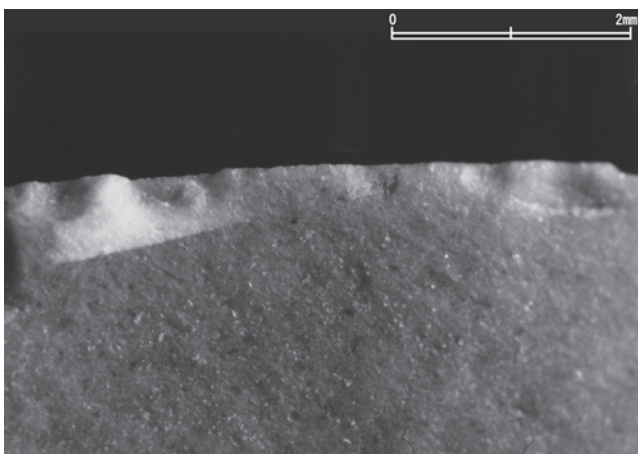
(2) 4.4-1. wood cut 2500st (SH8d) 8x



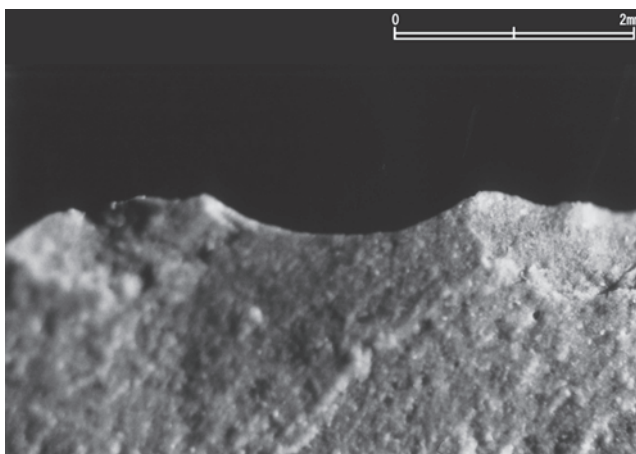
(3) 4.4-1. wood cut 2500st (SH8d) 8x



(4) 4.4-1. wood cut 2500st (SH8d) 8x

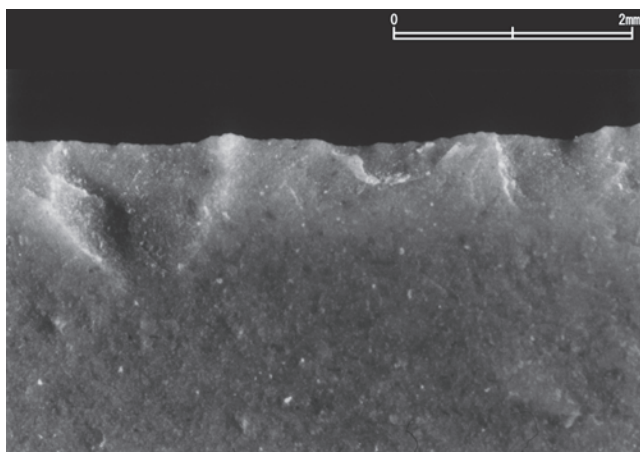


(5) 4.4-1. wood cut 2500st (SH8d) 8x

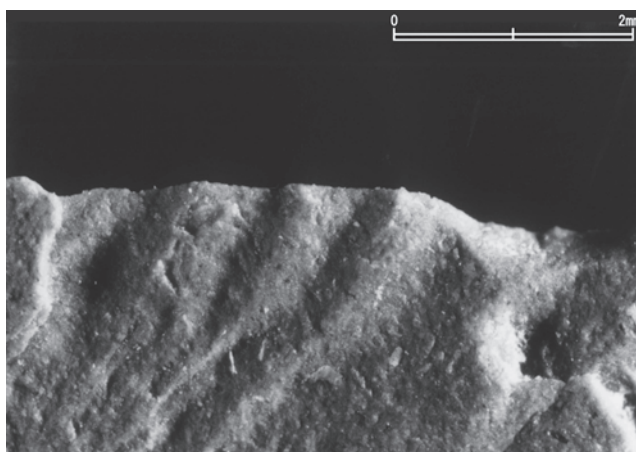


(6) 4.4-1. wood cut 2500st (SH8d) 8x

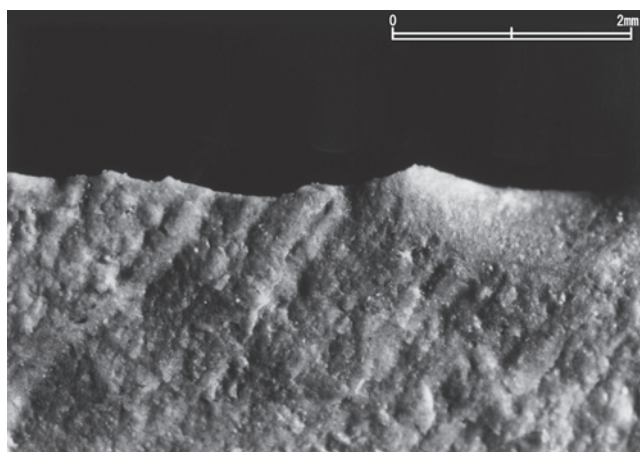
Figure 69. Experimental microflaking scars. (medium worked materials)



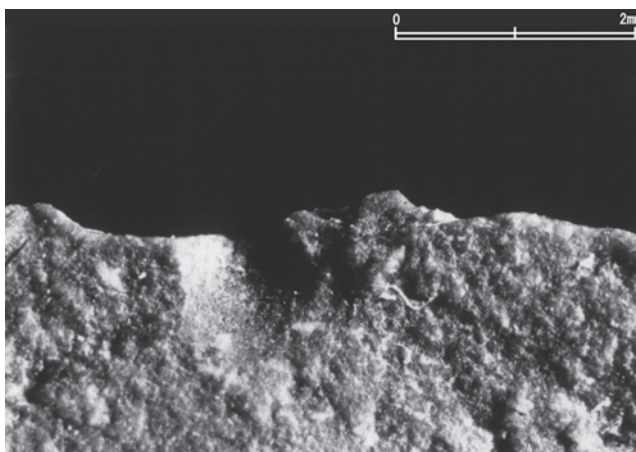
(1) 4. 4-1. wood cut 2500st (SH8d) 8x



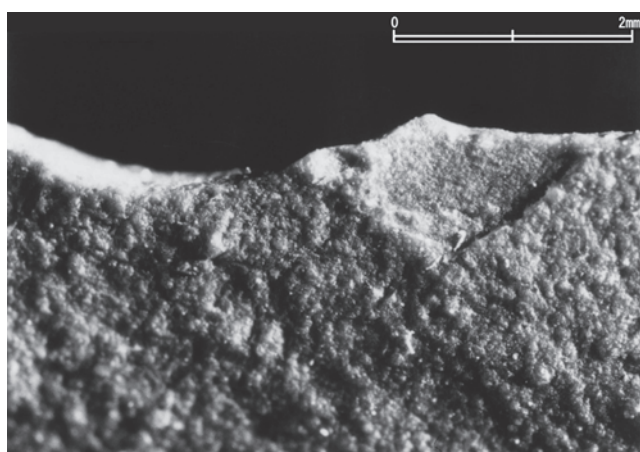
(2) 4. 4-1. wood cut 2500st (SH8v) 8x



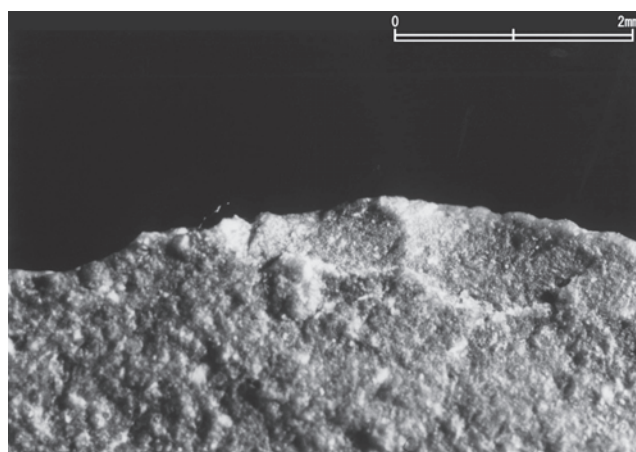
(3) 4. 4-1. wood cut 2500st (SH8v) 8x



(4) 4. 4-1. wood cut 3000st (SH12d) 8x

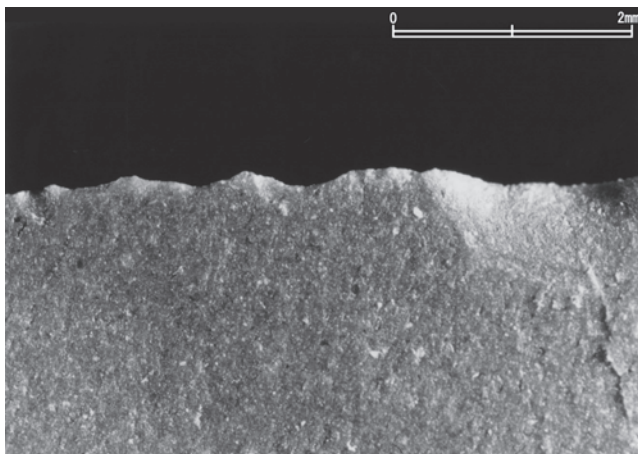


(5) 4. 4-1. wood cut 3000st (SH12d) 8x

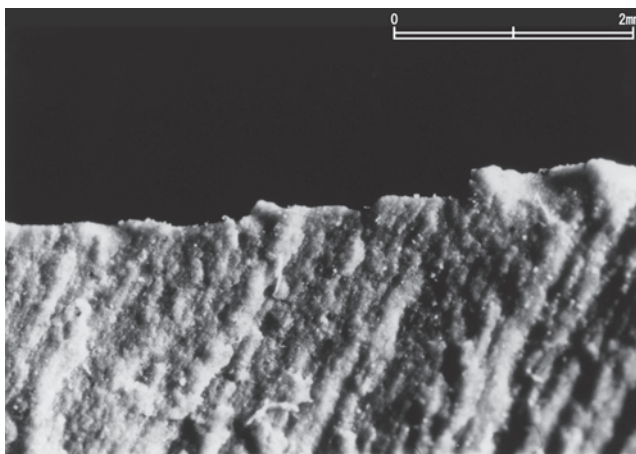


(6) 4. 4-1. wood cut 3000st (SH12d) 8x

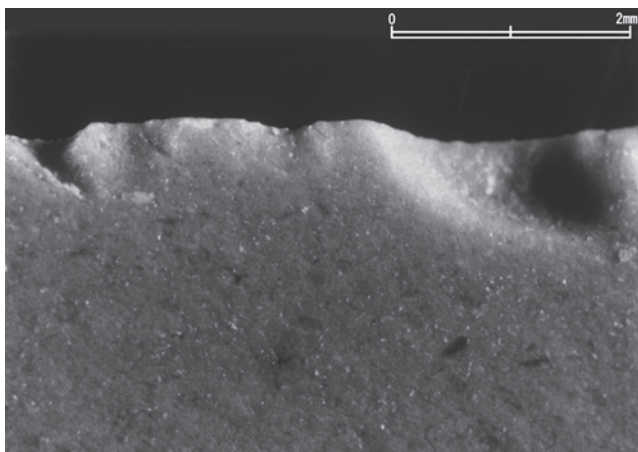
Figure 70. Experimental microflaking scars. (medium worked materials)



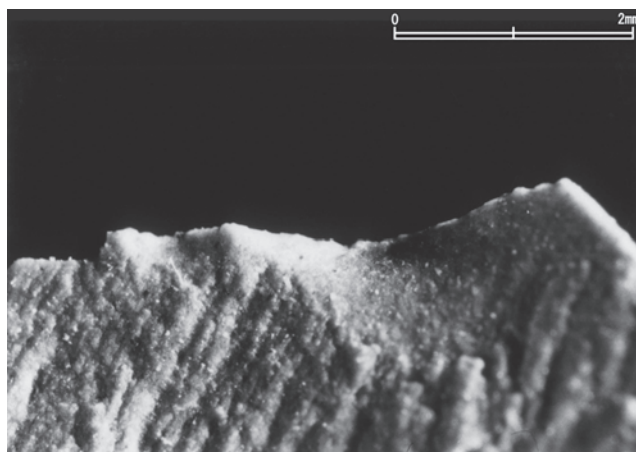
(1) 4.4-1. wood cut 2000st (SH10v) 8x



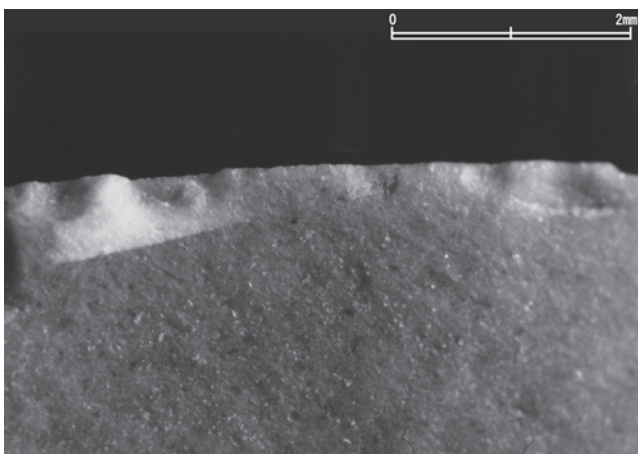
(2) 4.4-1. wood cut 2500st (SH8d) 8x



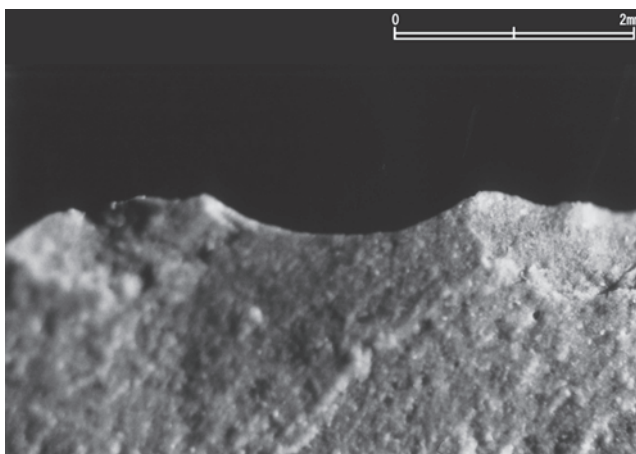
(3) 4.4-1. wood cut 2500st (SH8d) 8x



(4) 4.4-1. wood cut 2500st (SH8d) 8x

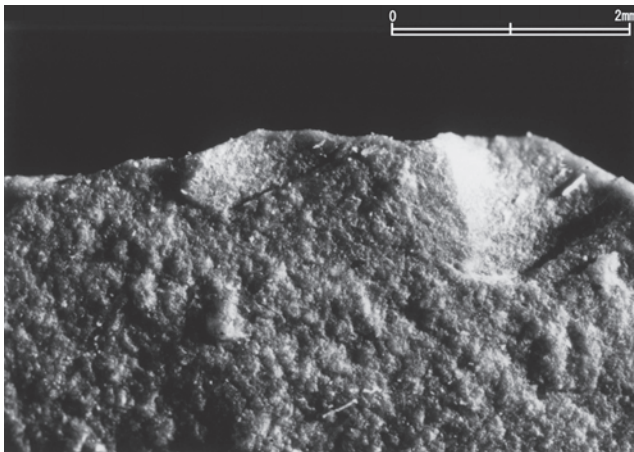


(5) 4.4-1. wood cut 2500st (SH8d) 8x

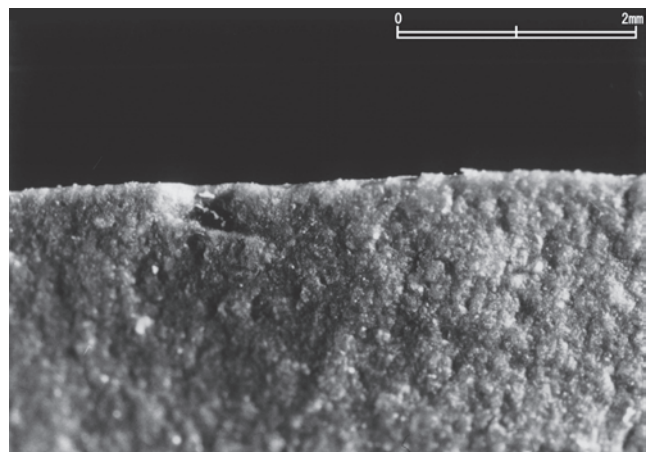


(6) 4.4-1. wood cut 2500st (SH8d) 8x

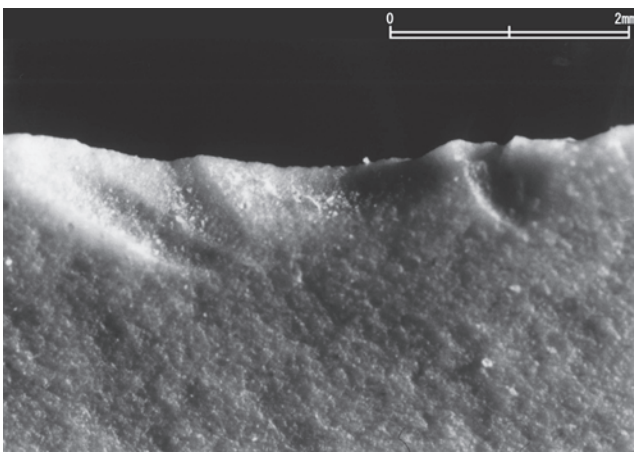
Figure 71. Experimental microflaking scars. (medium worked materials)



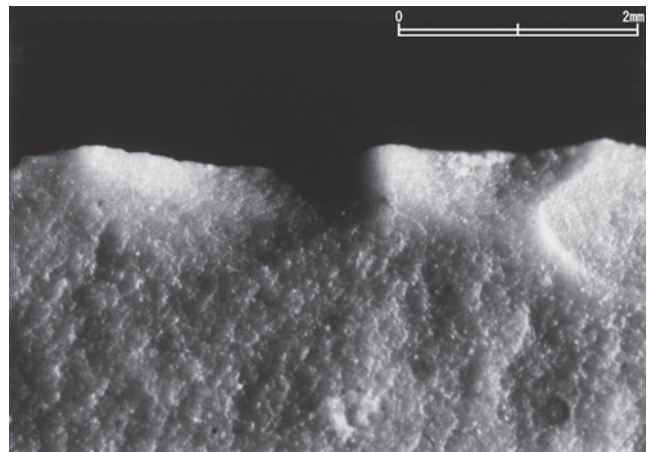
(1) 4.4-1. wood cut 3000st (SH12d) 8x



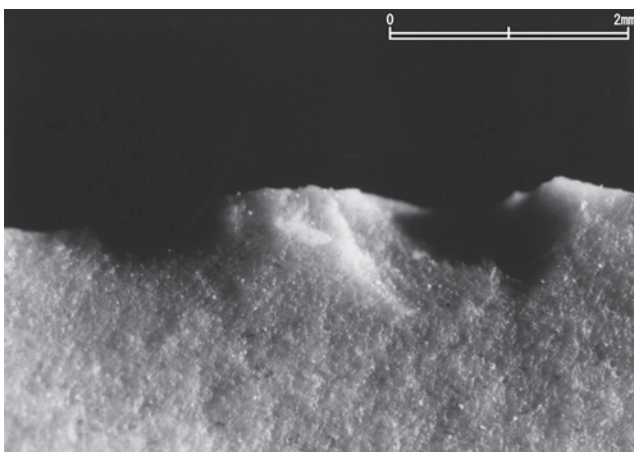
(2) 4.4-1. wood cut 3000st (SH12v) 8x



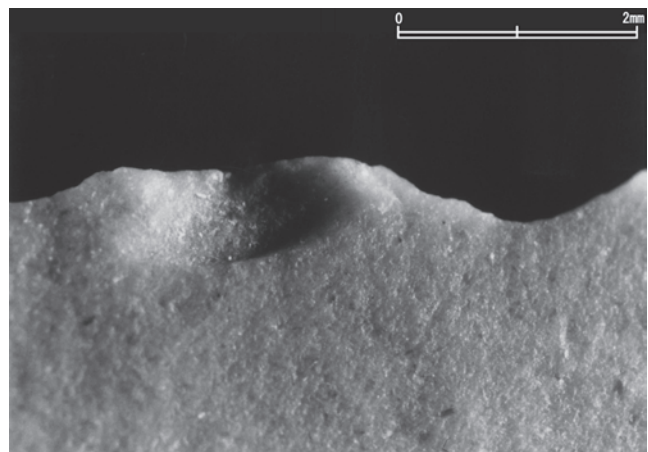
(3) 4.4-2. wood saw 5000st (SH49d) 8x



(4) 4.4-2. wood saw 5000st (SH49v) 8x

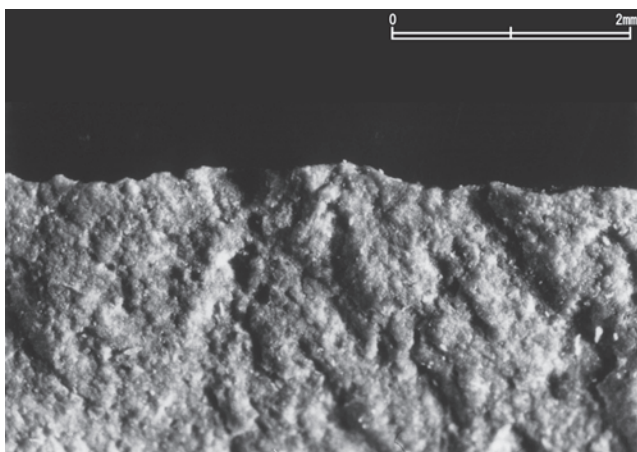


(5) 4.4-2. wood saw 5000st (SH49v) 8x

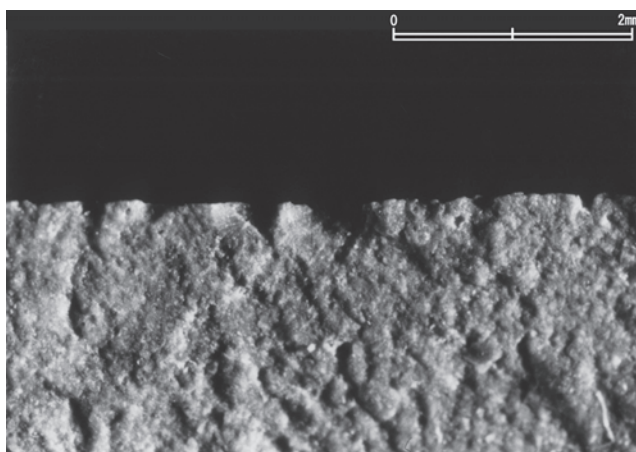


(6) 4.4-2. wood saw 5000st (SH49v) 8x

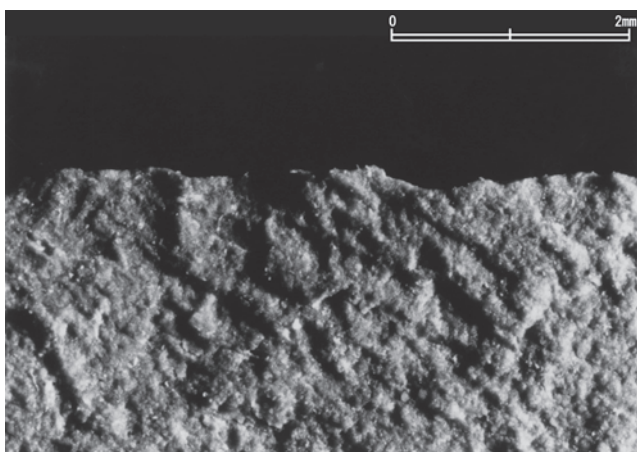
Figure 72. Experimental microflaking scars. (medium worked materials)



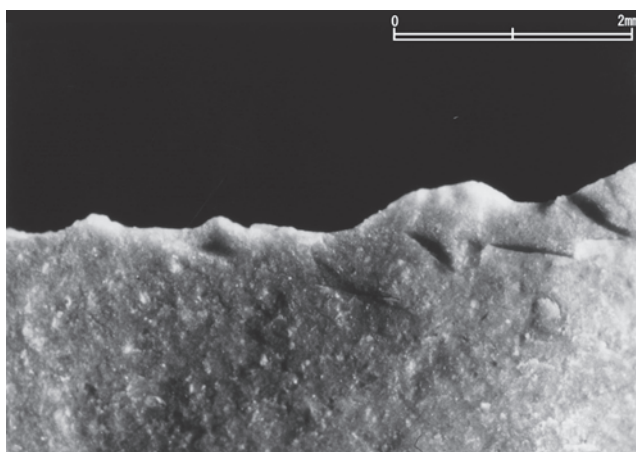
(1) 4. 4-3. wood whittle 2000st (SH13d) 8x



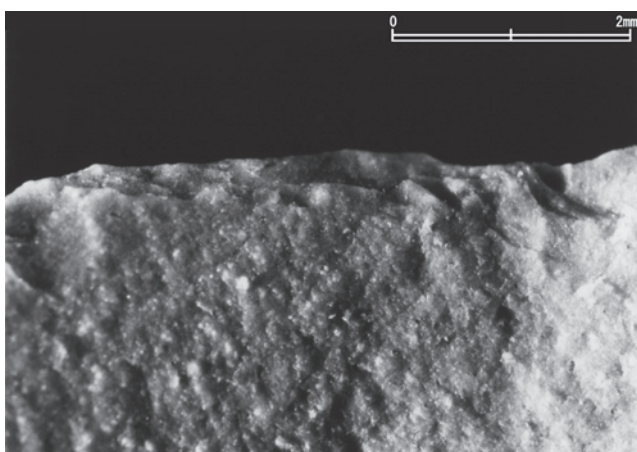
(2) 4. 4-3. wood whittle 2000st (SH13d) 8x



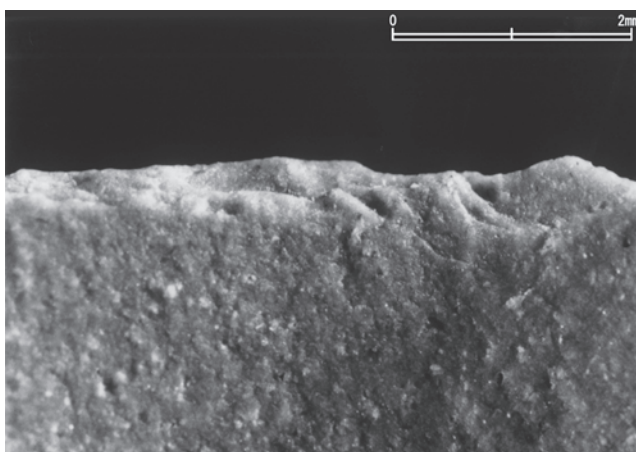
(3) 4. 4-3. wood whittle 2000st (SH13v) 8x



(4) 4. 4-3. wood whittle 2000st (SH99d) 8x

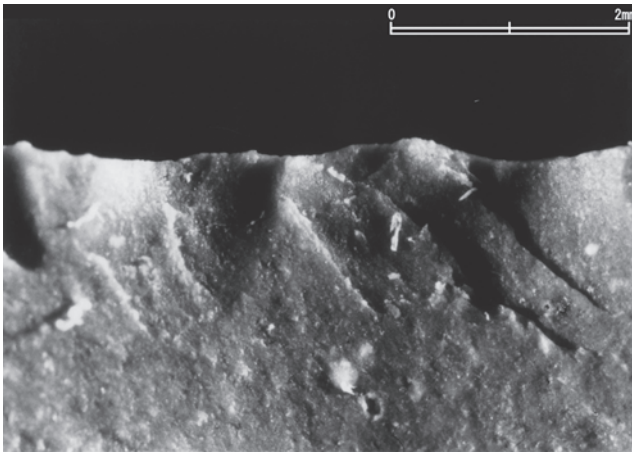


(5) 4. 4-3. wood whittle 2000st (SH99d) 8x

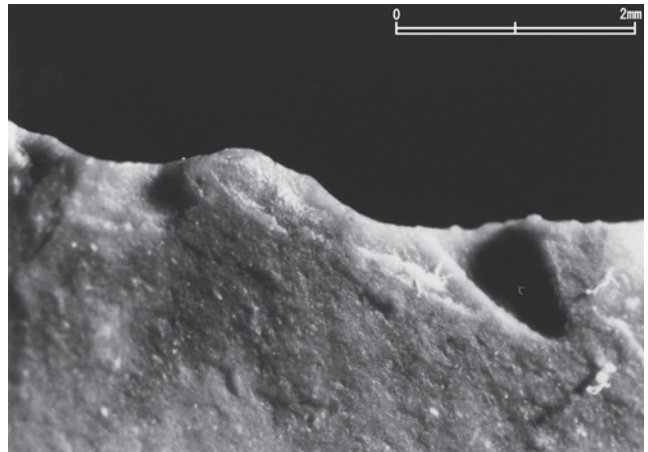


(6) 4. 4-3. wood whittle 2000st (SH99d) 8x

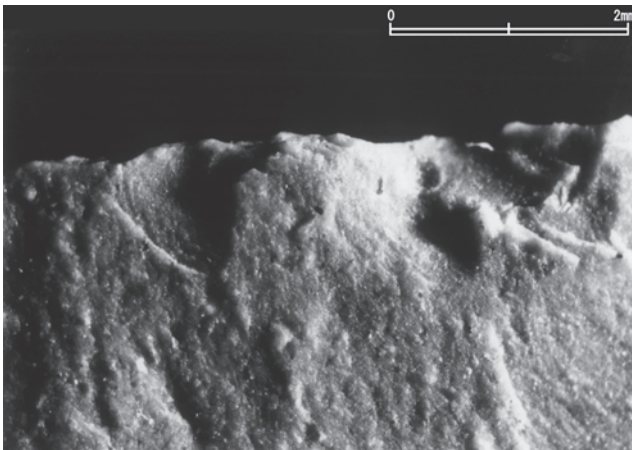
Figure 73. Experimental microflaking scars. (medium worked materials)



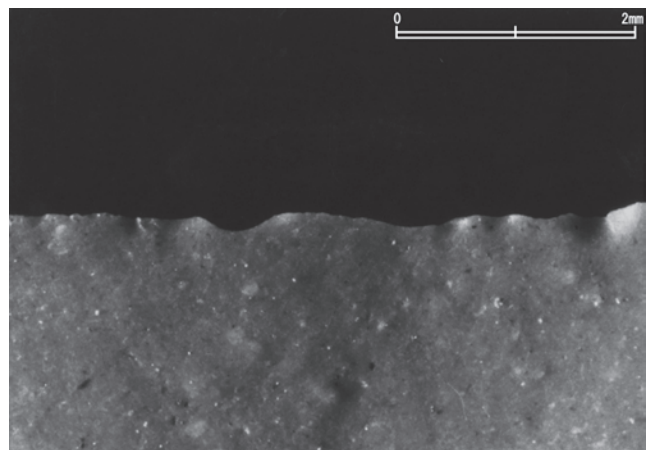
(1) 4.4-3. wood whittle 2000st (SH99v) 8x



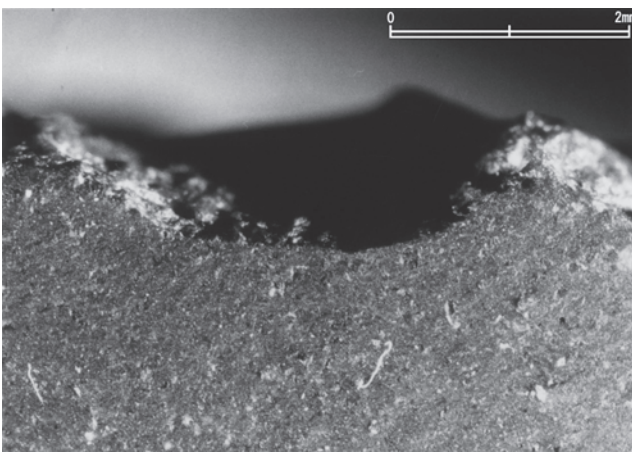
(2) 4.4-3. wood whittle 2000st (SH99v) 8x



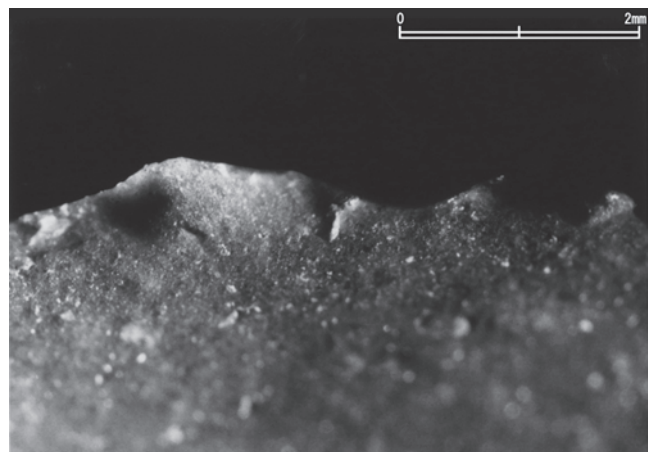
(3) 4.4-3. wood whittle 2000st (SH99v) 8x



(4) 4.6-1. wood cut 30m (KSM12d) 8x

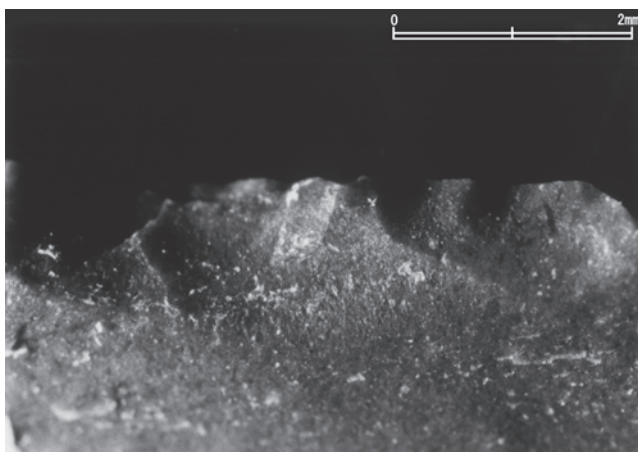


(5) 4.6-4. wood scrape 2000st (SH39v) 8x

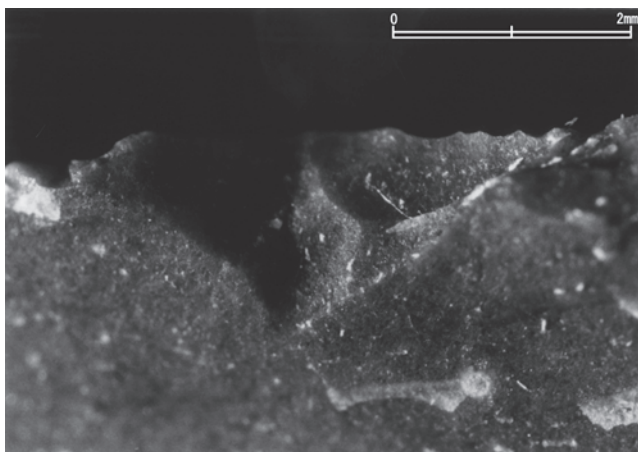


(6) 5.0-2. bamboo saw 2000st (SH79d) 8x

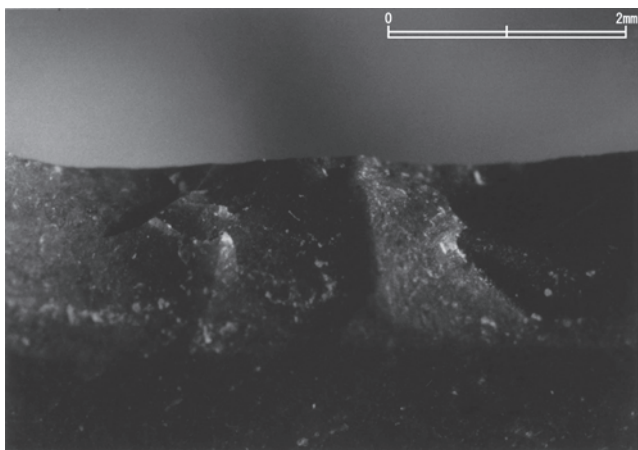
Figure 74. Experimental microflaking scars. (medium worked materials)



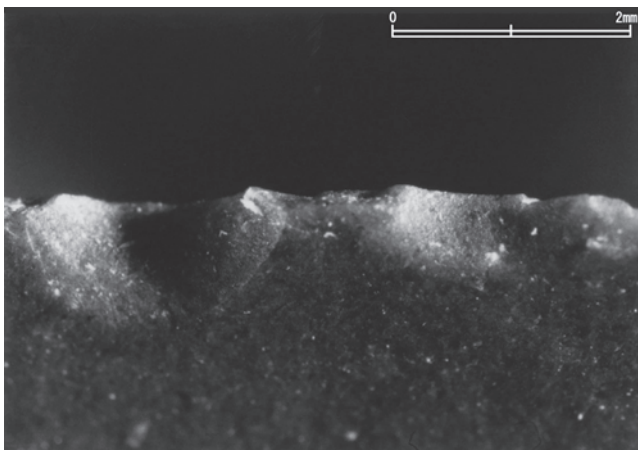
(1) 5.0-2. bamboo saw 2000st (SH79d) 8x



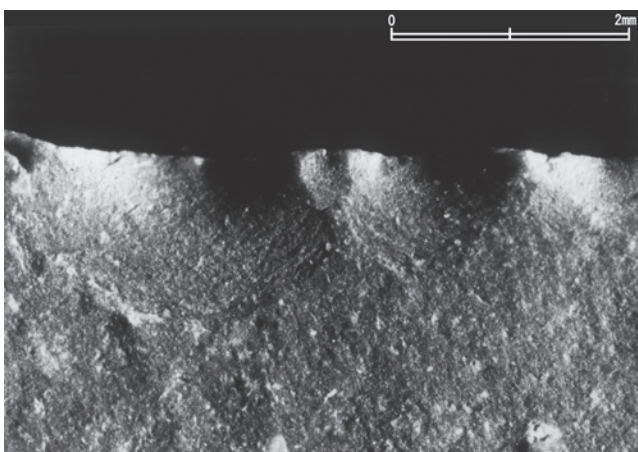
(2) 5.0-2. bamboo saw 2000st (SH79d) 8x



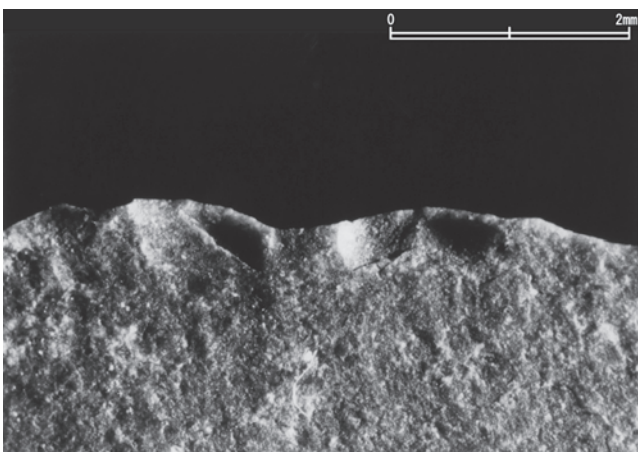
(3) 5.0-2. bamboo saw 2000st (SH79v) 8x



(4) 5.0-2. bamboo saw 2000st (SH79v) 8x

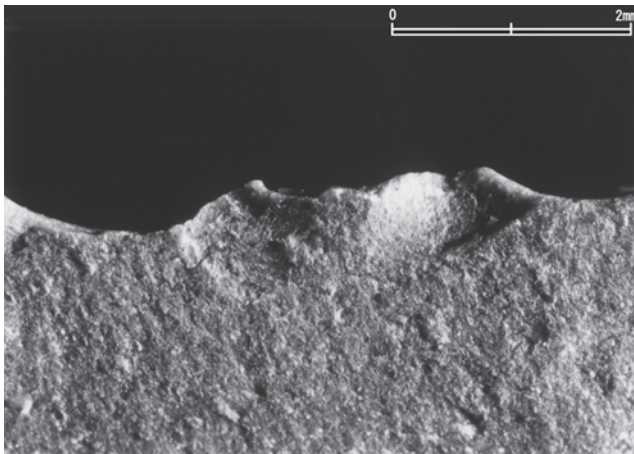


(5) 5.0-2. bamboo saw 4000st (SH80d) 8x

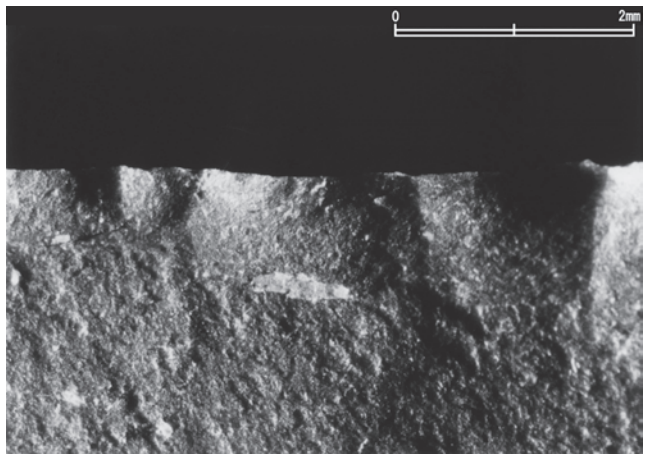


(6) 5.0-2. bamboo saw 4000st (SH80d) 8x

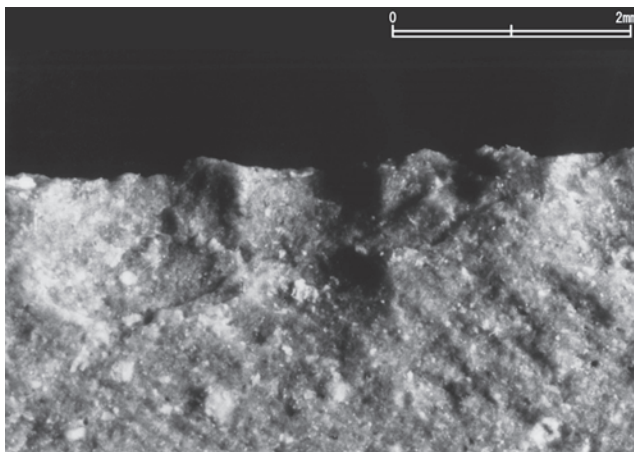
Figure 75. Experimental microflaking scars. (medium worked materials)



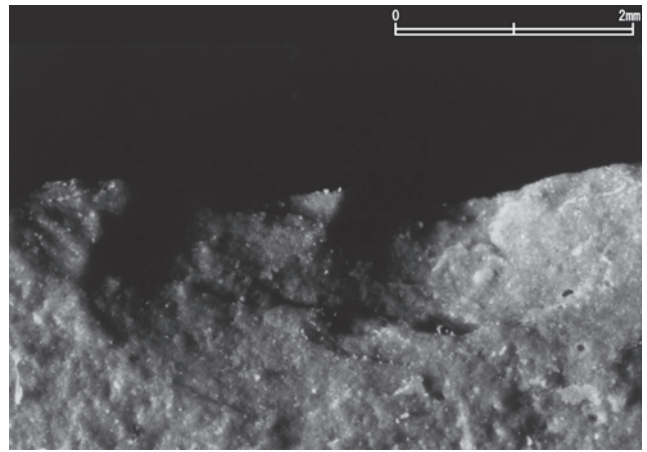
(1) 5.0-2. bamboo saw 4000st (SH80v) 8x



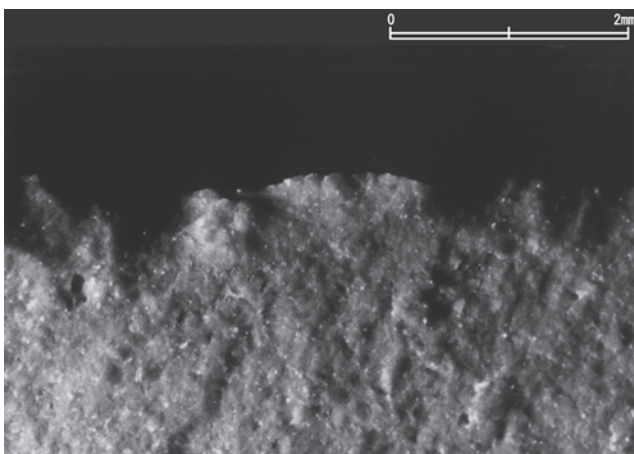
(2) 5.0-2. bamboo saw 4000st (SH80d) 8x



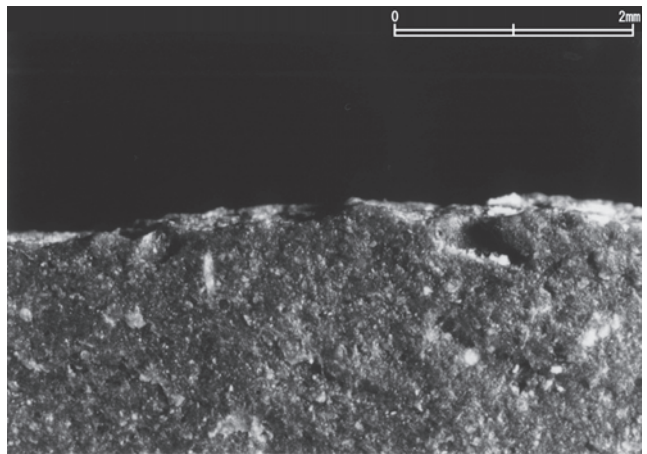
(3) 5.0-3. bamboo whittle (KSM21d) 8x



(4) 5.0-3. bamboo whittle (KSM23d) 8x

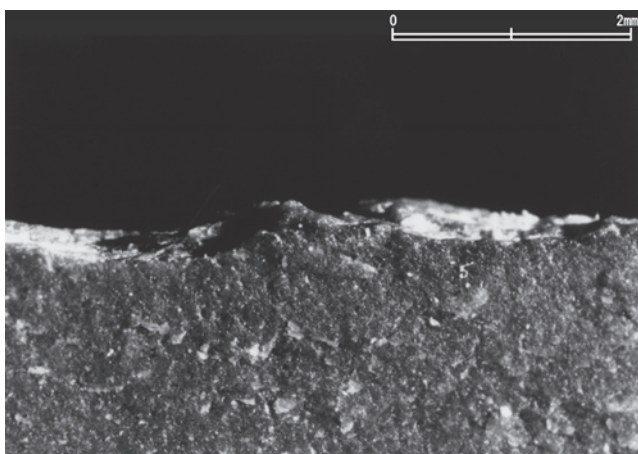


(5) 5.0-3. bamboo whittle (KSM23d) 8x

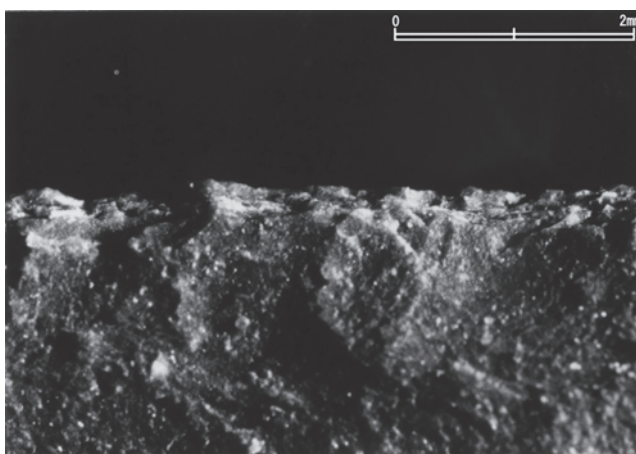


(6) 5.0-4. bamboo scrape 2000st (SH84d) 8x

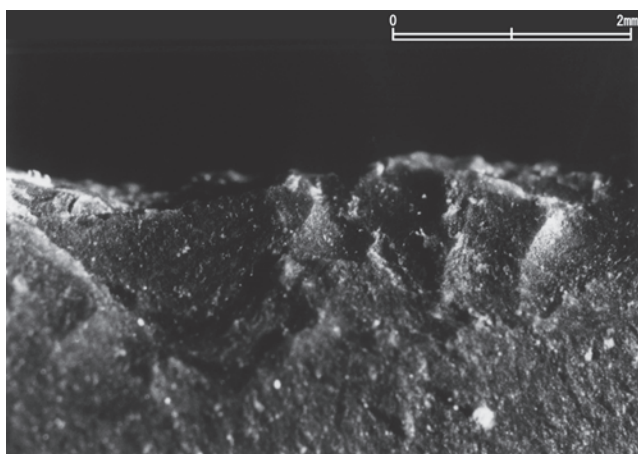
Figure 76. Experimental microflaking scars. (medium worked materials)



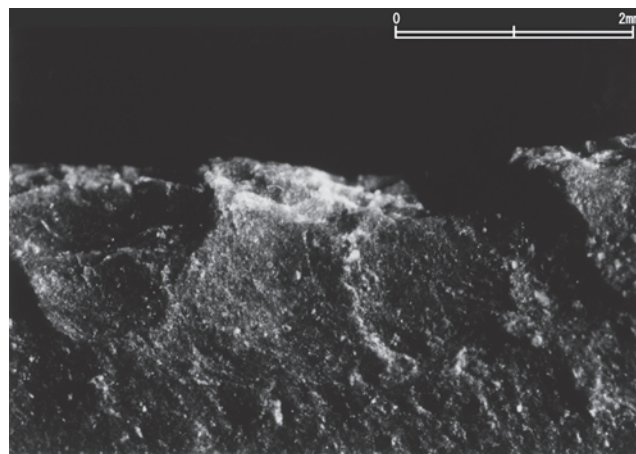
(1) 5.0-4. bamboo scrape 2000st (SH84d) 8x



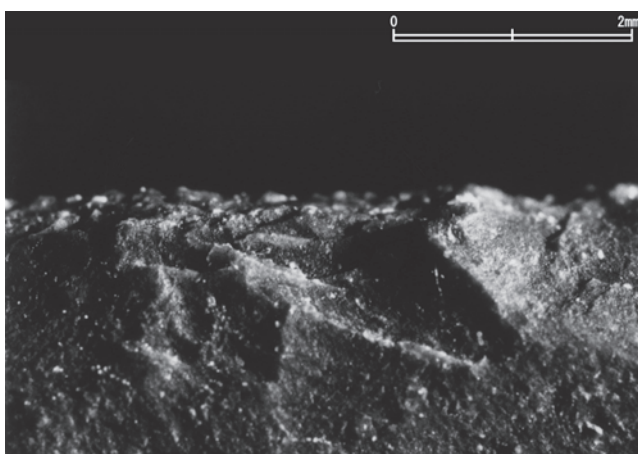
(2) 5.0-4. bamboo scrape 2000st (SH84v) 8x



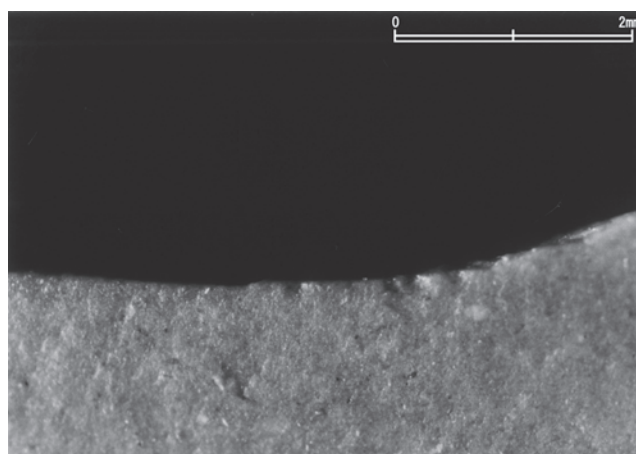
(3) 5.0-4. bamboo scrape 2000st (SH84v) 8x



(4) 5.0-4. bamboo scrape 2000st (SH84v) 8x

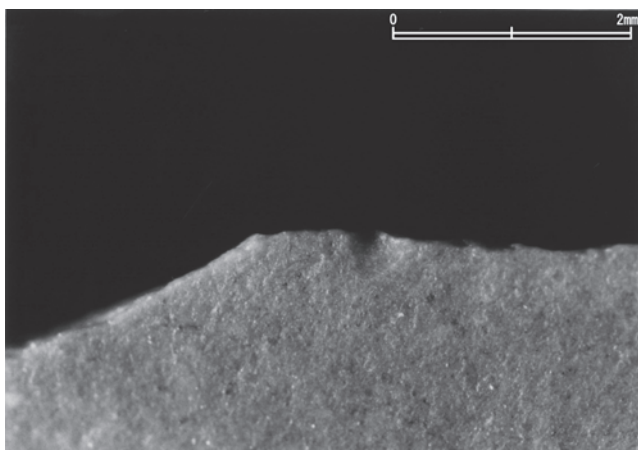


(5) 5.0-4. bamboo scrape (SH84v) 8x

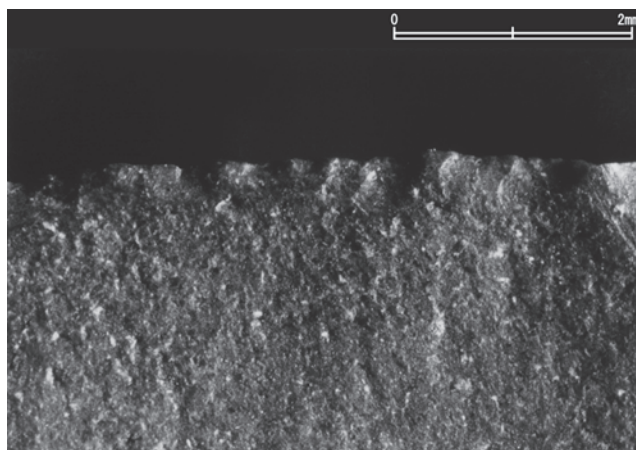


(6) 5.0-4. bamboo scrape 4000st (SH82d) 8x

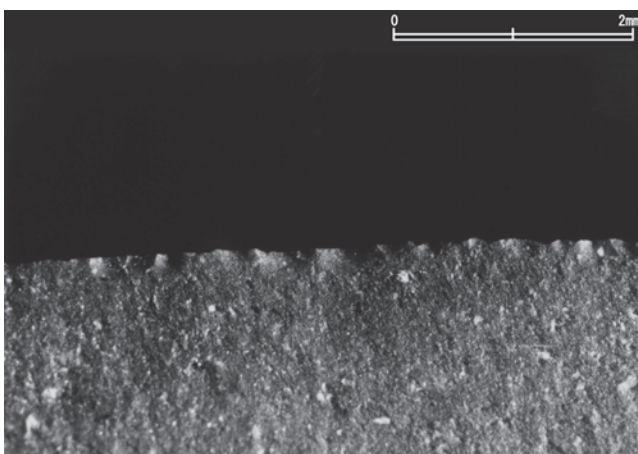
Figure 77. Experimental microflaking scars. (medium worked materials)



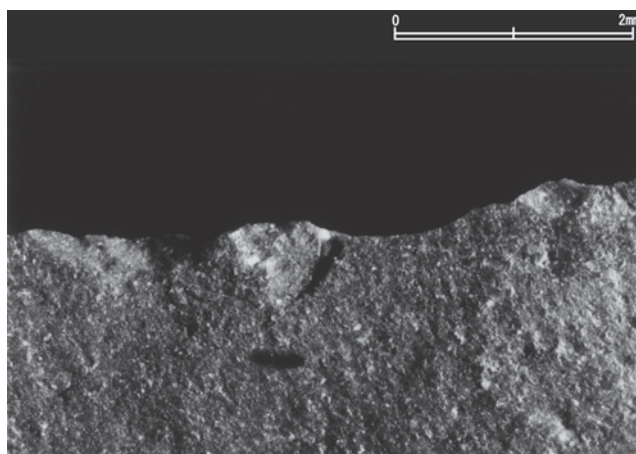
(1) 5.0-4. bamboo scrape 4000st (SH82d) 8x



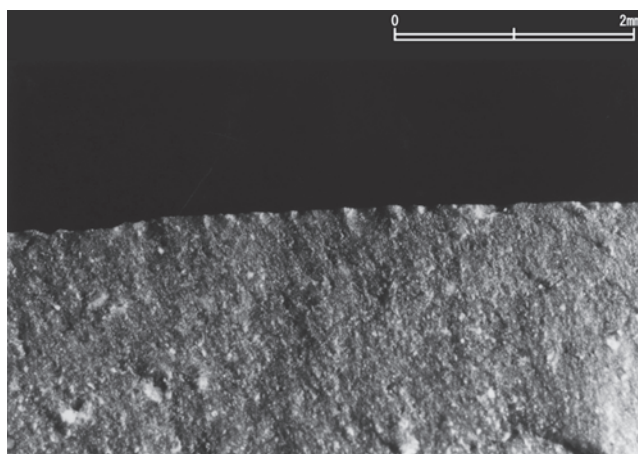
(2) 6.0-4. gourd saw 5000st (SH77d) 8x



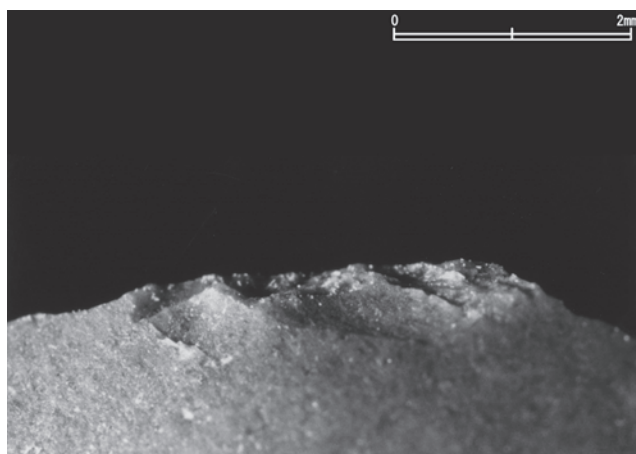
(3) 6.0-2. gourd saw 5000st (SH77d) 8x



(4) 6.0-2. gourd saw 5000st (SH77v) 8x

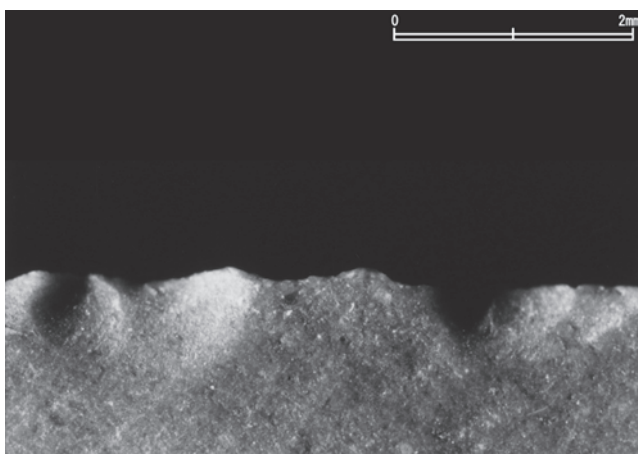


(5) 6.0-2. gourd saw 5000st (SH77v) 8x

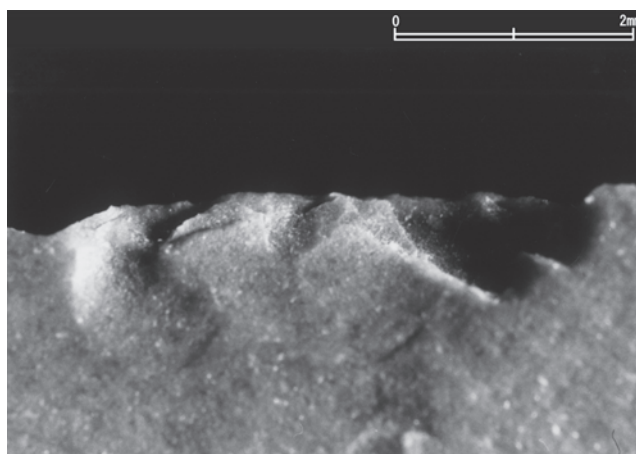


(6) 8.1-2. bone saw 3000st (SH86d) 8x

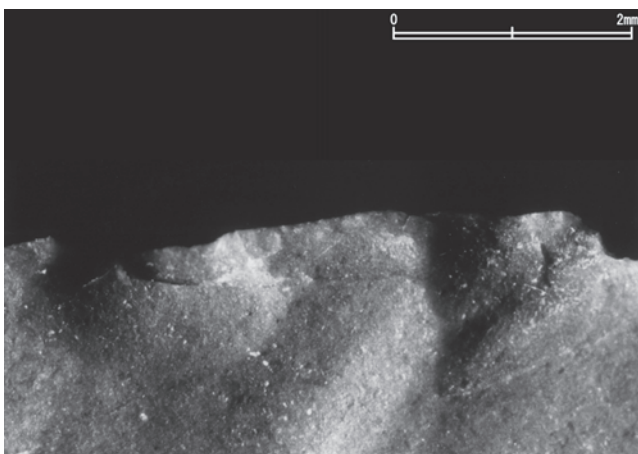
Figure 78. Experimental microflaking scars. (medium to hard worked materials)



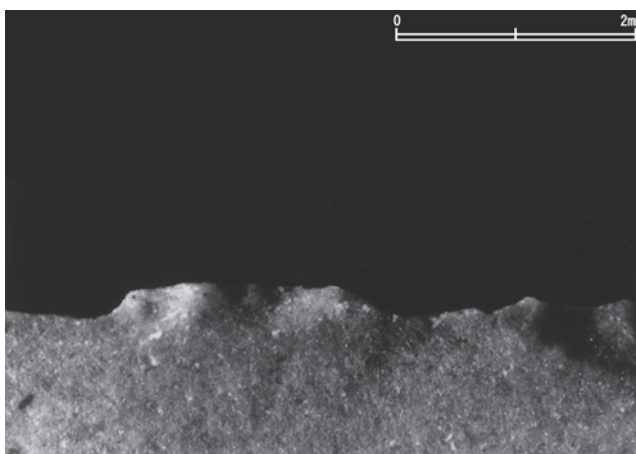
(1) 8.1-2. bone saw 3000st (SH86d) 8x



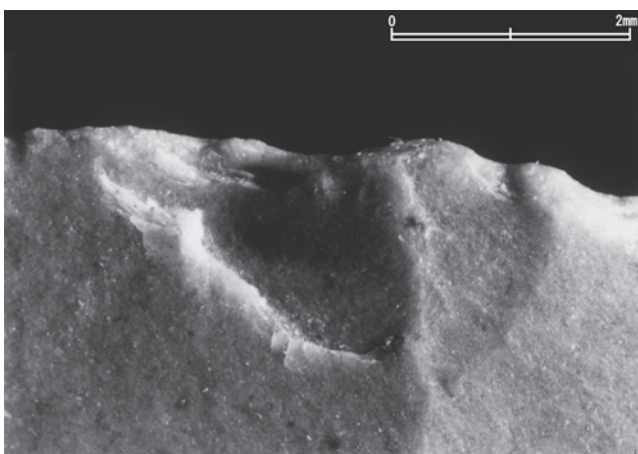
(2) 8.1-2. bone saw 3000st (SH86d) 8x



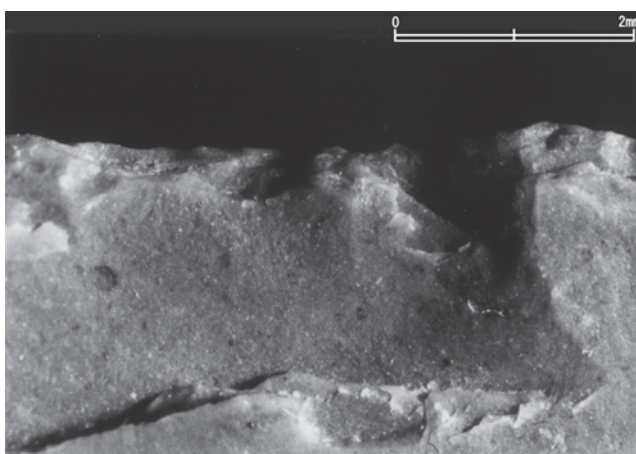
(3) 8.1-2. bone saw 3000st (SH86v) 8x



(4) 8.1-2. bone saw 3000st (SH86v) 8x

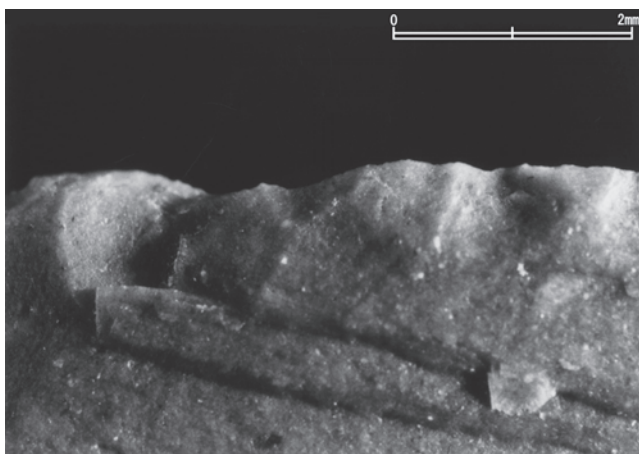


(5) 8.1-3. bone whittle 1100st (SH89d) 8x

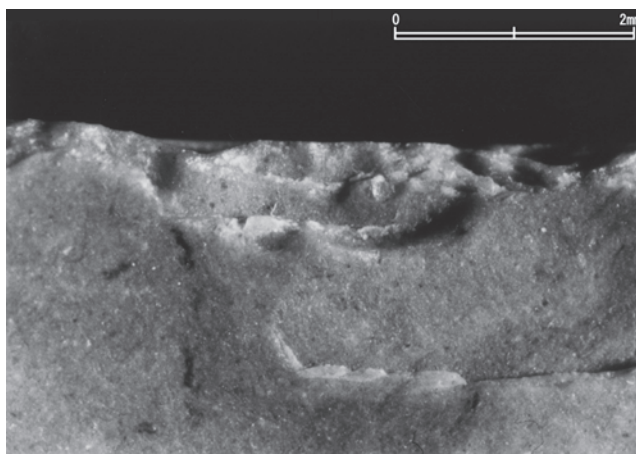


(6) 8.1-3. bone whittle 1100st (SH89d) 8x

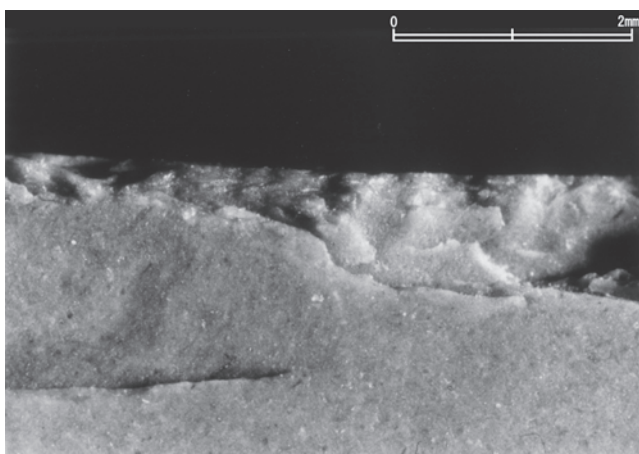
Figure 79. Experimental microflaking scars. (hard worked materials)



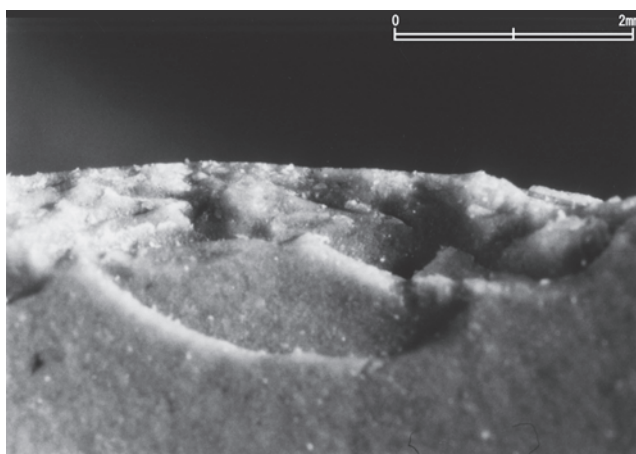
(1) 8.1-3. bone whittle 1100st (SH89v) 8x



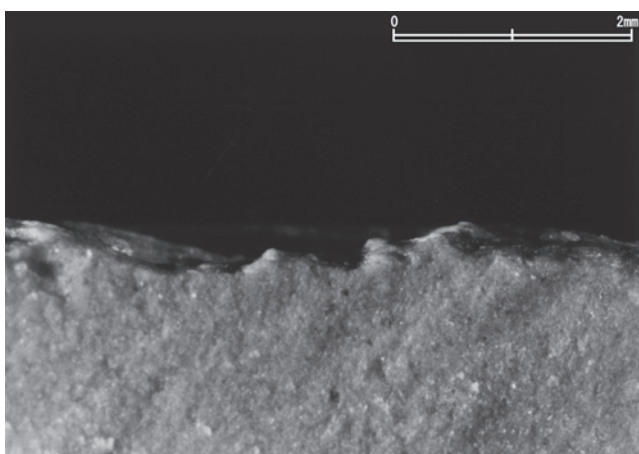
(2) 8.1-4. bone scrape 1000st (SH89d) 8x



(3) 8.1-4. bone scrape 1000st (SH89v) 8x



(4) 8.1-4. bone scrape 1000st (SH89d) 8x



(5) 8.1-4. bone scrape 1000st (SH89v) 8x

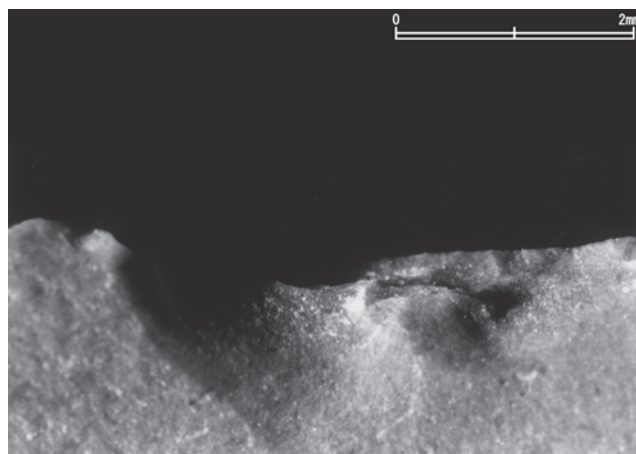


(6) 8.3-2. bone saw 500st (SH91) 3x

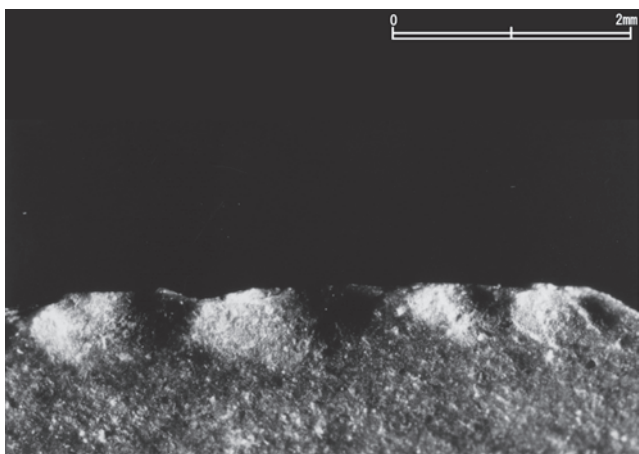
Figure 80. Experimental microflaking scars. (hard worked materials)



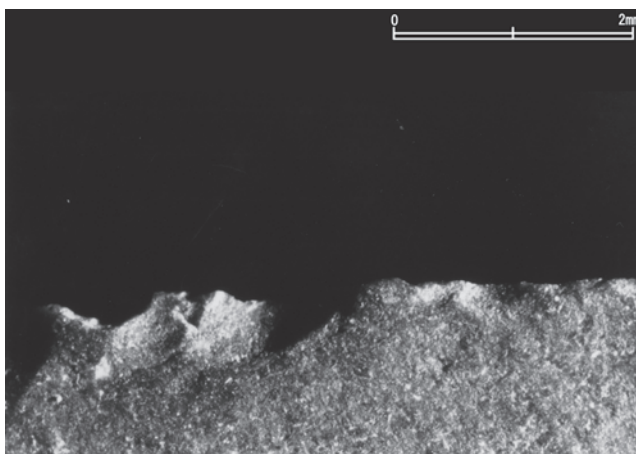
(1) 8.3-2. bone saw 500st (SH91) 3x



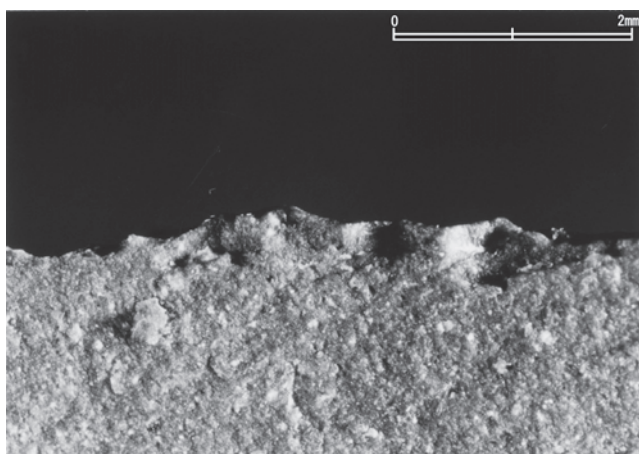
(2) 8.3-2. bone saw 3000st (SH86v) 8x



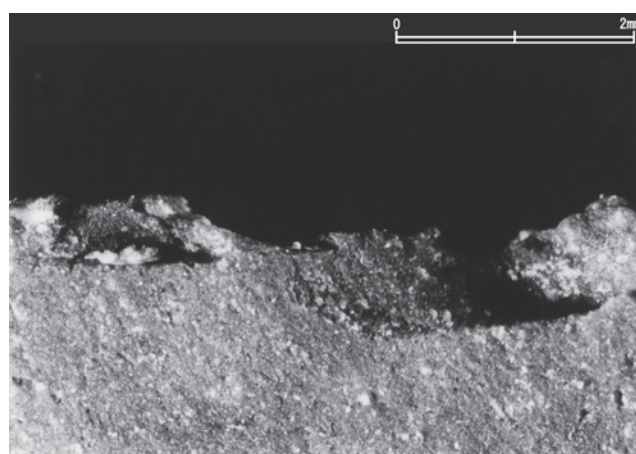
(3) 8.3-2. bone saw 5000st (SH92d) 8x



(4) 8.3-2. bone saw 5000st (SH92v) 8x

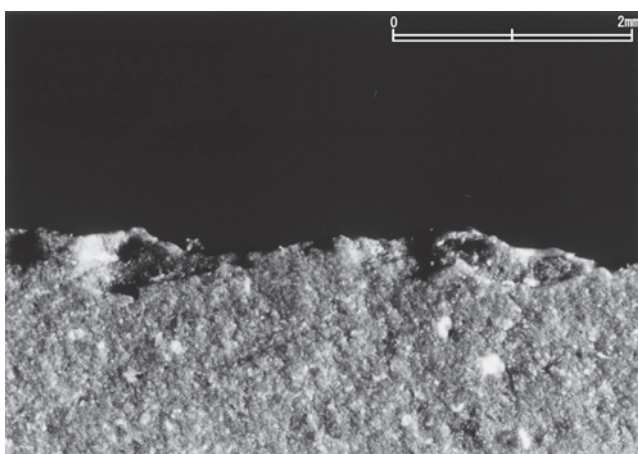


(5) 8.3-3. bone whittle 3000st (SH101d) 8x

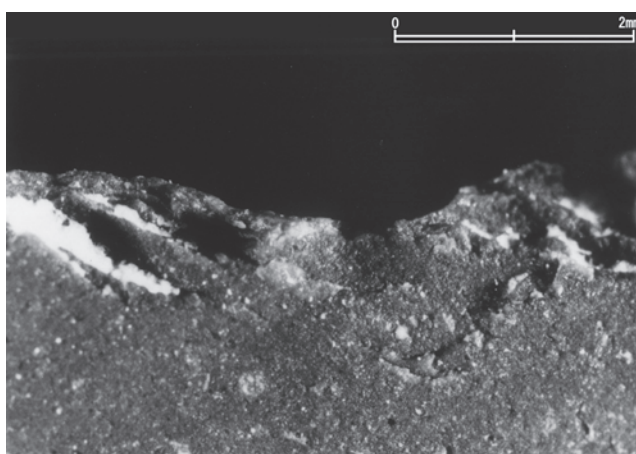


(6) 8.3-3. bone whittle 3000st (SH101d) 8x

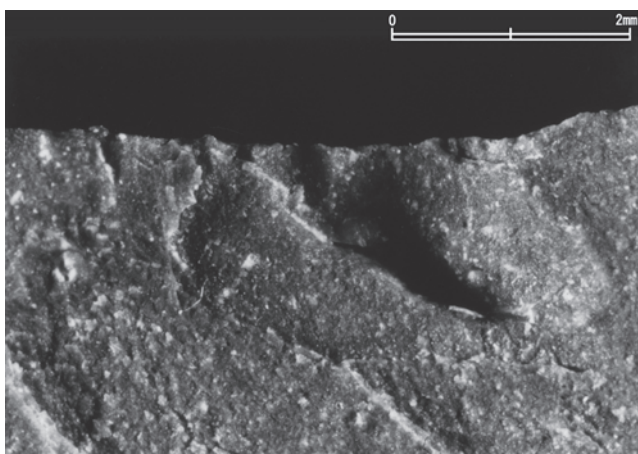
Figure 81. Experimental microflaking scars. (hard worked materials)



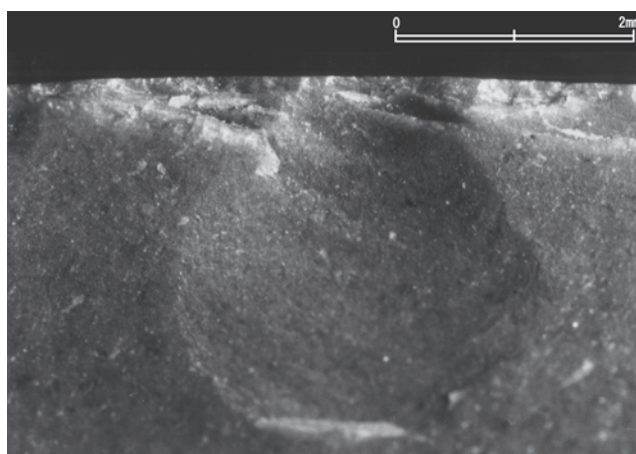
(1) 8.3-3. bone whittle 3000st (SH101d) 8x



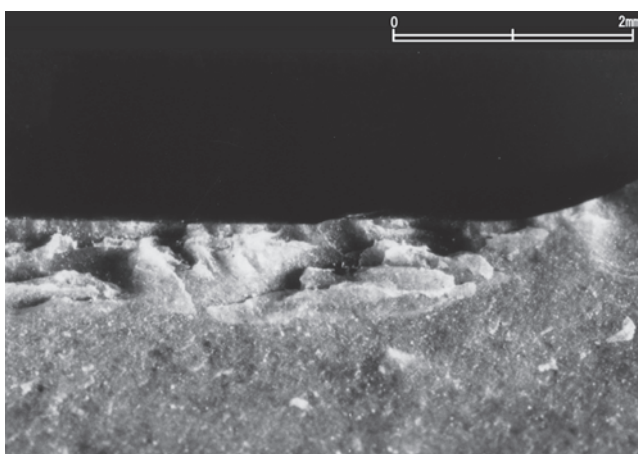
(2) 8.3-3. bone whittle 3000st (SH101v) 8x



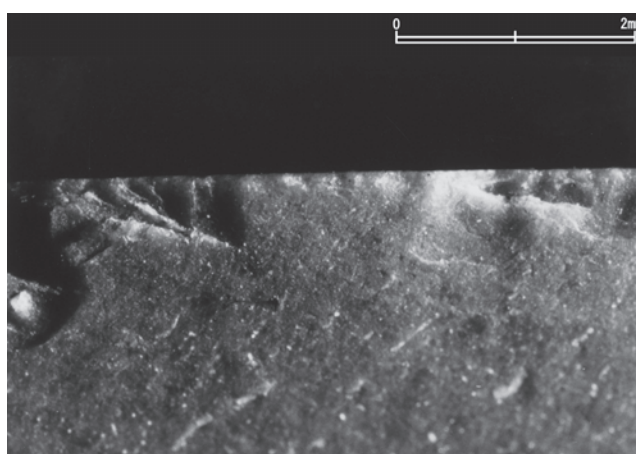
(3) 8.3-3. bone whittle 3000st (SH101v) 8x



(4) 8.3-4. bone scrape 1500st (SH93d) 8x

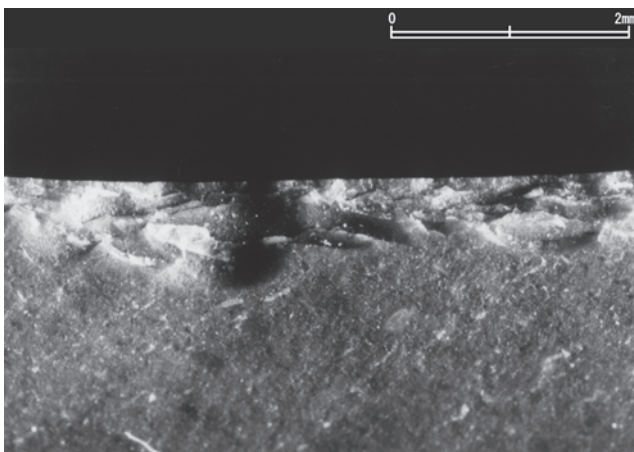


(5) 8.3-4. bone scrape 1500st (SH93d) 8x

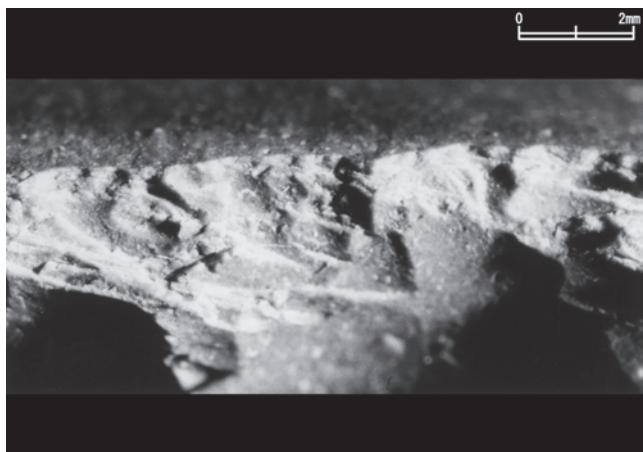


(6) 8.3-4. bone scrape 1500st (SH93d) 8x

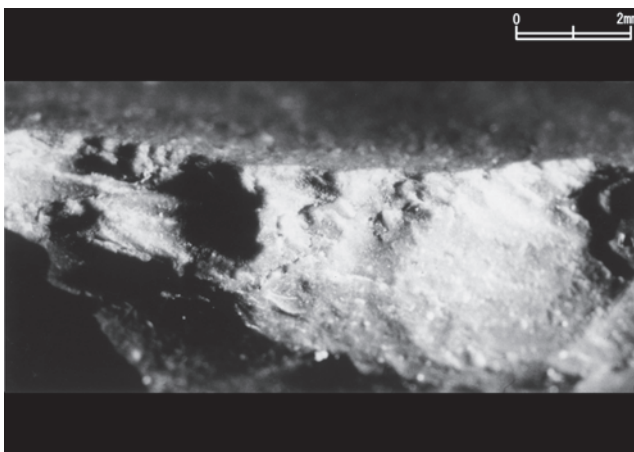
Figure 82. Experimental microflaking scars. (hard worked materials)



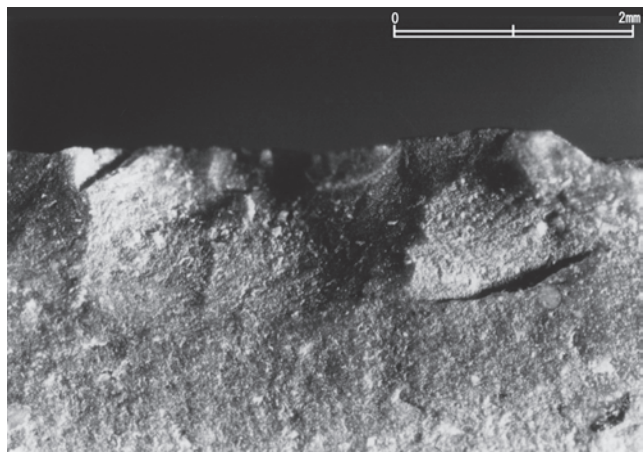
(1) 8.3-4. bone scrape 1500st (SH93d) 8x



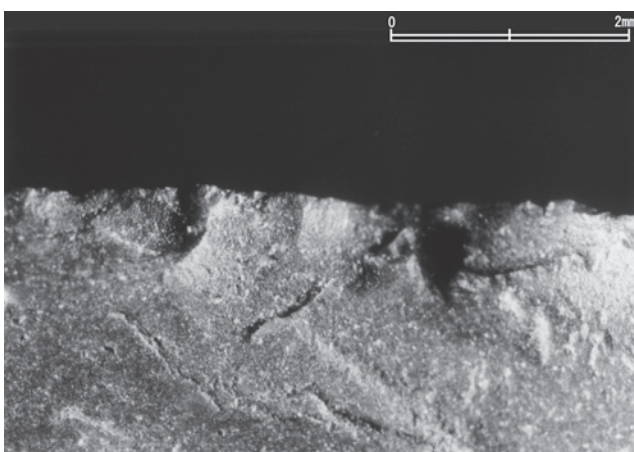
(2) 8.3-4. bone scrape 2000st (SH91) 3x



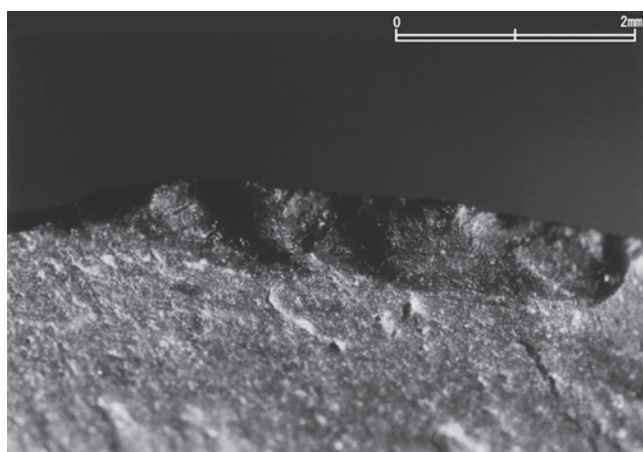
(3) 8.3-4. bone scrape 2000st (SH91) 3x



(4) 9.1-2. antler saw 4000st (SH47d) 8x

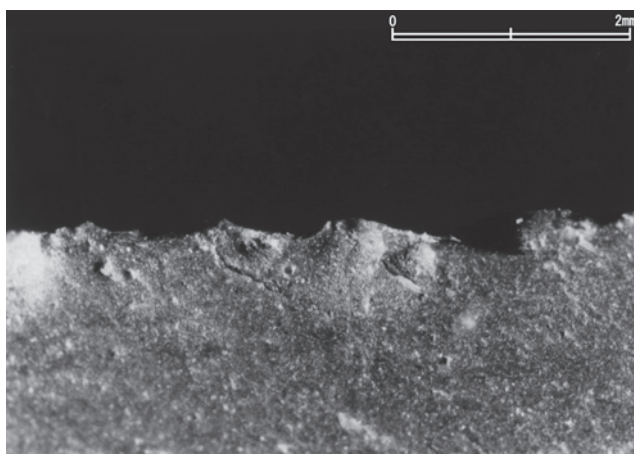


(5) 9.1-2. antler saw 4000st (SH47d) 8x

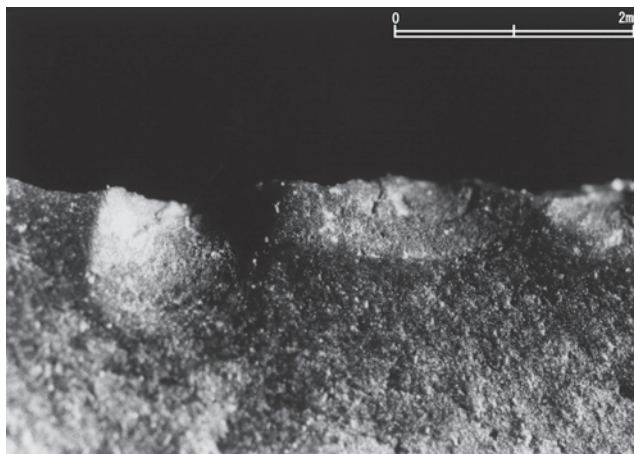


(6) 9.1-2. antler 4000st (SH47d) 8x

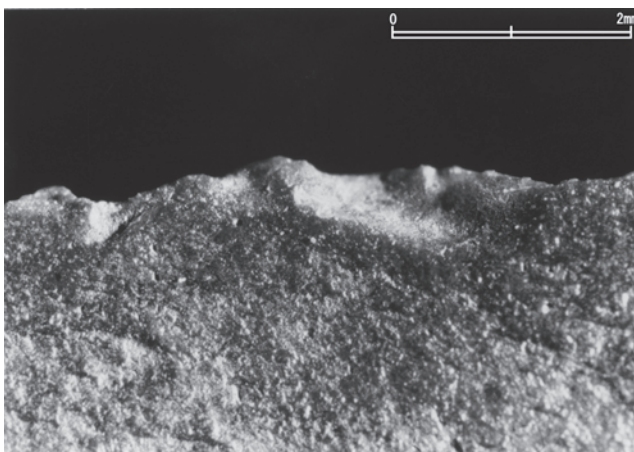
Figure 83. Experimental microflaking scars. (hard worked materials)



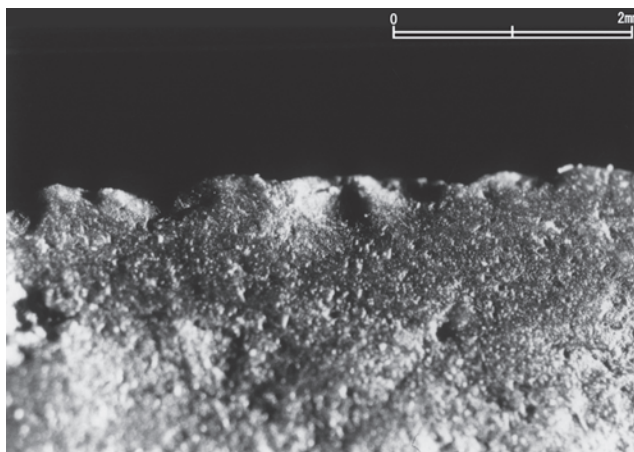
(1) 9.1-2. antler saw 4000st (SH47d) 8x



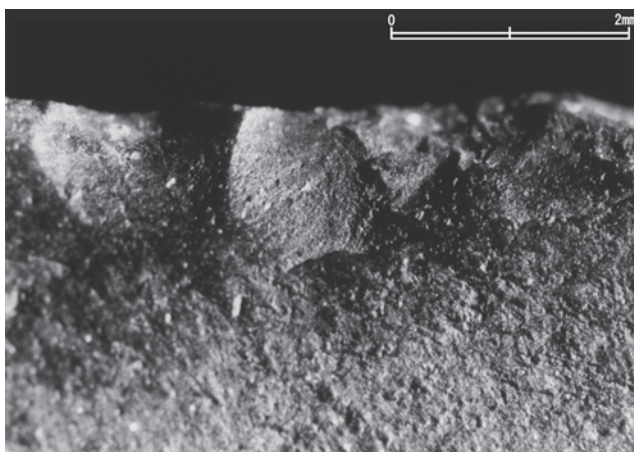
(2) 9.1-2. antler saw 4000st (SH47v) 8x



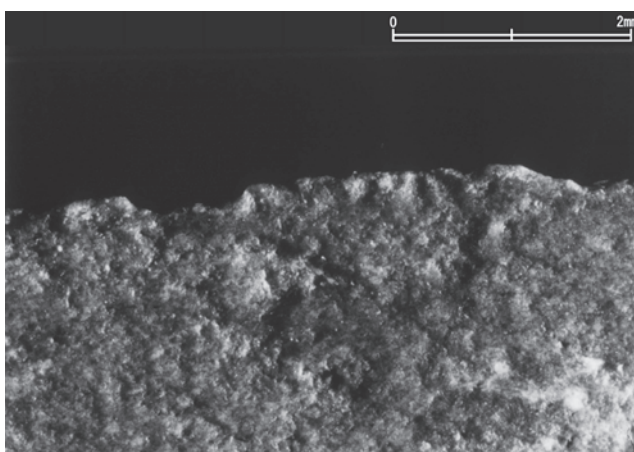
(3) 9.1-2. antler saw 4000st (SH47v) 8x



(4) 9.1-2. antler saw 4000st (SH47v) 8x

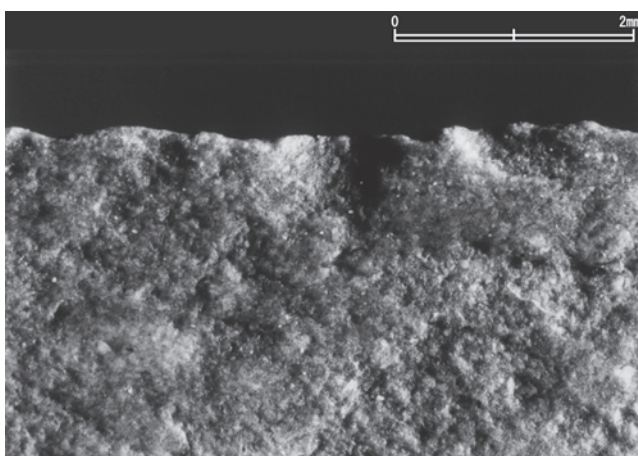


(5) 9.1-2. antler saw 4000st (SH47v) 8x

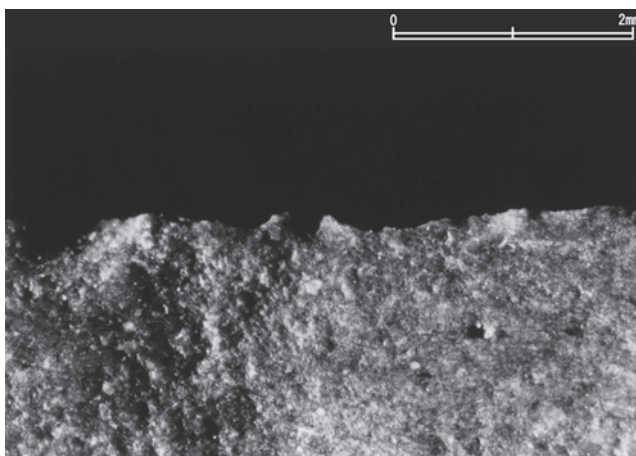


(6) 9.1-2. antler saw 15000st (SH48d) 8x

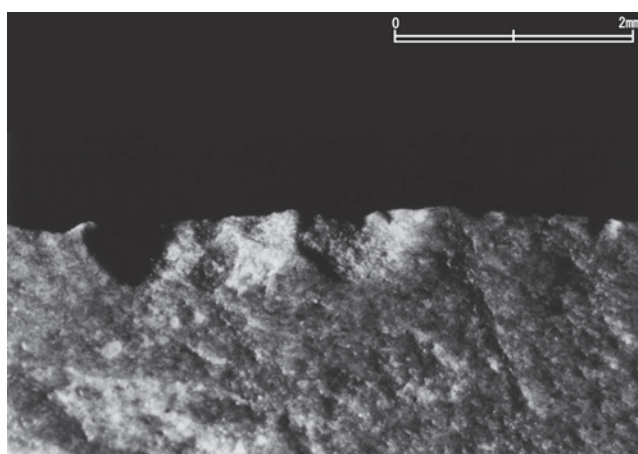
Figure 84. Experimental microflaking scars. (hard worked materials)



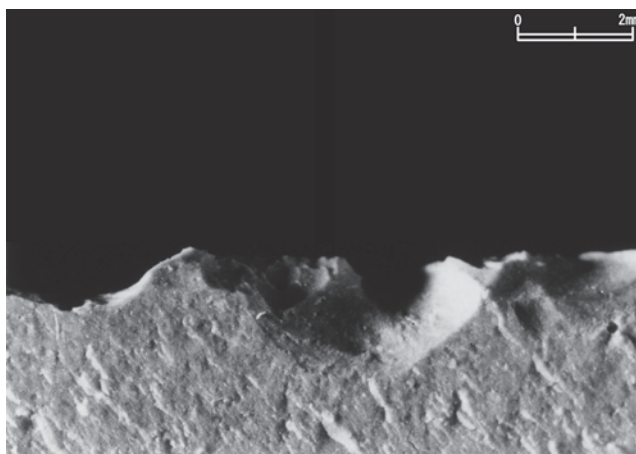
(1) 9.1-2. antler saw 15000st (SH48d) 8x



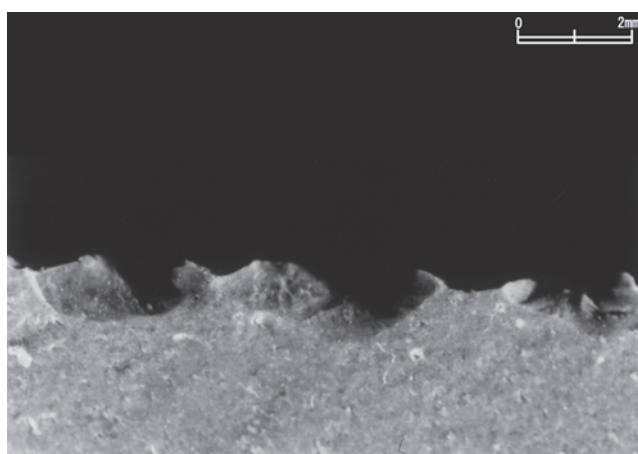
(2) 9.1-2. antler saw 15000st (SH48v) 8x



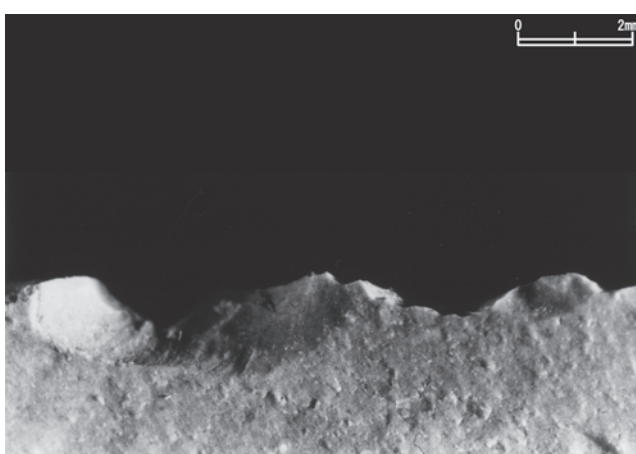
(3) 9.1-2. antler saw 15000st (SH48v) 8x



(4) 9.2-2. antler saw 1100st (SH71d) 3x

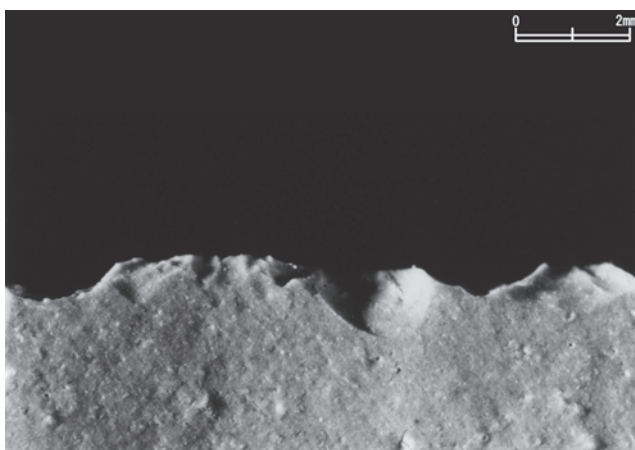


(5) 9.2-2. antler saw 1100st (SH71d) 3x

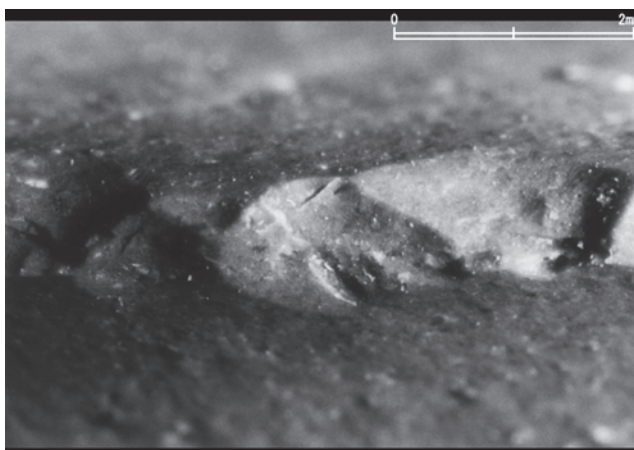


(6) 9.2-2. antler saw 1100st (SH71v) 3x

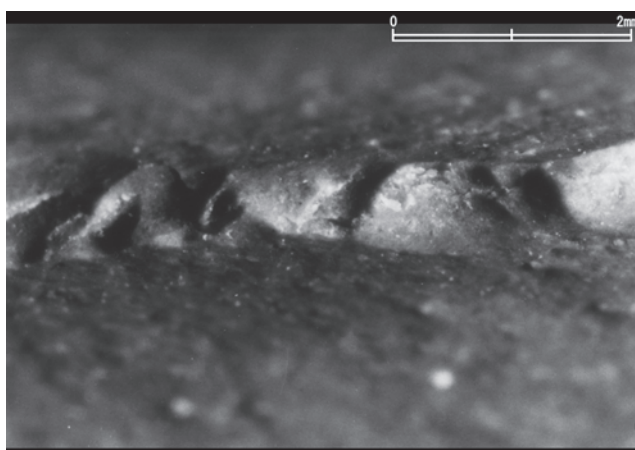
Figure 85. Experimental microflaking scars. (hard worked materials)



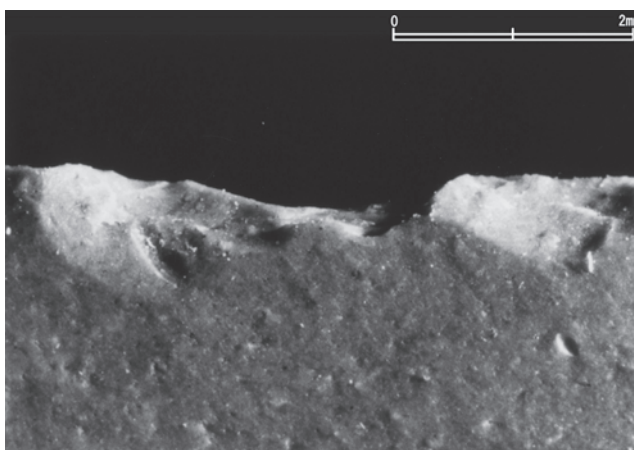
(1) 9.2-2. antler saw 1100st (SH71v) 3x



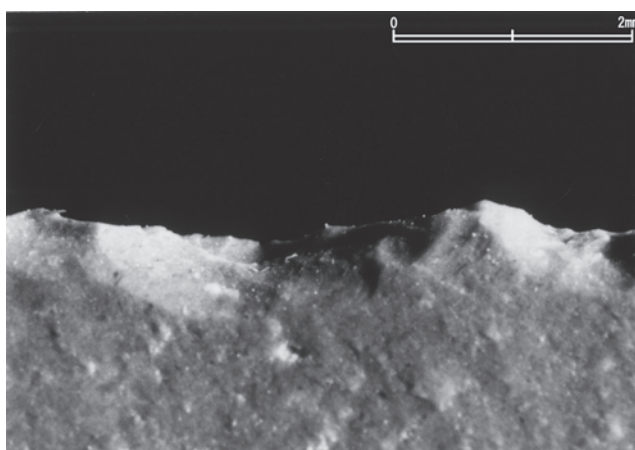
(2) 9.2-2. antler saw 4300st (SH68) 8x



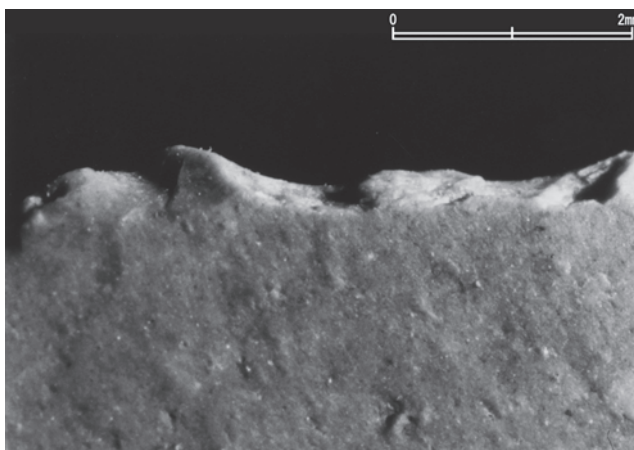
(3) 9.2-2. antler saw 4300st (SH68v) 8x



(4) 9.2-2. antler saw 4300st (SH68d) 8x

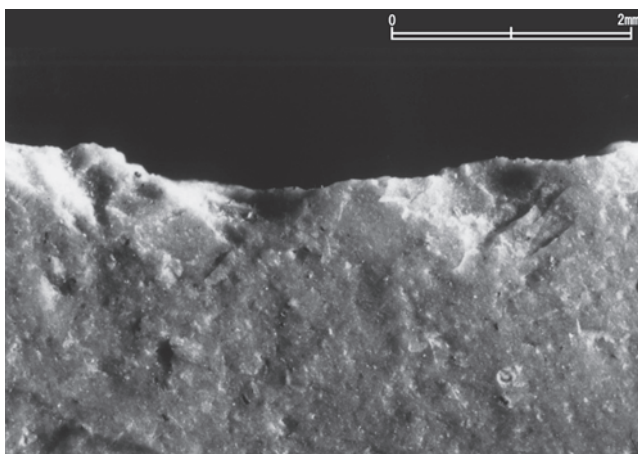


(5) 9.2-2. antler saw 4300st (SH68v) 8x

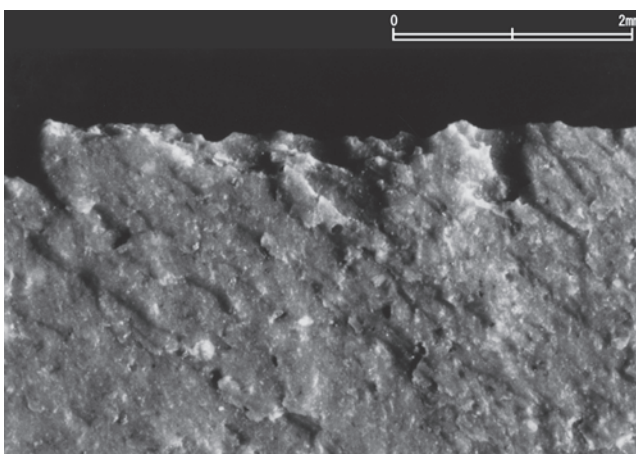


(6) 9.2-2. antler saw 4300st (SH68v) 8x

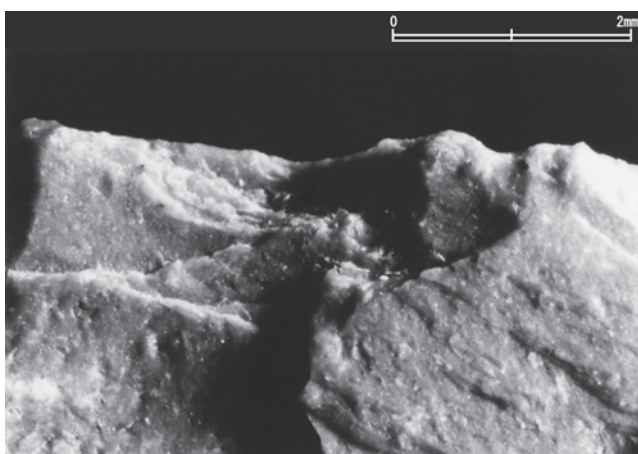
Figure 86. Experimental microflaking scars. (hard worked materials)



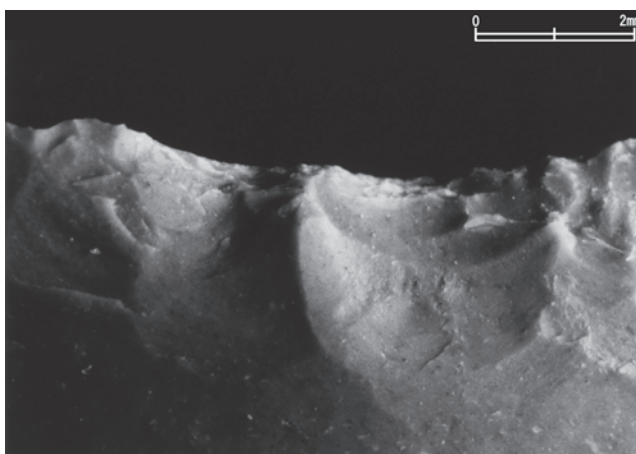
(1) 9.2-3. antler whittle 2000st (SH70d) 8x



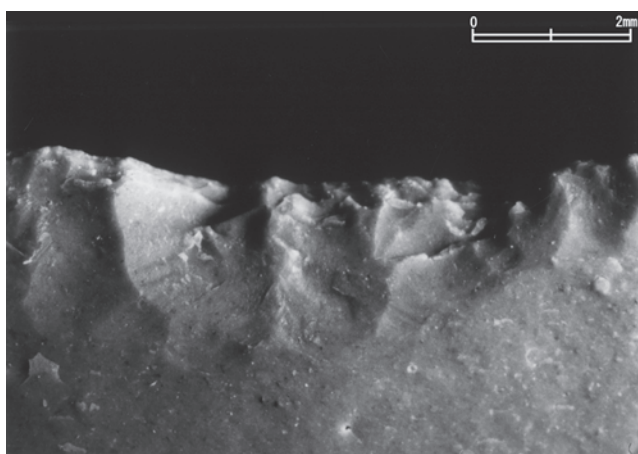
(2) 9.2-3. antler whittle 2000st (SH70v) 8x



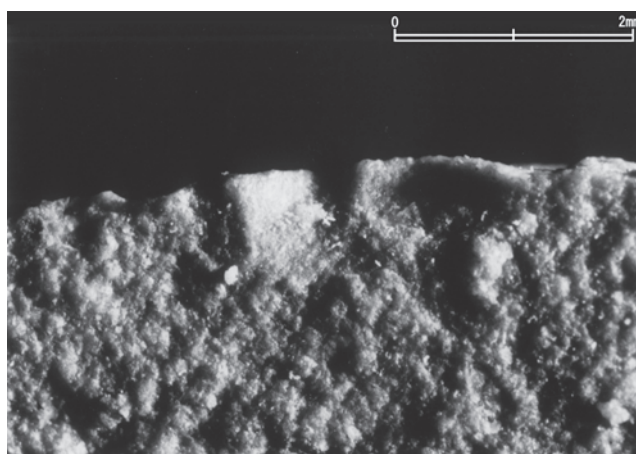
(3) 9.2-3. antler whittle 2000st (SH70v) 8x



(4) 9.2-4. antler scrape 100st (SH153d) 5x

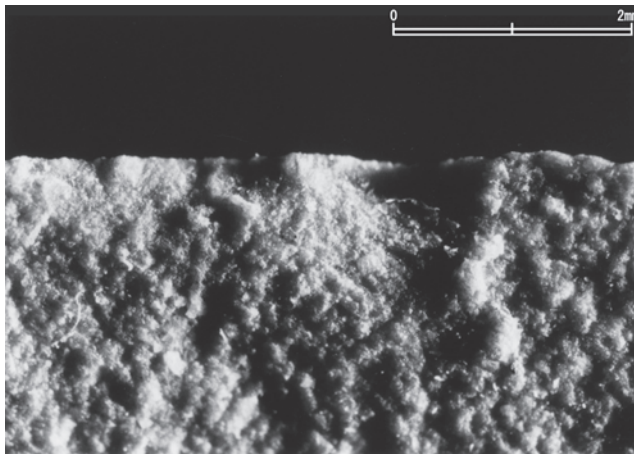


(5) 9.2-4. antler scrape 100st (SH153d) 5x

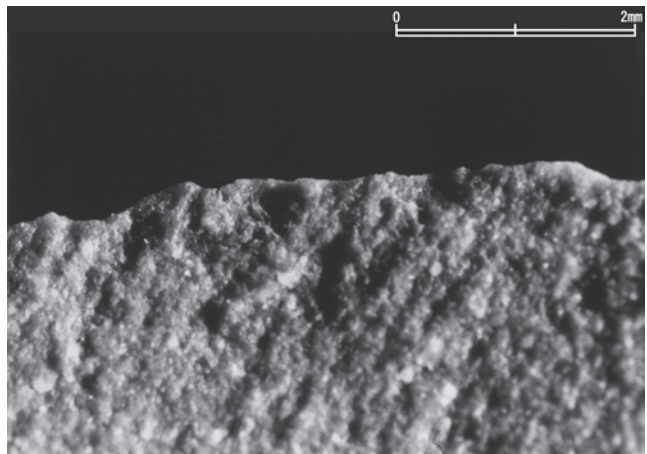


(6) 9.3-1. antler cut 1500st (SH16d) 8x

Figure 87. Experimental microflaking scars. (hard worked materials)



(1) 9.3-1. antler cut 1500st (SH16d) 8x



(2) 9.3-1. antler cut 1500st (SH16v) 8x

Figure 88. Experimental microflaking scars. (hard worked materials)

東北大学総合学術博物館紀要 (Bulletin of the Tohoku University Museum)

編集委員会規定

2004 年 1 月 31 日

(設置)

第 1 条 東北大学総合学術博物館(以下「博物館」という。)に東北大学総合学術博物館紀要編集委員会(以下「委員会」という。)を置く。

(任務)

第 2 条 委員会は、館長の求めに応じ、『東北大学総合学術博物館紀要』(以下「紀要」という。)に掲載する論文等の審査及び編集に当たるとともに、これに関する事項について審議する。

(組織)

第 3 条 委員会は、次に掲げる者をもって組織する。

- 一. 博物館の教官で館長が指名した者。
- 二. 博物館の運営委員及び兼任教官で館長が委託した者。
- 三. その他、特に館長が必要と認めた者。

(委員長)

第 4 条 委員会に、委員長を置く。

- 一. 委員長は、第 3 条第 1 項、及び第 2 項の委員の互選によって定める。
- 二. 委員長は、委員会を召集し、その議長となり、会務を掌理する。

(任期)

第 5 条 第 3 条に定める委員の任期は、1 年とし、再任を妨げない。

(議事)

第 6 条 委員会は、委員の過半数の出席がなければ会議を開くことができない。

2. 委員会の議事は、出席入数の過半数をもって決し、可否同数の時は、委員長が決するところによる。

(論文等の審査)

第 7 条 委員会は、寄稿された論文等について審査をおこなう。

2. 審査は掲載の可否、修正範囲、掲載分類等とする。
3. 審査にあたって、査読を実施する。

(委員以外の出席)

第 8 条 委員長が必要と認めた時は、委員以外の者を委員会に出席させ、意見を求めることができる。

(査読者の委託)

第 9 条 委員会は、論文等の審査にあたり、委員以外の者に査読を委託することができる。

(審議結果の報告)

第 10 条 委員会は、審議結果について、館長に報告する。

(庶務)

第 11 条 委員会の庶務は、博物館の事務において処理する。

(雑則)

第 12 条 この規定に定めるもののほか、論文等の審査及び編集に関し必要な事項は、委員会が別に定める。

附則

この規定は、2004 年 1 月 31 日から施行する。

東北大学総合学術博物館『紀要』寄稿要項

- 1 東北大学総合学術博物館紀要（以下「紀要」という。）は総合学術博物館（以下「博物館」という。）に関連する諸科学に関する研究報告、調査報告等を掲載・発表することにより、それらの学問の発展に寄与するものである。
- 2 紀要に寄稿することができる者は、次の通りとする。
 - ① 東北大学の教職員（同客員教官を含む）
 - ② 東北大学の名誉教授
 - ③ その他、博物館において適当と認めた者
- 3 原稿執筆における使用言語は英語・日本語を原則とする。
- 4 寄稿する原稿には英文要旨（300 語程度）を添付する。
- 5 原稿は A 4 判横書き、1 ページ 1 段組で 1,000 字（40 字× 25 行）とし、十分な余白を取る。英文の場合はこれに準ずる。（図、写真、表、図版などはそれぞれ別ページとして準備する。さらにそれらのキャプションを別途準備する。）図、写真類のできあがりの最大の大きさは 1 ページ縦 22 cm×横 17 cm とする。
- 6 原稿はワープロ、パソコンで作成し、印字原稿 2 部（図表、写真等も含める。）と CD、フロッピーディスク等を添えて提出する。
- 7 原稿の提出は 11 月末とする。
- 8 原稿の提出は、紀要編集委員会とする。
- 9 原稿は編集委員会から委託した査読者の審査を経て編集委員会が採択する。
- 10 掲載した一論文につき、別刷り 30 部まで無償とし、それ以上は著者の負担とする。
- 11 紀要に掲載された論文等の著作権は、博物館に帰属するものとする。