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Recent and fossil *Papyridea* (Bivalvia: Cardiidae) of the World

Alexander I. Kafanov

Institute of Marine Biology, Far East Branch of the Russian Academy of Sciences,
Vladivostok 690041, Russia

Abstract

An illustrated check-list of all valid taxa of the genus *Papyridea* Swainson, 1840, made up of subgenera *Papyridea* s. str. and *Profulvia* Kafanov, 1976, is presented. There are 5 species of *Papyridea* s. str., known for the Recent fauna. For the species, commonly known as *P. soleniforme* (Bruguière, 1789), the prior name *P. lata* (Born, 1780) is used. Major Cenozoic fossils (20 species and subspecies) are representatives of the North Pacific subgenus *Profulvia*. *Papyridea* (*Profulvia*) *tatarica* Kafanov, sp. nov. (ex Lautenschläger, MS) is described from the lower Middle Miocene Verkhneduyskaya Suite, Sakhalin Island. Bibliographic references, primary synonyms, type-locality, depository of the type material, taxonomic and/or nomenclatorial comments, geographic and geologic distribution for each species and subspecies are presented. As a rule, some photo-pictures of the type specimens are enclosed.

Key words: *Papyridea*, Bivalvia, Cardiidae, Recent, fossil.

Introduction

The Recent representatives of the Cenozoic genus *Papyridea* inhabit mostly the tropical waters (intertidal up to depth 250 m) of the western Atlantic and eastern Pacific. Meanwhile in Paleogene and Neogene of the Russian Far East and Japan, they were usual components of the marine biota. If we reconstruct the history of this easily distinguishable genus, it would be a clue to how the Recent epicontinental tropical faunas had appeared. This paper revises all the known *Papyridea* species. This revision is a result of the author's long-term research into the Recent and Cenozoic marine bivalves, deposited in the main zoological and paleontological depositories of Russia (see below). Precious data for the comparison have been studied when the collections, deposited in Californian institutions, USA, are reviewed, and after the type-specimens' photo pictures and latex casts, which my collegues from different countries had kindly sent to me, have been studied.

Collections consulted

All-Russia (former-All-Union) Petroleum Scientific-Research Geological-Exploration Institute (VNIGRI), St. Petersburg (former-Leningrad), Russia.

All-Union Petroleum Scientific-Research Geological-Exploration Institute, Sakhalin Branch, Okha Town, Russia.

California Academy of Sciences (CAS), San Francis-

co, USA.

Central Scientific-Research Geological-Exploration Museum named after Academician F.N. Chernychev (CNIGRM), St. Petersburg (former-Leningrad), Russia.

Department of Geology, University of California, Davis, USA.

Geological Institute (GIN), Russian (former-USSR) Academy of Sciences, Moscow, Russia.

Informgeocentre of 〈Vostokgeologiya〉 Research and Production Association (former-Central Laboratory of the Stratigraphical Party of the Sakhalin Territorial Geological Administration), Yuzhno-Sakhalinsk, Russia.

Institute of Marine Geology and Geophysics (former-Sakhalin Interdisciplinary Scientific-Research Institute), Far East Branch, Russian (former-USSR) Academy of Sciences, Yuzhno-Sakhalinsk, Russia.

The Institute Museum, Institute of Marine Biology, Far East Branch of the Russian Academy of Sciences, Vladivostok, Russia.

Los Angeles County Museum of Natural History (LACMNH), Los Angeles, USA.

Moscow Geological-Exploration Institute, Moscow, Russia.

Museum of Paleontology, University of California (UCMP), Berkeley, USA.

Paleontological Institute (PIN), Russian (former-USSR) Academy of Sciences, Moscow, Russia.

Santa Barbara Museum of Natural History (SBMNH), Santa Barbara, USA.

United States Geological Survey (USGS), Menlo Park, USA.

Zoological Institute (ZIN), Russian (former-USSR) Academy of Sciences, St. Petersburg (former-Leningrad), Russia.

Zoological Museum of the Far East State University, Vladivostok, Russia.

Abbreviation for other institutions:

ANSP - The Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania, USA.

BMNH - The Natural History Museum (former-British Museum (Natural History)), London, England.

UMUT - Department of Historical Geology and Palaeontology, The University Museum, The University of Tokyo, Tokyo.

MNHN - Muséum National d'Histoire Naturelle, Paris, France.

NMW - Naturhistorisches Museum Wien, Vienna, Austria.

USNM - U.S. National Museum, Smithsonian Institution, Washington, D.C., USA.

Systematics

Family Cardiidae Lamarck, 1809

Subfamily Cardiinae Lamarck, 1809

Tribus Profulviini Kafanov *in* Kafanov *et* Popov, 1977

Genus *Papyridea* Swainson, 1840

Papyridea Swainson, 1840, p. 374.

Type species: By subsequent designation of Gray, 1847; *Cardium soleniforme* Bruguière, 1789 (=*Cardium latum* Born, 1780). See Vokes (1977, p. 164) about problems with the type-designation.

Diagnosis (after: Clench and Smith, 1944, p. 16): Shell transversely oval, inequilateral, the anterior and posterior sides almost always gaping. Radially and obliquely ribbed, the ribs more or less spiny. Posterior portion of shell longer than anterior, with the ribs of the posterior slope extending beyond the margins of the valves, so that the ribs of the opposing valves form a series of interlocking teeth.

Comments: The genus *Papyridea* is commonly assigned to subfamily *Trachycardiinae* Stewart, 1930 (see Keen, 1969). Schneider (1992) proposed a preliminary phylogenetic hypothesis for the Cardiidae based on a cladistic analysis using 54 characters of 36 taxa and believed Trachycardiinae and Cardiinae were synonyms. I fully agree with such a concept. But the North Pacific Cenozoic species somehow differ from the typical *Papyridea* and might be pooled to form a separate subgenus *Profulvia*, which has beforehand (Kafanov and Popov, 1977, p. 62) formed a separate tribus Profulviini among Clinocardiinae Kafanov, 1975. Both *Papyridea* and *Profulvia* markedly differ from the other genera within Cardiinae in the shell

shape and gaping, and deserve to be pooled into separate tribus. According to International Code of Zoological Nomenclature (art. 40, *etc*), the tribus should be named Profulviini Kafanov *in* Kafanov and Popov, 1977.

Subgenus *Profulvia* Kafanov, 1976

Profulvia Kafanov, 1976, p. 111.

Type species: By original designation; *Papyridea harrimani* Dall, 1904.

Diagnosis: Shell elongate-ovate, truncated, variable inequilateral, moderately convex, with gape at posterior or both ends. Beaks relatively low, obtuse, nearly orthogyrate, opisthogyrate or weakly prosogyrate. Ribs about 30-65 in number; ribs straight, narrow and low on the anterior valve surfaces, more curved posteriorly. Ribs frequently reduced on the posterior slope. Ridges of ribs with numerous commarginal lines and wrinkles; weak nodes occur where growth lines cross costal crests. Paired cardinal teeth small and straight in both valves; lateral teeth usually single.

Comments: Formerly *Profulvia* was wrongly viewed as a separate genus into subfamily *Clinocardiinae* Kafanov, 1975 (Kafanov, 1976, 1980; Kafanov and Popov, 1977; Schneider, 1982). But for the ribs spinose sculpture significantly reduced, *Profulvia* hardly differs from the typical *Papyridea* and might be considered to be a subgenus among them. Both *Profulvia* and *Papyridea* are easily distiguished from other genera of Clinocardiinae by the shape of ribs: the ribs of both genera are curved and convex anteriorly (like it occurs in major *Trachycardium* Mörch, 1853), while other genera Clinocardiinae have posteriorly convex ribs.

Recent Species

Papyridea (*Papyridea*) *aspersa*
(Sowerby *in* Broderip *et* Sowerby, 1833)
(Pl. 1, Figs. 1a-c)

Cardium aspersum Sowerby *in* Broderip and Sowerby, 1833, p. 85.

Synonyms: *part. Cardium spinosum auctt. non* J. Sowerby, 1804, p. 65, pl. 32 *nec.* Dillwyn, 1817, p. 115; *part. Cardium variegatum auctt. non* Sowerby, 1834, fig. 57; 1841, p. 4, 8 *nec.* [Lightfoot], 1786, p. 106; *Papyridea bullata californica* Verrill, 1870, p. 225.

Distribution: Pariñas Cape, northern Peru, north to Northern Baja California, Mexico; Gulf of California.

Papyridea (*Papyridea*) *crockeri*
(Strong *et* Hertlein, 1937)
(Pl. 1, Figs. 2a-c; Pl. 2, Fig. 4)

Cardium (*Papyridea*) *crockeri* Strong and Hertlein, 1937, p. 161, pl. 34, figs. 1, 2, 7, 10.

Distribution: Mazatlan north to Cedros Island, Baja California, Mexico; Gulf of California.

Papyridea (*Papyridea*) *lata* (Born, 1780)
(Pl. 1, Figs. 3a, b; Pl. 2, Figs. 1a-d, 2a-e;
Pl. 3, Figs. 1a-c)

Cardium latum Born, 1780, p. 48, pl. 3, fig. 9 (not 8 as indicated).

Synonyms: *Cardium hians* Meuschen, 1787, invalid., p. 442 (refers to: Gualtieri, 1742, pl. 85, fig. H); *Cardium spinosum* Meuschen, 1787, invalid., p. 442 (refers to: Lister, 1685, pl. 342, fig. 179) *non* [Lightfoot], 1789, p. 105; *Solen bullatus auctt. non* Linnaeus, 1758, p. 673, no. 31 (see: Hanley, 1855; Dodge, 1952); *Cardium soleniforme* Bruguière, 1789, p. 235; *Cardium hiulcum* Reeve, 1845, pl. 21, fig. 123.

Taxonomical notes: In literarature this species was named different ways (see synonyms), though Dall (1900a) was one of the first to suggest it to be similar to *Cardium latum* Born, 1780. Dr. Jaques Vidal has kindly sent me the photoimages of the syntypes (NMW reg. no. 891a) of *Cardium latum* Born. These pictures evidence, that this species called most often *Cardium soleniforme* Bruguière, 1789 by no means ought to be named *Cardium latum* Born, 1780. Dall (1900a, p. 387) considers *Cardium hiulcum* is a monstrosity of *Cardium* (*Papyridea*) *spinosum* Meuschen, 1787, and I fully agree with that conclusion. Fischer-Piette (1977, p. 74) thought *Papyridea* (s.s.) *hiulca* to be a separate species, Fischer-Piette (1977, p. 74)

though *Papyridea* (s.s.) *hiula* to be a separate species, but at the same time he presented the pictures (Fischer-Piette, 1977, pl. 9, figs. 1, 2) of the shell, that have nothing to do with the *Cardium hiulcum* Reeve syntypes (see pl. 2, figs. 2a-e; pl. 3, figs. 1a-c of this paper).

Distribution: Hatteras Cape, North Carolina, south to southern Brasil, Bahamas, Cuba, Virgin and Caribbean Islands; Cape Verde Islands, Angola, Western Africa (Voskuil and Onverwagt, 1989); Ascension Island, South Atlantic Ocean (Rosewater, 1975).

Papyridea (*Papyridea*) *mantaense* Olsson, 1961
(Pl. 1, Figs. 4a, b; Pl. 2, Fig. 3)

Papyridea mantaensis Olsson, 1961, p. 250, pl. 37, figs. 5, 5a; pl. 38, fig. 7.

Distribution: northern Peru north to southern Mexico, Pacific Ocean.

Papyridea (*Papyridea*) *semisulcata* (Gray, 1825)

Cardium semisulcatum Gray, 1825, p. 138.

Synonyms: *Cardium ringiculum* Sowerby, 1834, pl. 48, fig. 11; 1841, pp. 2, 8; *Cardium petitianum* Orbigny *in* Sabra, 1846, p. 309, pl. 27, figs. 50-52.

Distribution: Southern Florida, Bermuda and south through the West Indies to Trinidad.

Cardium transversale Deshayes (1854, p. 333) (pl. 3, figs. 2a-d), that somehow earlier I (Kafanov, 1976, p. 110) mis-assigned to the genus *Papyridea*, appears to be a representative of *Parvicardium* Monterosato, 1884; Fischer-Piette (1977, p. 87) thought it to be a synonym of *P. exiguum* (Gmelin, 1791). Fischer-Piette (1977, p. 74) places *Cardium levisulcatum* Smith (1903, p. 624, pl. 36, figs. 25, 26) into *Papyridea* as well. Dr. J. Vidal (in his letter dated from 2 December, 1996), who dealt into syntypes (3 right and 2 left valves) of the latter species in BMNH, drew out, that *C. levisulcatum* appears to be a true representative of Fraginae Stewart, 1930 related to *Fragum sueziense* (Issel, 1869). I fully agree with this conclusion.

Cenozoic Species

Papyridea (*Papyridea*) *bulbosa* (Dall, 1900)
(Pl. 6, Figs. 1a, b)

Cardium (*Papyridea*) *bulbosum* Dall, 1900b, p. 1109: 1 mile below Baileys Ferry, Chipola River, Calhoun County, Florida, USA (fide Gardner, 1926, p. 142); Chipola Formation, uppermost Lower Miocene [equivalent to the European Burdigalien]. Holotype (figured specimen: Dall, 1903, pl. 48, fig. 20) - USNM no. 114762.

Taxonomical comments see: Vokes, 1977, p. 165, pl. 4, fig. 4; pl. 9, fig. 4.

Papyridea (*Papyridea*) *capsoides* (Bayan, 1873)
(Pl. 6, Figs. 2a-i)

Cardium capsoides Bayan, 1873, p. 125, as new name for *Cardium venustum* Deshayes, 1858 *non* Wood, 1853, p. 160, pl. 13, figs. 2, a, b [*nec*. Dunker, 1861, p. 37].

Cardium venustum Deshayes, 1858, p. 575, pl. 55, figs. 22-24: Auvers, Valmondois, Le Fayel, Bassin de Paris, France; ‹sables moyens› [Lutetian], Middle Eocene. Syntypes - Université de Lyon I, reg. nos.?

Papyridea (*Papyridea*) *miocica* Vokes, 1977
(Pl. 1, Fig. 5)

Papyridea miocica Vokes, 1977, p. 168, pl. 5, figs. 1-4; pl. 9, fig. 3: Farley Creek, north bank at abandoned mill ca. 0.25 mile west of bridge of Florida Highway 275, Calhoun County, Florida, USA; Chipola Formation, uppermost Lower Miocene [equivalent to the European Burdigalien]. Holotype - USNM no. 243530.

Papyridea (*Papyridea*) *multicostula* Vokes, 1977
(Pl. 1, Fig. 6)

Papyridea multicostula Vokes, 1977, p. 169, pl. 4, figs. 1-3; pl. 9, fig. 5: Chipola River, west bank at bend about 1800 feet downstream from mouth of

Farley Creek, Calhoun County, Florida, USA; Chipola Formation, uppermost Lower Miocene [equivalent to the European Burdigalien]. Holotype - USNM no. 243525.

Papyridea (*Papyridea*) *ponteleviense* (Mayer, 1868)

Cardium ponteleviense Mayer, 1868, p. 189, pl. 7, fig. 5: Pont-Levoy, Bassin de la Loire, France; ‹Helvétien inférieur› [Langhian], lower Middle Miocene. Syntypes-possibly in Muséum d'Histoire Naturelle de Zürich.

Taxonomical notes and illustrations see: Dolfuss and Dautzenberg, 1913, p. 330, pl. 27, figs. 1-6.

Papyridea (*Profulvia*) *adacnoides*
(Kafanov *et* Savizky, 1982)
(Pl. 6, Figs. 3a, b)

Profulvia adacnoides Kafanov and Savizky, 1982, p. 39, fig. 1, a, b: right tributary of Verkhovka River, 2 km upstream the mouth, Kril'on Peninsula, Nevel'sk District, Sakhalin; uppermost part of Lower Arakayskaya sub-Suite, Oligocene. Holotype - PIN no. 1/3962.

Papyridea (*Profulvia*) *angulata* Slodkewitsch, 1938 *ex* Kogan, MS
(Pl. 4, Figs. 1a-e)

Papyridea angulata Slodkewitsch, 1938, p. 404, pl. 81, figs. 8, 8a: between the mouths of Noyami and Malyi Sertunay Rivers, Aleksandrovsk-Sakhalinskiy District, Sakhalin; ‹Rykhlaya› [Sertunayskaya] Suite, Middle Miocene. Holotype - CNIGRM no. 180/5294.

Papyridea (*Profulvia*) *harrimani harrimani* Dall, 1904
(Pl. 5, Fig. 3; Pl. 6, Figs. 4a, b)

Papyridea harrimani Dall, 1904, p. 114, pl. 10, fig. 5: northern shore of Popov Island, Alaska; [early Middle Miocene Bear Lake Formation, fide Schuchert *et al.*, 1905; Eocene and Oligocene Stepovak Formation, see: Marincovich and McCoy, 1984; Marincovich, 1988, 1990]. Holotype - USNM no. 164867. In the Machigarskaya Suite, the northeastern part of the Sakhalin Island, the intermediate specimens (pl. 5, fig. 3) between *P. matschigarica* and typical *P. harrimani* were found. These records reveal the need in the extra researches into the taxonomic relation between *P. harrimani, P. matschigarica, P. kipenensis* and related forms. So, first two may be the same species.

Papyridea (*Profulvia*) *harrimani nipponica*
Yokoyama, 1924
(Pl. 1, Fig. 7)

Papyridea (*Fulvia*) *nipponica* Yokoyama, 1924, p. 17, pl. 3, figs. 3, 4: Tatsuta coal-field, Futaba District, Fukushima Prefecture, Honshu; Asagai Formation, Oligocene. Lectotype (designated as holotype by Hatai and Nisiyama, 1952, p. 105) - UMUT, missing.

Papyridea (*Profulvia*) *kipenense* Slodkewitsch, 1938
(Pl. 5, Figs. 1a, b; Pl. 7, Fig. 2)

Papyridea kipenensis Slodkewitsch, 1938, p. 409, pl. 82, figs. 1, 2; pl. 83, figs. 1-3: left bank of Snatol River, 18 km from the mouth, Western Kamchatka; upper horizon of Kavranskaya Series [Etolonskaya Suite], upper Middle Miocene. Holotype - CNIGRM no. 902/5060.

Distribution: Kavranskaya Series of Western Kamchatka (Ilyinskaya, Kakertskaya and Etolonskaya Suites).

Papyridea (*Profulvia*) *korfiense* Barinov *in* Gladenkov *et al.*, 1987
(Pl. 4, Figs. 2a, b)

Papyridea korfiensis Barinov *in* Gladenkov *et al.*, 1987, p. 41, pl. 13, figs. 7, 8: Ugol'naya River, coast of Korfa Gulf, Eastern Kamchatka; Pakhachinskaya Suite, lentil 3, Lower Miocene. Holotype - PIN no. 6/1-1.

Papyridea (*Profulvia*) *kurodai* Sawada, 1962

(Pl. 5, Figs. 2a, b)

Papyridea (*Fulvia*) *kurodai* Sawada, 1962, p. 82, pl. 1, figs. 15, 16: Sawane, Sawada-machi, Sado-gun, Niigata Prefecture, Honshu; Sawane Formation, Pliocene.

The name *Papyridea kurodai* was firstly proposed by Hatai and Nisiyama (1952, pp. 39, 105) both for *Papyridea* (*Fulvia*) *nipponica* (Yokoyama, 1926, p. 294, pl. 34, fig. 16) and for *Cardium* (*Papyridea*) *nipponicum* (Kuroda *in* Homma, 1931, p. 54, pl. 6, fig. 35) not of Yokoyama (1924). Following Masuda and Noda (1976, p. 11), as first revisers, I accept Sawada (1962) as the author of this species.

Distribution: Pliocene Suginoya Siltstone and Shigarami Formation in Honshu; Lower Pleistocene Nakanokawa, Shimonopporo, Zaimokuzawa and Umaoi Formations in Hokkaido, Sawane, Haizume and Kota Formations in Honshu (Akamatsu and Suzuki, 1992; Amano and Tahara, 1992).

Papyridea (*Profulvia*) *matschigarica matschigarica* Khomenko, 1938
(Pl. 7, Figs. 1a, b; Pl. 8, Figs. 1a, b)

Papyridea matschigarica Khomenko, 1938, p. 47, pl. 7, figs. 5–7; pl. 8, fig. 6; pl. 9, fig. 7: between Marii Cape and Monchigar Bay, Schmidt Peninsula, Okha District, Sakhalin; lower part of Machigarskaya Suite, Oligocene. Lectotype (designated by Slodkewitsch, 1938, p. 407) – CNIGRM no. 81/5044.

Distribution: Oligocene – Machigarskaya, Arakayskaya, Akhsnayskaya and Gastellovskaya Suites of Sakhalin; Mallenskaya Suite of Koryak Upland; Amaninskaya Suite of Western Kamchatka.

Papyridea (*Profulvia*) *matschigarica uspenica* Barinov *in* Gladenkov *et al.*, 1987
(Pl. 4, Figs. 3a–d)

Papyridea matschigarica uspenica Barinov *in* Gladenkov *et al.*, 1987, p. 39, pl. 13, figs. 9a, b, 22: Ugol'naya River, coast of Korfa Gulf, Eastern Kamchatka; Aluginskaya Suite, lentil 1, Oligocene. Holotype – PIN no. 1/1-1.

Distribution: Oligocene and Lower Miocene Aluginskaya and Pakhachinskaya Suites of Eastern Kamchatka.

Papyridea (*Profulvia*) *minima* (Zhidkova, 1980)
(Pl. 8, Fig. 4)

Profulvia minima Zhidkova, 1980, p. 163, pl. 36, fig. 2: Agnevo River, Aleksandrovsk-Sakhalinskiy District, Sakhalin; Gennoyshinskaya Suite, Oligocene. Holotype – VNIGRI no. 5/817.

Papyridea (*Profulvia*) *noyamiana* Slodkewitsch, 1938 *ex* Kogan, MS
(Pl. 7, Figs. 3a–e)

Papyridea noyamiana Kogan, Slodkewitsch, 1938, p. 413, pl. 86, figs. 2, 3, 3a: between the mouths of Noyami and Malyi Sertunay Rivers, Aleksandrovsk-Sakhalinskiy District, Sakhalin; "Rykhlaya" [Sertunayskaya] Suite. Holotype – CNIGRM no. 181/5294.

Papyridea (*Profulvia*) *sakhalinense* Slodkewitsch, 1938 *ex* Kogan, MS
(Pl. 8, Figs. 2a–d)

Papyridea sakhalinensis Kogan, Slodkewitsch, 1938, p. 412, pl. 86, figs. 1, 1a: between the mouths of Noyami and Malyi Sertunay Rivers, Aleksandrovsk-Sakhalinskiy District, Sakhalin; "Rykhlaya" [Sertunayskaya] Suite. Holotype – CNIGRM no. 182/5294.

Papyridea (*Profulvia*) *securiforme* Slodkewitsch, 1938
(Pl. 5, Fig. 4)

Papyridea securiformis Slodkewitsch, 1938, p. 411, pl. 85, fig. 1: coast of Kovachinskaya Bight, Western Kamchatka; lower horizon of Kovachinskaya Suite, Oligocene. Holotype – CNIGRM no. 899/5060.

Papyridea (*Profulvia*) *tatarica* Kafanov, sp. nov. *ex* Lautenschläger, MS
(Pl. 8, Fig. 3)

Holotype: CNIGRM no. 170/6199.

Type locality: off the Chasha River mouth, Aleksandrovsk-Sakhalinskiy District, Sakhalin; lower part of Verkhneduyskaya Suite, lower Middle Miocene.

Holotype measurement (in mm): length - 46.2; height- 34.0; length of anterior part - 19.2; convexity (one valve) - 8.2.

Description: Shell of small or medium size (length - up to 50 mm), scaphoid-oval, equilateral, flattened, lightly bevelled. Valve's anterior edge narrow and rounded, imperceptibly transforming into the lower edge, almost perfectly arched. Lower edge anteriorly goes upwards rather sharply, while its posterior part gradually connected with posterior edge. Posterior edge broader than anterior one, cut slantwise, connected with long and right posterior branch of hinge margin at marked angle. Posterior-dorsal angle is not distinct. Keel-bend unclear. Umbones are rather low and very broad (average umbonal angle 120), pointed, straight, opisthogyrate. Radial ribs about 30 in number, most markedly curved at central area posteriorly. Ribs straightened at anterior area. Ribs triangular in cross section, with intercostae as wide or wider than ribs. Growth rings not distinct.

Comparison: The species is rather similar to *P. noyamiana*, but differs from the latter in less number of ribs, shell much more flattened, and in mating pattern of valve's posterior edge and anterior branch of the hinge margin.

Papyridea (*Profulvia*) *utcholokense* Slodkewitsch, 1938
(Pl. 5, Fig. 5)

Papyridea utcholokensis Slodkewitsch, 1938, p. 403, pl. 82, figs. 4-6: Utkholok Cape, Western Kamchatka; lower horizon of Voyampol'skaya Series, Oligocene. Holotype - CNIGRM no. 911/5060.

Synonym: *Papyridea kovatschensis* Ilyina, 1962, p. 343, pl. 2, figs. 8, 8a: Utkholok Cape, Western Kamchatka; "Tufogennyi horizon", lower horizon of Voyampol'skaya Series, Oligocene. Holotype - CNIGRM no. 121/6068.

Distribution: Oligocene though Miocene - Zmeykovskaya Suite of Koryak Upland, Aglikichskaya Series of Chukotka Peninsula, Amaninskaya and Ilyinskaya Suites of Western Kamchatka, Pakhachinskaya Suite (lentil 5) of Eastern Kamchatka. *Profulvia prosogyrata* Kafanov *in* Arkhipova *et al.* ([1994], p. 206, pl. 34, fig. 7) belongs to *Keenocardium* Kafanov, 1974.

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Plate 1

Figs. 1a-c. *Papyridea* (*Papyridea*) *aspersa* (Sowerby *in* Broderip *et* Sowerby, 1833). Panama Canal Zone, shell length 44 mm. Exterior (a), interior (b) and dorsal (c) of same shell. Copied after Olsson, 1961, pl. 38, figs. 38, figs. 6, 6b.

Figs. 2a-c. *Papyridea* (*Papyridea*) *crockeri* (Strong *et* Hertlein, 1937). Holotype, CAS, Paleo. Type Coll. no. 6969, off Margarita Island, Lower California; shell length 46.8 mm. Exterior (a), interior (b) and dorsal (c). Copied after Strong and Hertlein, 1937, pl. 34, figs. 1, 2, 7.

Figs. 3a, b. *Papyridea* (*Papyridea*) *lata* (Born, 1780). Two syntypes, locality do not given, NMW no. 891a; shells length 23.1 and 23.6 mm. Exterior view (a) and labels accompanied the syntypes (b).

Figs. 4a, b. *Papyridea* (*Papyridea*) *mantaense* Olsson, 1961. Holotype, ANSP no. 218895 (a) and paratype (b), Manta, Equador; exterior, shell length 40.5 (a) and interior, shell length 35.7 (b) mm. Copied after Olsson, 1961, pl. 37, figs. 5, 5a; pl. 38, fig. 7.

Fig. 5. *Papyridea* (*Papyridea*) *miocica* Vokes, 1977. Holotype, Farley Creek, Calhoun County, Florida, USA; Chipola Formation, uppermost Lower Miocene, USNM no. 234530; shell length 39.2 mm. Right valve exterior. Copied after Vokes, 1977, pl. 5, fig. 2.

Fig. 6. *Papyridea* (*Papyridea*) *multicostula* Vokes, 1977. Holotype, Chipola River, Calhoun County, Florida, USA; Chipola Formation, uppermost Lower Miocene, USNM no. 243525; shell length 31.8 mm. Left valve exterior. Copied after Vokes, 1977, pl. 4, fig. 1.

Fig. 7. *Papyridea* (*Profulvia*) *harrimani nipponica* Yokoyama, 1924. Tatsuta coal-field, Futaba District, Fukushima Prefecture, Honshu; Asagai Formation, Oligocene. Right valve, side view and exterior. Copied after Yokoyama, 1924, pl. 3, figs. 3, 4.



1a



2a



4a



2c



1b



2b



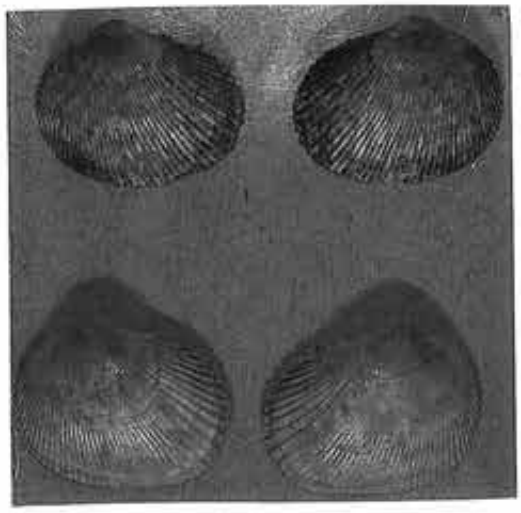
4b



1c



3b



3a





6



7



5

Plate 2

Figs. 1a–d. *Papyridea* (*Papyridea*) *lata* (Born, 1780). Two syntypes, the same shells as on pl. 1, fig. 3a, interior.

Figs. 2a–e. *Papyridea* (*Papyridea*) *lata* (Born, 1780). Syntypes of *Cardium hiulcum* Reeve, 1845, locality do not given, BMNH no. 1978137; a, b – lectotype (herein designated, Reeve's figured specimen), exterior, × 3; c, d – paralectotype, exterior, × 3; e – lectotype, hinge of right valve, × 6.

Fig. 3. *Papyridea* (*Papyridea*) *mantaense* Olsson, 1961. Salango Island, Equador, shell length 59.0 mm, exterior, PIN coll. 3962.

Fig. 4. *Papyridea* (*Papyridea*) *crockeri* (Strong *et* Hertlein, 1937). SE of Punta San Antonio, Guaymas, Sonora, Mexico, shell length 47.2 mm, exterior, PIN coll. 3962 (former LACMNH no. 79-108.5).

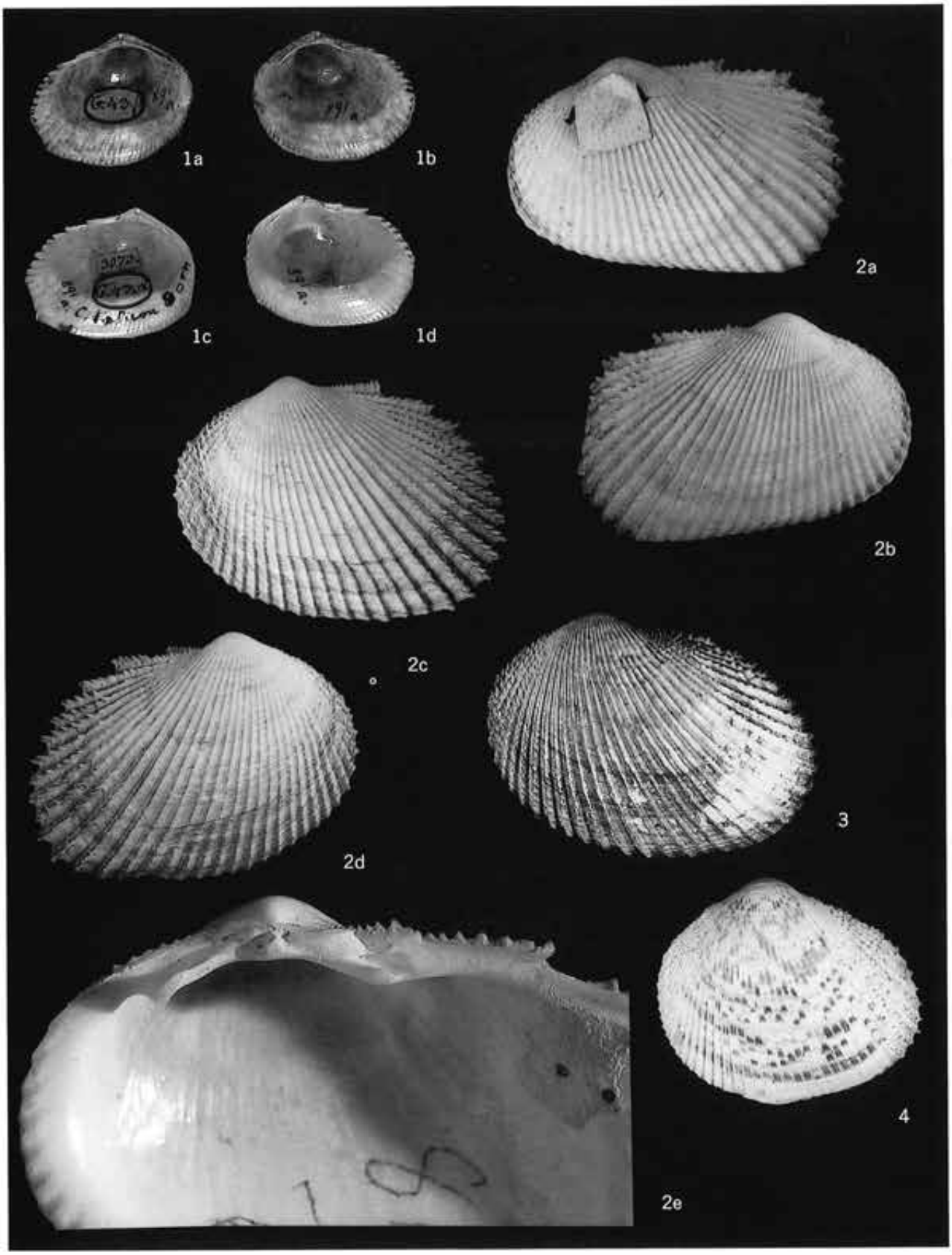

1a
1b
1c
1d
2a
2b
2c
2d
2e
3
4

Plate 3

Figs. 1a–c. *Papyridea* (*Papyridea*) *lata* (Born, 1780). Syntypes of *Cardium hiulcum* Reeve, 1845, locality do not given, BMNH no. 1978137; a – lectotype, hinge of left valve, × 6; b, c – paralectotype, exterior, × 3.

Figs. 2a–d. *Parvicardium* cf. *exiguum* (Gmelin, 1791). Lectotype (herein designated from syntypes lot, 11 valves) of *Cardium transversale* Deshayes, 1854, Alboran Island, off Spain coast, Mediterranean, BMNH no. 1974137, × 18, exterior (a, b) and interior (c, d).

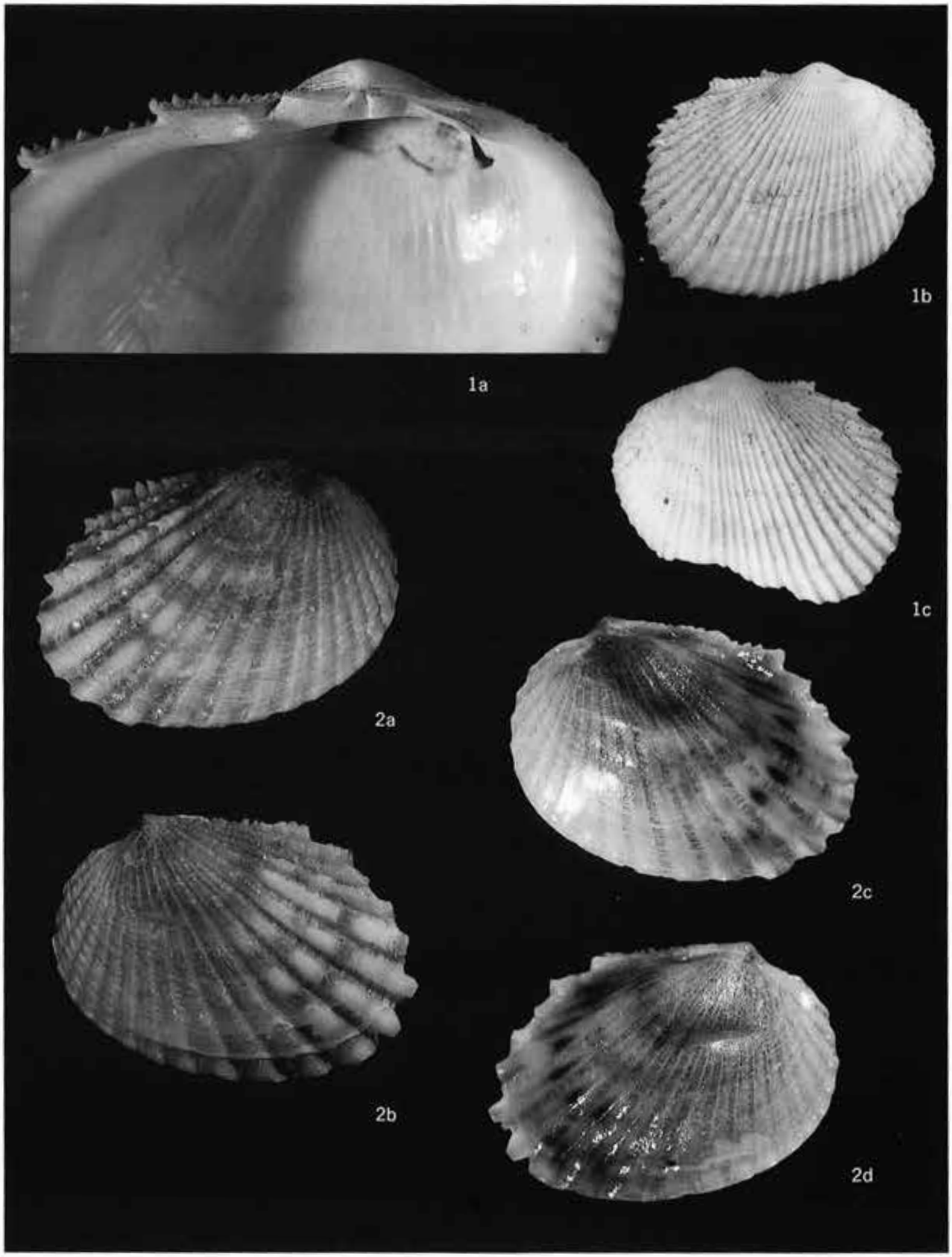

1a
1b
1c
2a
2b
2c
2d

Plate 4

(all figures are given in natural size)

Figs. 1a-e. *Papyridea* (*Profulvia*) *angulata* Slodkewitsch, 1938 *ex* Kogan, MS. Holotype exterior (a,b), dorsal (c), ventral (d) and side view (e), between the mouths of Noyami and Malyi Sertunay Rivers, Aleksandrovsk-Sakhalinskiy District, Sakhalin; 〈Rykhlaya〉 [Sertunayskaya] Suite, Middle Miocene; CNIGRM no. 180/5294.

Figs 2a, b. *Papyridea* (*Profulvia*) *korfiense* Barinov *in* Gladenkov *et al.*, 1987: a - paratype, Ugol'naya River, coast of Korfa Gulf, Eastern Kamchatka; Pakhachinskaya Suite, lentil 3, Lower Miocene; b - holotype, the same locality, PIN no. 6/1-1.

Figs. 3a-d. *Papyridea matschigarica uspenica* Barinov *in* Gladenkov *et al.*, 1987: a, b - holotype exterior (a) and hinge (b), Ugol'naya River, coast of Korfa Gulf, Eastern Kamchatka; Aluginskaya Suite, lentil 1, Oligocene; PIN no. 1/1-1; c, d - paratypes, the same locality.



1a



1b



2a



1c



1d



1e



2b



3c



3b



3a



3d

Plate 5

(all figures are given in natural size)

Figs. 1a, b. *Papyridea* (*Profulvia*) *kipenense* Slodkewitsch, 1938: a - holotype, left bank of Snatol River, 18 km from the mouth, Western Kamchatka; upper horizon of Kavranskaya Series [Etolonskaya Suite], CNIGRM no. 902/5060; b - Western Kamchatka, Ilyinskaya Suite, Middle Miocene, PIN coll. 3962.

Figs. 2a, b. *Papyridea* (*Profulvia*) *kurodai* Sawada, 1962. Sawane, Sawada-machi, Sado-gun, Niigata Prefecture, Honshu; Sawane Formation, Pliocene. After Yokoyama, 1926, pl. 34, fig. 16.

Fig. 3. *Papyridea* (*Profulvia*) cf. *harrimani* Dall, 1904. Nairo River, Eastern Sakhalin, Machigarskiy Horizon, Oligocene; CNIGRM no. 103/6818.

Fig. 4. *Papyridea* (*Profulvia*) *securiforme* Slodkewitsch, 1938. Holotype, coast of Kovachinskaya Bight, Western Kamchatka; lower horizon of Kovachinskaya Suite, Oligocene; CNIGRM no. 899/5060.

Fig. 5. *Papyridea* (*Profulvia*) *utcholokense* Slodkewitsch, 1938. Holotype, Utkholok Cape, Western Kamchatka, lower horizon of Voyampol'skaya Series, Oligocene, CNIGRM no. 911/5060.

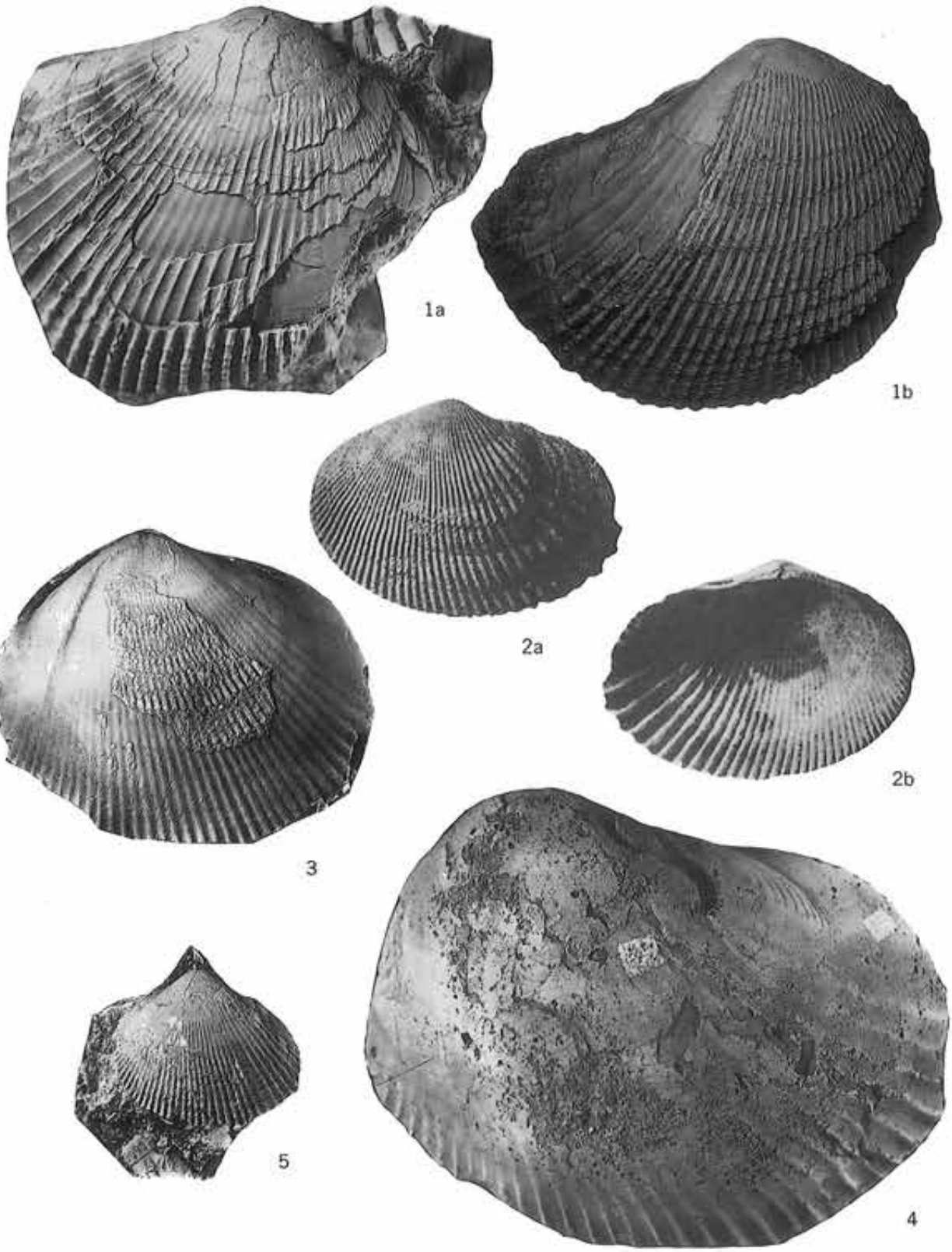

1a
1b
2a
2b
3
4
5

Plate 6

Figs. 1a, b. *Papyridea* (*Papyridea*) *bulbosa* (Dall, 1900). Holotype, 1 mile below Baileys Ferry, Chipola River, Calhoun County, Florida, USA; Chipola Formation, uppermost Lower Miocene, USNM no. 114762; left valve exterior (a) and interior (b), × 3.

Figs. 2a–i. *Papyridea* (*Papyridea*) *capsoides* (Bayan, 1873). Syntypes of *Cardium venustum* Deshayes, Auvers (a), Le Fayel (b, c – lectotype, herein designated, d) and Valmondois (e–i), Bassin de Paris, France; ‹sables moyens› [Lutetian], Middle Eocene, Université de Lyon I, reg. nos.? Exterior (a, b, e, g, h) and interior (c, d, f, i), × 3.

Figs. 3a, b. *Papyridea* (*Profulvia*) *adacnoides* (Kafanov *et* Savizky, 1982). Holotype, right tributary of Verkhovka River, 2 km upstream the mouth, Kril'on Peninsula, Nevel'sk District, Sakhalin; uppermost part of Lower Arakayskaya sub-Suite, Oligocene, PIN no. 1/3962; right valve exterior (a) and interior (b), natural size.

Figs. 4a, b. *Papyridea* (*Profulvia*) *harrimani harrimani* Dall, 1904. Holotype, northern shore of Popov Island, Alaska; [Eocene and Oligocene Stepovak Formation], USNM no. 164867. External casts of left (a) and right (b) valves, natural size.

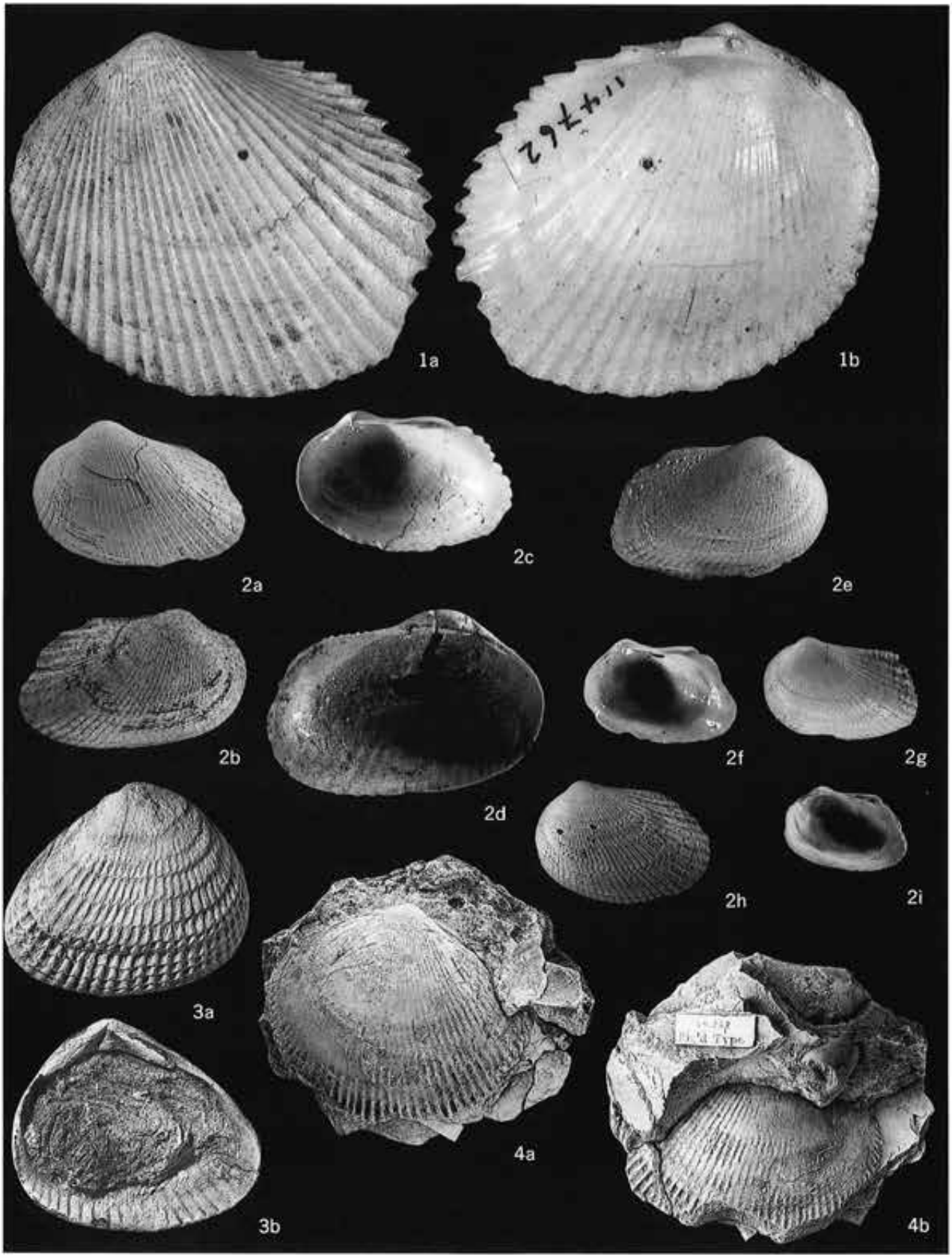

1a
1b
2a
2c
2e
2b
2d
2f
2g
2h
2i
3a
3b
4a
4b

Plate 7

(all figures are given in natural size)

Figs. 1a, b. *Papyridea* (*Profulvia*) *matschigarica matschigarica* Khomenko, 1938: a – lectotype, between Marii Cape and Monchigar Bay, Schmidt Peninsula, Okha District, Sakhalin; lower part of Machigarskaya Suite, Oligocene, CNIGRM no. 81/5044, external; b – paralectotype, the same locality, CNIGRM no. 85/5044.

Fig. 2. *Papyridea* (*Profulvia*) *kipenense* Slodkewitsch, 1938. Paratype, left bank of Snatol River, 18 km from the mouth, Western Kamchatka; upper horizon of Kavranskaya Series [Etolonskaya Suite], upper Middle Miocene, CNIGRM no. 901/5060.

Figs. 3a–e. *Papyridea* (*Profulvia*) *noyamiana* Slodkewitsch, 1938 *ex* Kogan, MS. Holotype, between the mouths of Noyami and Malyi Sertunay Rivers, Aleksandrovsk-Sakhalinskiy District, Sakhalin; "Rykhlaya" [Sertunayskaya] Suite; CNIGRM no. 181/5294; exterior (a, b), dorsal (c), ventral (d) and side view (e).

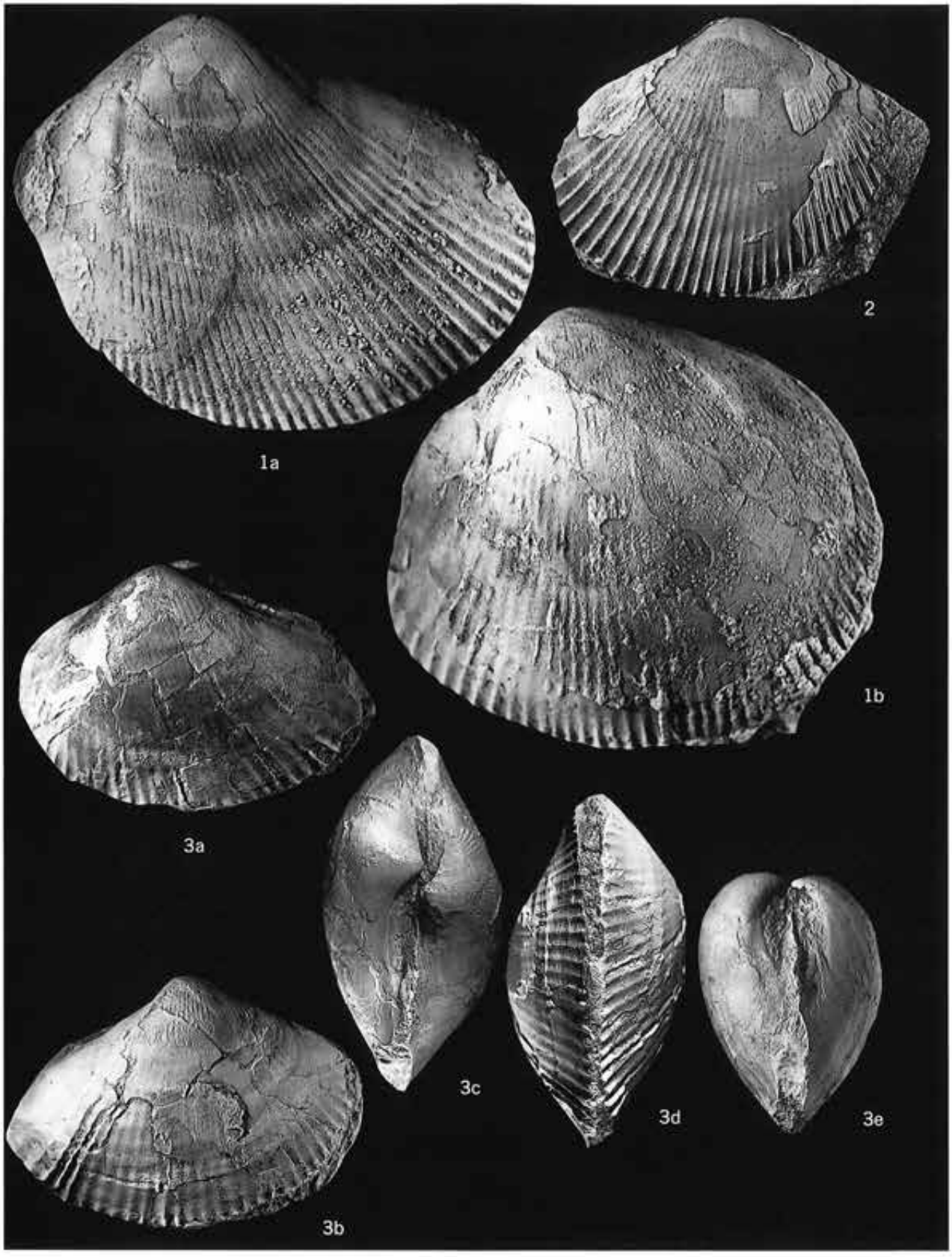

2
1a
1b
3a
3c
3d
3e
3b

Plate 8

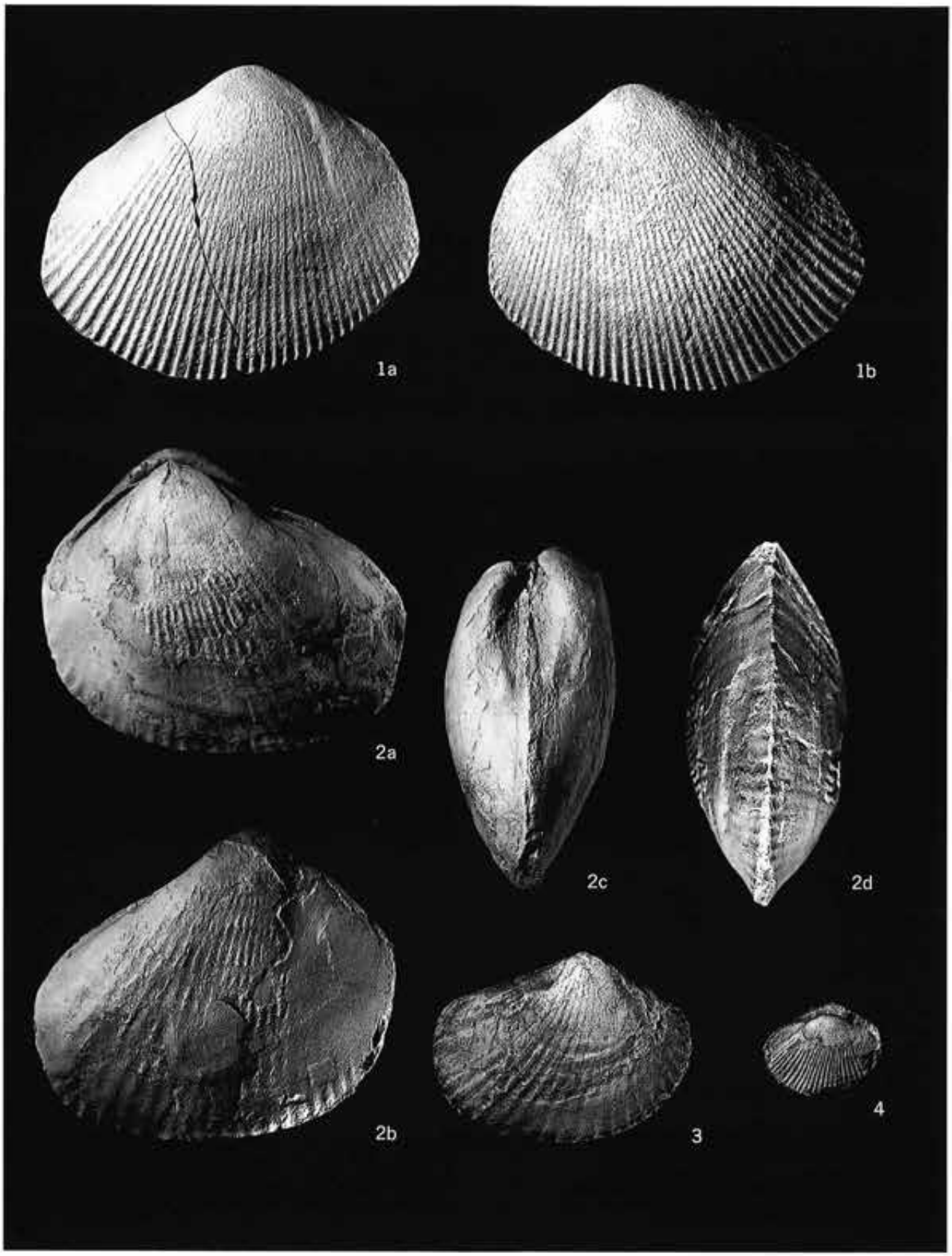
(all figures are given in natural size)

Figs. 1a, b. *Papyridea* (*Profulvia*) *matschigarica matschigarica* Khomenko, 1938. Northern coast of the Schmidt Peninsula, Machigar section, Northern Sakhalin; Machigarskaya Suite; PIN no. 90/3962.

Figs. 2a-d. *Papyridea* (*Profulvia*) *sakhalinense* Slodkewitsch, 1938 ex Kogan, MS. Holotype, between the mouths of Noyami and Malyi Sertunay Rivers, Aleksandrovsk-Sakhalinskiy District, Sakhalin; "Rykhlaya" [Sertunayskaya] Suite. CNIGRM no. 182/5294; exterior (a, b), side view (c) and ventral (d).

Fig. 3. *Papyridea* (*Profulvia*) *tatarica* Kafanov, sp. nov. *ex* Lautenschläger, MS. Holotype, off the Chasha River mouth, Aleksandrovsk-Sakhalinskiy District, Sakhalin; lower part of Verkhneduyskaya Suite, lower Middle Miocene, CNIGRM no. 170/6199; right valve exterior.

Fig. 4. *Profulvia minima* Zhidkova, 1980. Holotype, Agnevo River, Aleksandrovsk-Sakhalinskiy District, Sakhalin; Gennoyshinskaya Suite, Oligocene, VNIGRI no. 5/817; right valve exterior.


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