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The Status of *Ostrea pestigris* Hanley, 1846 and *Ostrea rivularis* Gould, 1861 (Bivalvia: Ostreidae)

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Abstract

The status of *Ostrea pestigris* Hanley, 1846 and *O. rivularis* Gould, 1861 are reexamined. *O. pestigris* is assigned to *Crassostrea* Sacco, 1897. *O. revularis* is the correct name of *O. paulucciae* Crosse, 1869 and includes *O. paulucciae* and *O. palmipes* G. B. Sowerby II, 1871 as the junior synonym.

Key words: Bivalvia, Ostreidae, *Ostrea pestigris, O. rivularis, O. ariakensis,* Quaternary, Recent.

Introduction

Since Hanley (1846) originally described *Ostrea pes-tigris* from Luzon, Philippines, this living species has been well-known from East and South China Seas (Grabau and King, 1928, Wang *ed.*, 1988, Zhai *et al.*, 1989 *etc.*). In Japan, it is only distributed in the Ariake Sea (Habe and Tanaka, 1959, Hayasaka, 1961, Itoigawa, 1990), and often found from the Pleistocene and Holocene deposits (Hayasaka, 1961, Ando, 1965, Itoigawa and Nakayama, 1968, Ueda, 1984). Although Torigoe (1981) summarized living oysters of Japan and figured 22 species in 8 genera, he did not refer to this species.

After Tchang and Lou (1956), this species has been assigned to the genus *Crassostrea* Sacco, 1897 (Itoigawa and Nakayama, 1968, Masuda and Noda, 1978, Zhai *et al.*, 1989 *etc.*). In his recent revision of Gryphaeidae and Ostreidae, Harry (1985) proposed a new genus, *Planostrea*, for his *O. pestigris* and indicated that junior synonyms are *O. rivularis* Gould, 1861, *O. paulucciae* Crosse, 1869, and *O. palmipes* G. B. Sowerby II, 1871. Therefore, the taxononic nomenclature for *O. pestigris* has been somewhat confused.

In this paper, we reexamine the status of *O. pestigris* and *O. rivularis*. As a result of our reexamination, *O. pestigris* is assigned to *Crassostrea* Sacco, 1897, and separated from *O. rivularis* which includes *O. paulucciae* and *O. palmipes* as the junior synonym. In addition, the stratigraphic and geographic distributions of these species are summarized.

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Systematics

Family Ostreidae Rafinesque, 1815
Subfamily Crassostreinae Torigoe, 1981

Genus *Crassostrea* Sacco, 1897 emend. Harry, 1985

Type species: *Ostrea virginica* Gmelin, 1791 by original designation (ICZN Opinion 338).

Crassostrea pestigris (Hanley, 1846)
(Pl. 16, Figs. 1a, b–24)

1846 *Ostrea pes-tigris* Hanley, p. 106.
1871 *Ostrea pes-tigris* Hanley; G. B. Sowerby II, pl. 30, figs. 78a, b.
1928 *Ostrea chemnitzi* var. *elongata* Grabau *et* King, p. 164, pl. 2, fig. 14, *non Ostrea elongata* Born, 1778.
?1928 *Ostrea spinosa* G. B. Sowerby II; Amemiya, p. 335, pl. 20, fig. 3 (ex partin).
1956 *Ostrea* (*Crassostrea*) *pes-tigris* Hanley; Tchang and Lou, p. 89, pl. IV, figs. 4–6.
1959 *Crassostrea irregularis* (Tokunaga); Habe and Tanaka, p. 12 (name only).
1961 *Ostrea* (*Crassostrea*) *pestigris* Hanley; Oyama, p. 207 (name only).
1961 *Ostrea* (*Crassostrea*) *pes-tigris* Hanley; Hayasaka, p. 35, pl. 3, figs. 8–10b.
1965 *Ostrea* (*Crassostrea*) *pes-tigris* Hanley; Ando, p. 208, figs. 18, 19.
1968 *Crassostrea pes-tigris* (Hanley); Itoigawa and Nakayama, p. 65 (name only).
1976 *Crassostrea pestigris* (Hanley); Masuda and Noda, p. 301 (name only).
1984 *Saccostrea* ? *chemnitzi* (Hanley); Ueda, p. 13, pl. 2, fig. 8.
non 1985 *Planostrea pestigris* (Hanley); Harry, p. 143, fig. 22 (= *Ostrea rivularis* Gould).
1988 *Ostrea* (*Crassostrea*) *pestigris* Hanley; Wang *ed.*, p. 110, fig. 493.
1989 *Crassostrea pestigris* (Hanley); Zhai *et al.*, p. 178, pl. 10, fig. 4.
1990 *Crassostrea pestigris* (Hanley); Itoigawa, p. 89 (name only).
1990 *Crassostrea pestigris* (Hanley); Tanaka, p. 152 (name only).
1993 *Planostrea pestigris* (Hanley); Barnard *et al.*, p. 45 (name only).

Comments: Hanley (1846) originally described *O. pestigris* from Luzon Island, Philippines, but he did not illustrated this species. In his monographs of living oysters, G. B. Sowerby II (1871) first figured *O. pestigris*. Harry (1985) showed that junior synonyms of this species include *Ostrea revularis*, *O. paulucciae*, and *O. palmipes*. The small, elongate valve without the chomata, readily distinguishes *O. pestigris* from the latter three species, *O. rivularis, O. paulucciae,* and *O. palmipes.*

O. pestigris is assigned to *Crassostrea* by lacking the chomata. It is a species of *Crassostrea* with small, elongate, thin valves and a typical right valve forming a cat foot-like outline with strong radial ridges.

Occurrence:

Takamatsu, Akabane-cho, Atsumi-gun, Aichi Prefecture; Takamatsu silty Sandstone, Toyohashi Formation, Atsumi Group (Middle Pleistocene, 0.44± 0.18 Ma, Shimamoto *et al.*, 1994) (Hayasaka, 1961).

Wakaba-gakuen, Tarumi-ku, Kobe City, Hyogo Prefecture; Takatsukayama Clay, Meimi Formation, Osaka Group (Middle Pleistocene, 0.49±0.09 Ma, Huzita and Maeda, 1984) (Ando, 1965).

Yokohama, Takahama-cho, Hekikai-gun, Aichi Prefecture; Hekikai Formation (Late Pleistocene, about 30,000 y. B.P.) (Itoigawa and Nakayama, 1968).

Minamiokuda-cho, Nishio City, Aichi Prefecture; ? Hekikai Formation (Late Pleistocene, about 30,000 y. B.P.) (Tanaka, 1990).

Shippo-cho, Ama-gun, Aichi Prefecture; Nanyo Formation (about 6,000 y. B. P.) (Ueda, 1984).

Hananoki-yatsu, Kisarazu City, Chiba Prefecture; Kiyokawa Formation, Shimosa Group (Middle Pleistocene, 0.26–0.23 Ma by Kikuchi et al., 1988) (= Loc. 19 of Itoigawa *et al.* (1978)) (NEW LOCALITY).

Off Hakatajima, Hakata-cho, Ehime Prefecture; ? Middle Pleistocene (NEW LOCALITY).

Geologic range: Middle Pleistocene–Recent.

Distribution of living species: Japan—Ariake Sea, Hosonosu and off Onomichi City, Hiroshima Prefecture (NEW LOCALITY); off Hakatajima, Hakata

-cho, Ehime Prefecture (NEW LOCALITY), off Suji, Amakusa-gun, Kumamoto Prefecture; Shanghai, Hong Kong, South and East China Seas, Philippines.

Crassostrea ariakensis (Wakiya *in* Fujita, 1929)
(Pl. 17, Figs. 1a-d)

1869 *Ostrea rivularis* Gould; Lischke, p. 176, pl. 14, figs. 2, 3.
1882 *Ostrea arborea* Chemnitz; Dunker, p. 250.
1913 *Ostrea ariakensis* Wakiya; Fujita (*nom. nud.*).
1919 *Ostrea rivularis* Gould; Iwakawa, p. 255 (name only).
1928 *Ostrea rivularis* Gould; Amemiya, p. 336, pl. 19, figs. 1, 2.
1929 *Ostrea ariakensis* Wakiya *in* Fujita, p. 363, pl. 9, figs. 1, 2.
1930 *Ostrea rivularis* Gould; Kuroda, p. 54 (name only).
1930 *Ostrea* (*Crassostrea*) *rivularis* Gould; Hirase, p. 55, figs. 81-92.
1952 *Ostrea* (*Crassostrea*) *rivularis* Gould; Oyama, p. 504 (name only).
1956 *Ostrea* (*Crassostrea*) *rivularis* Gould; Tchang and Lou, p. 85, pl. II, figs. 3, 4.
1961 *Crassostrea rivularis* (Gould); Oyama, p. 209 (name only).
1977 *Crassostrea ariakensis* (Wakiya); Habe and Kosuge, p. 138, pl. 51, fig. 18.
1973 *Crassostrea rivularis* (Gould); Higo, p. 331 (name only).
1973 *Crassostrea rivularis* (Gould); Kira, p. 127, pl. 51, fig. 6.
1977 *Crassostrea ariakensis* (Wakiya); Habe, p. 108 (name only).
1977 *Crassostrea ariakensis* (Wakiya); Torigoe, p. 326, pl. 15, figs. 1-7.
1981 *Crassostrea ariakensis* (Wakiya); Habe, p. 83 (name only).
1981 *Ostrea ariakensis* "Fujita" Wakija; Harry, p. 41 (name only).
1988 *Crassostrea rivularis* (Gould); Zhai *et al.*, p. 179, pl. 10, fig. 8.
1989 *Ostrea* (*Crassostrea*) *rivularis* Gould; Wang *ed.*, p. 172, fig. 494.
1993 *Crassostrea ariakensis* (Wakiya *in* Fujita); Higo and Goto, p. 587 (name only).
1993 *Crassostrea rivularis* (Gould); Barnard *et al.*, p. 46 (name only).
1993 *?Crassostrea ariakensis* (Wakiya *in* Fujita); Nakano, p. 163 (name only).

Comments: Torigoe (1981) given the detail discussion. A fossil of *C. ariakensis* is only recorded from the Middle Pleistocene Toriyamahama Formation of Miyazaki Prefecture (Nakano, 1993).

Geologic range: Middle Pleistocene-Recent.

Distribution of living species: Japan (Kii, Osaka Bay, Seto Inland Sea, Ariake Sea, Omura Bay); Celebes Sea, South and East China Seas, Taiwan, Yellow Sea, Bohai Sea.

Subfamily Ostreinae Rafinesque, 1815
Genus *Ostrea* Linnaeus, 1758 emend. Harry, 1985

Type species: Ostrea edulis Linnaeus, 1758 by Linnean tautonymy (ICZN Direction 94, Opinion 356).

Ostrea rivularis Gould, 1861
(Pl. 18, Figs. 1a-6d)

1861 *Ostrea rivularis* Gould, p. 39.
1862 *Ostrea rivularis* Gould; Gould, p. 178.
1869 *Ostrea paulucciae* Crosse, p. 188.
non 1869 *Ostrea rivularis* Gould; Lischke, p. 176, pl. 14, figs. 2, 3 (=*Crassostrea ariakensis* (Wakiya *in* Fujita)).
1870 *Ostrea paulucciae* Crosse; Crosse, p. 108, pl. 2, fig. 5.
1871 *Ostrea palmipes* G. B. Sowerby II, pl. 24, figs. 56a-c.
non 1919 *Ostrea rivularis* Gould; Iwakawa, p. 255 (= *Crassostrea ariakensis* (Wakiya *in* Fujita)) (name only).
1924 *Ostrea paulucciae* Crosse; Nakamura and Kuroda, p. 170, fig. 5.
non 1928 *Ostrea rivularis* Gould; Amemiya, p. 336, pl. 19, figs. 1, 2 (=*Crassostrea ariakensis* (Wakiya *in* Fujita)).
non 1930 *Ostrea rivularis* Gould; Kuroda, p. 54 (= *Crassostrea ariakensis* (Wakiya *in* Fujita)) (name only).

1930 *Ostrea paulucciae* Crosse; Kuroda, p. 54 (name only).

non 1930 *Ostrea* (*Crassostrea*) *rivularis* Gould; Hirase, p. 55, figs. 81-92 (=*Crassostrea ariakensis* (Wakiya *in* Fujita)).

1941 *Ostrea* (*Saxostrea*) *paulucciae* Crosse; Kuroda, p. 157 (name only).

1951 *Dendostrea paulucciae* (Crosse); Habe, p. 93 (name only).

non 1951 *Ostrea* (*Crassostrea*) *rivularis* Gould; Habe, p. 95 (=*Crassostrea ariakensis* (Wakiya *in* Fujita)) (name only).

non 1952 *Ostrea* (*Crassostrea*) *rivularis* Gould; Oyama, p. 504 (=*Crassostrea ariakensis* (Wakiya *in* Fujita)) (name only).

1952 *Ostrea paulucciae* Crosse; Kuroda and Habe, p. 27 (name only).

non 1956 *Ostrea* (*Crassostrea*) *rivularis* Gould; Tchang and Lou, p. 85, pl. 2, figs. 3, 4 (=*Crassostrea ariakensis* (Wakiya *in* Fujita)) .

1956 *Ostrea* (*Crassostrea*) *paulucciae* Crosse; Tchang and Lou, p. 87, pl. 5. figs. 4-7.

1961 *Crassostrea paulucciae* (Crosse); Oyama, p. 209 (name only).

1964 *Ostrea revularis* Gould; Johnson, p. 140 (name only).

1973 *Dendostrea paulucciae* (Crosse); Higo, p. 329 (name only).

non 1973 *Crassostrea rivularis* Gould; Higo, p. 331 (=*Crassostrea ariakensis* (Wakiya *in* Fujita)) (name only).

1974 *Dendostrea paulucciae* (Crosse); Matsushima, p. 30 (name only).

1974 *Dendostrea paulucciae* (Crosse); Matsushima and Oshima, p. 142 (name only).

1976 *Dendostrea paulucciae* (Crosse); Masuda and Noda, p. 294 (name only).

1976 *Dendostrea paulucciae* (Crosse); Matsushima, p. 110 (name only).

1977 *Dendostrea paulucciae* (Crosse); Matsuura, p. 136, pl. 15, figs. 8, 9.

1977 *Dendostrea paulucciae* (Crosse); Habe, p. 110 (name only).

1978 *Ostrea paulucciae* Crosse; Sugiura, p. 16, fig. 23.

1980 *Ostrea rivularis* Gould; Ruhoff, p. 468 (name only).

1980 *Dendostrea paulucciae* (Crosse); Matsuura, p. 56 (name only).

1981 *Dendostrea paulucciae* (Crosse); Habe, p. 84 (name only).

non 1981 *Ostrea* cf. *palmipes* G. B. Sowerby II; Yoshida, p. 330 (name only) (=*Ostrea denselamellosa* Lischke, 1869).

1981 *Kamonoashigaki*, Kajiyama and Kaneko, p. 112, pl. 73, figs. 3a-c.

1982 *Ostrea paulucciae* Crosse; Oyama, p. 5 (with 1 fig.).

1982 *Ostrea* (*Dendostrea*) *paulucciae* Crosse; Fujiyama, p. 342, fig. 1658.

1984 *Dendostrea paulucciae* (Crosse); Matsushima, p. 90 (name only).

1985 *Dendostrea paulucciae* (Crosse); Itoigawa and Kimura, p. 161 (name only).

1985 *Dendostrea paulucciae* (Crosse); Matsuura, p. 112 (name only).

1985 *Planostrea pestigris* (Hanley); Harry, p. 143, fig. 22.

1985 *Dendostrea paulucciae* (Crosse); Matsushima, p. 31 (name only).

1987 *Dendostrea paulucciae* (Crosse); Ishii, p. 9, pl. 7, figs. 2a, b.

non 1988 *Crassostrea rivularis* (Gould); Zhai *et al.*, p. 179, pl. 10, fig. 8 (=*Crassostrea ariakensis* (Wakiya *in* Fujita)).

non 1989 *Ostrea* (*Crassostrea*) *rivularis* Gould; Wang *ed.*, p. 172, fig. 494 (=*Crassostrea ariakensis* (Wakiya *in* Fujita)).

1990 *Dendostrea paulucciae* (Crosse); Itoigawa, p. 89 (name only).

1993 *Ostrea rivularis* Gould; Inaba, p. 32 (name only).

non 1993 *Crassostrea rivularis* Gould; Barnard *et al.*, p. 46 (=*Crassostrea ariakensis* (Wakiya *in* Fujita)) (name only).

1993 *Crassostrea paulucciae* (Crosse); Barnard *et al.*, p. 46 (name only).

Comments: Torigoe (1981) showed that the hitherto known, *O. rivularis* Gould, 1861, which was described and figured from Kyushu by Lischke (1869), is identical with *O. ariakensis* Wakiya *in* Fujita, 1929. *O. rivularis* is the senior synonym of *O. paulucciae*

Crosse, 1869 and *O. palmipes* G. B. Sowerby II, 1871 (Harry, 1985, Inaba, 1983). Although many workers used the name, *O. paulucciae,* their action to substitute a name for *O. rivularis* is not correct. *O. rivularis* has eight year's priority over *O. paulucciae*. According to Inaba (1993), the correct name for the species that for so long has been named *Ostrea paulucciae* Crosse, 1869, now is *Ostrea revularis* Gould, 1861.

This species is not assigned to *Dendostrea* Swainson, 1835 because in *O. rivularis,* valves without lophine chomata, is not plicate and have a wide marginal commissural shelf in the left valve.

Harry (1985) proposed a new genus, *Planostrea*, for *O. pestigris* which contains *O. rivularis* as the junior synonym. However, his described and illustrated species is *O. rivularis.*

Occurrence:

Nakazato, Kaminagatani-cho, Minami-ku, Yokohama City, Kanagawa Prefecture; Shimosueyoshi Formation (Late Pleistocene, about 0.13 Ma) (Fujiyama, 1982).

Nanao City, Ishikawa Prefecture; Okuhara, Akaura and Aobadai Formations (Late Pleistocene, about 0.12 Ma) (Matsuura, 1977, 1980, 1985).

Tenminishi, Matsubara City, Osaka Prefecture; Uemachi Formation (Late Pleistocene, >37,600 y. B. P.) (Kajiyama and Kaneko, 1981, Ishii, 1987).

Sakai, Minabe-cho, Wakayama Prefecture; ? Late Pleistocene (Nakamura and Kuroda, 1924).

Nakate-cho, Kariya City, Aichi Prefecture; (Sugiura, 1978).

Hekikai Formation (Late Pleistocene, $32{,}170^{+2910}_{-2130}$ y. B. P.)

Okuda, Mihama-cho, Chita-gun, Aichi Prefecture; Noma Formation (Late Pleistocene, 28,060±2, 350 y. B. P. by Kimura and Hosoyama, 1986) (Itoigawa and Kimura, 1985).

Minari-cho, Kamakura City, Kanagawa Prefecture; Holocene (4,390±85 y. B. P.) (Matsushima, 1974).

Numama, Zushi City, Kanagawa Prefecture; Holocene (5,620±120 y. B. P.) (Matsushima, 1974).

Shimomiyata and Babadani, Miura City, Kanagawa Prefecture; Holocene (5,870±180 y. B. P.) (Matsushima, 1976).

Beppu-gawa, Kagoshima Bay, Kagoshima Prefecture; Holocene (7,000 y. B. P.) (Matsushima, 1985).

Shimizu City, Shizuoka Prefecture; Holocene (4,500 y. B. P.) (Matsushima, 1985).

Miura Peninsula, Kanagawa Prefecture; Holocene (6,500-4,000 y. B. P.) (Matsushima, 1985).

Geologic range: Middle Pleistocene-Recent.

Distribution of living species: Japan (Tanabe Bay, Ariake Sea); Indonesia, Thailand, Philippines, South China Sea, Hainan, Taiwan.

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ネコノアシガキとカモノアシガキの分類上の位置

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要　　旨

ネコノアシガキ *Ostrea pestigris* Hanley, 1846 の分類上の位置を再検討する．本種は，殻内面に chomata が発達せず *Crassostrea* 属に所属することは明らかであるが，特徴のあるネコの足状の小型の殻をもつ．Harry (1985) は *O. pestigris* を模式種とする *Planostrea* 属を創設し，カモノアシガキ *Ostrea rivularis* Gould, 1861 をその新参シノニムとした．しかし，*O. rivularis* は chomata が発達し，四角形の中型の殻をもつことで明らかに *C. pestigris* から区別される．Harry は *O. rivularis* Gould を誤って *C. pestigris* (Hanley) と同定し新属を創設したらしい．

カモノアシガキの種名には *O. paulucciae* Crosse, 1869 が用いられてきたが，これは，その古参シノニムである *rivularis* Gould, 1861 を使用すべきであろう (稲葉, 1983)．スミノエガキの種名に，しばしば，*O. rivularis* Gould が用いられてきたが，この種の有効名は，Torigoe (1981) が指摘したように *Crassostrea ariakensis* (Wakiya *in* Fujita, 1929) となる．

この機会に，日本の第四系産 *Crassostrea pestigris*・*Ostrea rivularis* の産出記録をまとめるとともに，*C. pestigris* の新産地を報告する．

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Plate

Plate 16

Figs. 1a–24. *Crassostrea pestigris* (Hanley, 1846), × 1.2.

Figs. 1a, b–3a, b, 11a, b. Meibi Formation (Middle Pleistocene), Hyogo Prefecture, 1a, 3a, inner; 1b, 3b, outer view of left valve. 2a, 11a, outer; 2b, 11b, inner view of right valve.

Figs. 4a, b, 15a, b, 9. ?Middle Pleistocene, off Hakatajima, Ehime Prefecture, Seto Inland Sea, 4a, 15a, outer; 4b, 15b, inner view of right valve. 9, outer view of left valve.

Figs. 5, 8a, b. Off Hakatajima, Ehime Prefecture, Seto Inland Sea. 5, outer view of left valve. 8a, outer; 8b, inner view of right valve.

Figs. 6a, b, 10a, b, 17a, b, 20a, b–22a, b.. Atumi Group (Middle Pleistocene), Aichi Prefecture, 6a, 10a, 17a, inner; 6b, 10b, 17b, outer view of left valve. 20a, 21a, 22a, outer; 20b, 21b, 22b, innter view of right valve.

Figs. 7a, b, 14a, b 15a, b. Off Onomichi City, Seto Inland Sea. 7a, 14a, outer; 7b, 14b, inner view of right valve. 15a, inner; 15b, outer view of left valve.

Figs. 12a, b, 13, 18a, b, 19a, b, 23. Off Suji, Kumamoto Prefecture, Ariake Sea, 12a, 13, 18a, 19a, outer; 12b, 18b, 19b, 23, inner view of right valve.

Fig. 23. Shimosa Group (Middle Pleistocene), Chiba Prefecture, outer view of right valve.

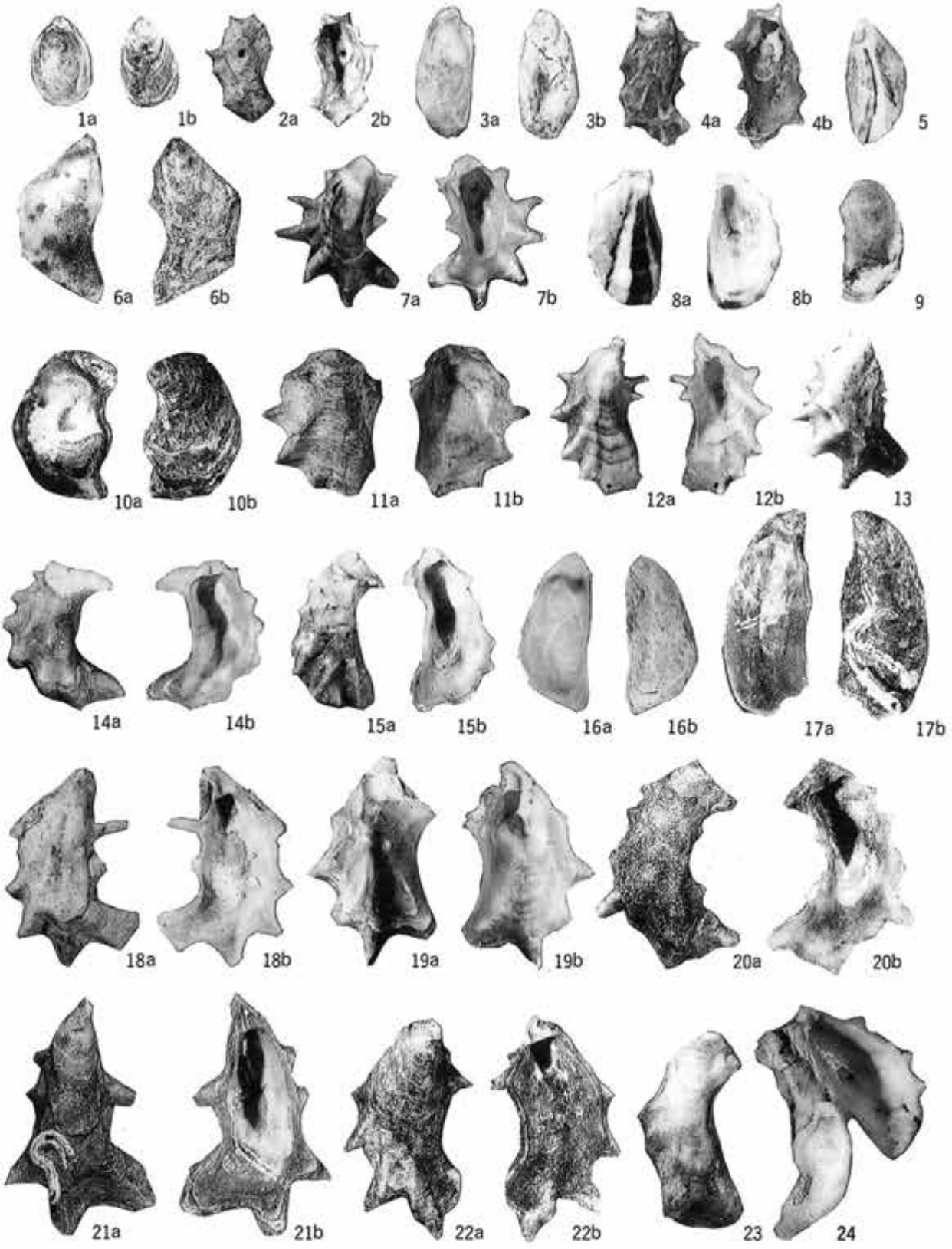
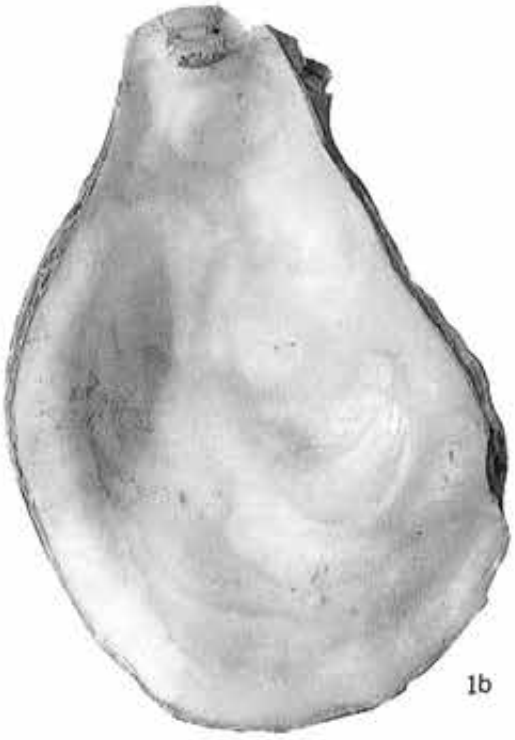

1a
1b
2a
2b
3a
3b
4a
4b
5
6a
6b
7a
7b
8a
8b
9
10a
10b
11a
11b
12a
12b
13
14a
14b
15a
15b
16a
16b
17a
17b
18a
18b
19a
19b
20a
20b
21a
21b
22a
22b
23
24

Plate 17

Figs. 1a–d. *Crassostrea ariakensis* (Wkiya *in* Fujita, 1929), Ariake Sea, collected by Mr. S. Noda, × 0.6. a, outer; b, inner view of left valve. c, outer; d, inner view of right valve.



1a



1b



1c



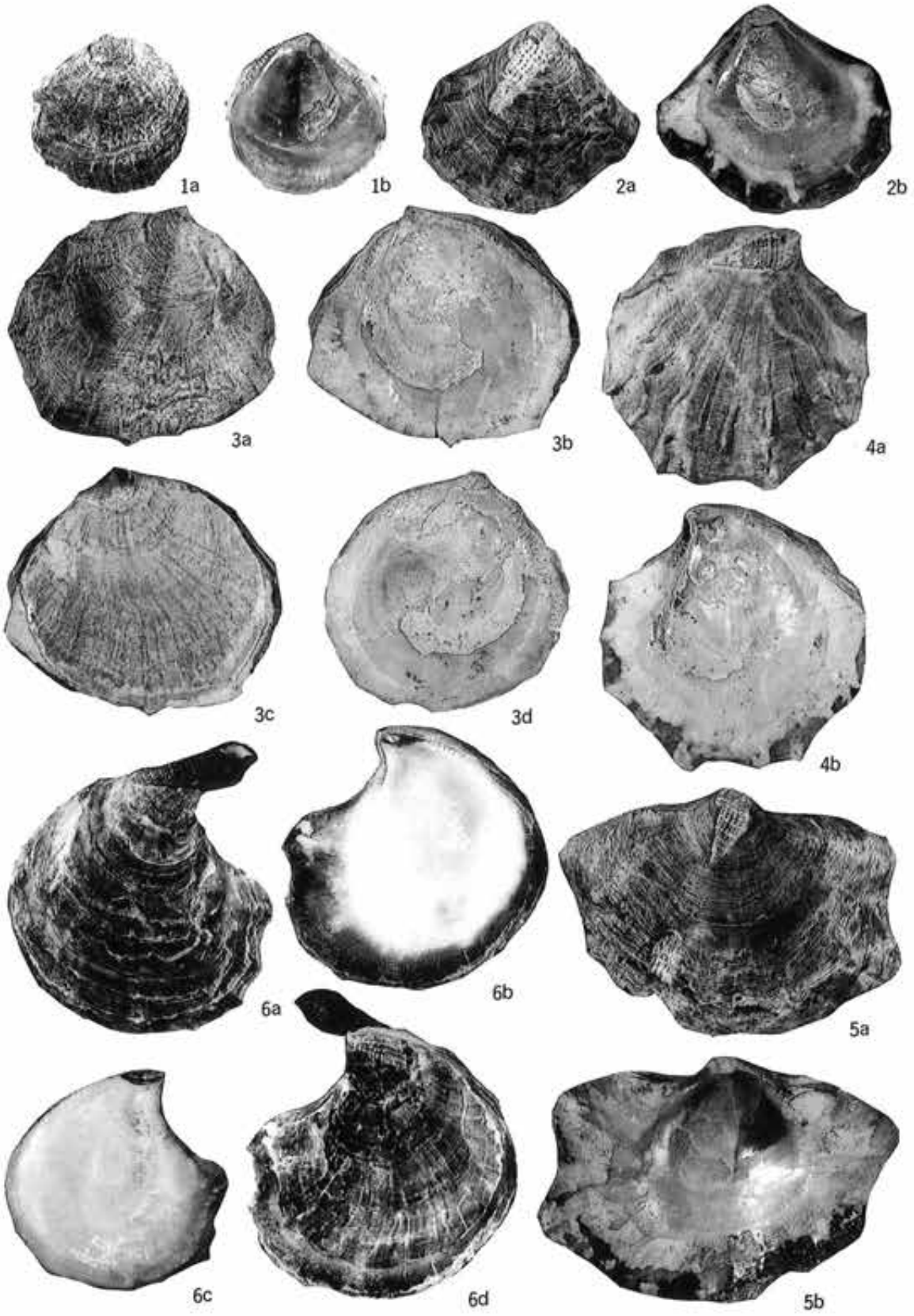
1d

Plate 18

Figs. 1a–6b. *Ostrea revularis* Gould, 1861, × 0.95.

Figs. 1a, b–5a, b. Hekikai Formation (Upper Pleistocene), Aichi Prefecture. 1a, 3c, outer; 1b, 3d, inner view of left valve. 2a, 3a, 4a, 5a, outer; 2b, 3b, 4b, 5b, inner view of right valve.

Figs. 6a–d. Bohol Island, Borneo. a, outer; b, inner view of right valve. c, inner; d, outer view of left valve.


1a
1b
2a
2b
3a
3b
4a
3c
3d
4b
6a
6b
5a
6c
6d
5b