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Recent and fossil Clinocardiinae (Bivalvia, Cardiidae) of the World. V. Genus *Ciliatocardium* Kafanov, 1974 (part 1)

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Abstract

A taxonomic review of the genus *Ciliatocardium* Kafanov, 1974. In the modern fauna it is composed by *C. ciliatum ciliatum* (Fabricius. 1780), *C. ciliatum nordenskioeldi* Kafanov, 1981, *C. ciliatum ochotense* Kafanov, 1981, *C. ciliatum pubescens* (Couthouy, 1838), *C. ciliatum tchuktchense* Kafanov in Scarlato, 1981 and *C. likharevi* Kafanov in Scarlato, 1981. Pleistocene *C. ciliatum dawsoni* (Stimpson, 1863) is known from Arctic coast of North America. *C. ciliatum* has also two chronosubspecies: Miocene *C. ciliatum maruyamense* Kafanov et Savizky, 1982 and Pliocene *C. ciliatum chikagawaense* (Kotaka, 1950). Key for identification of all Recent and fossil species and subspecies is given.

Key words: Bivalvia, Cardiidae, Clinocardiinae, *Ciliatocardium*, Recent, Cenozoic, Arctic Ocean, North Pacific, North Atlantic

Genus *Ciliatocardium* Kafanov, 1974

Ciliatocardium Kafanov, 1974: 1469; Kafanov, 1980: 310.

Type-species (*OD*) : *Cardium ciliatum* Fabricius, 1780; Greenland, Recent.

Shell medium- and small sized or minute, oval-rounded or truncated-trigonal. Radial ribs about 17-52 in number, often widely arranged on the anterior area of external valve surface. Ribs triangular or tectate (roof-shaped) in cross-section. Crests of ribs with longitudinal rows of thin ciliated periostracal fringes (in adult and poorly preserved fossil shells ribs may be differently smoothed). Small spiniform lobes observed sometimes in juveniles on crests of ribs; sometimes these lobes are available and for the adult shells. The tooth *AI* without longitudinal ridge on its dorsal surface. Lunula oblong and cordiform or absent. Escutcheon if present narrow and lanceolate. Distal part of foot with narrow ventral sulculus surrounded on both sides by longitudinal rows of delicate papillae. Labial palps long but less than a half of the length of the inner demibranch.

Paleocene - Recent; cold and temperate waters of the northern hemisphere: northwestern (south to Kyushu, Japan) and northeastern (south to California, U.S.A.) Pacific; Arctic Ocean and North Atlantic (south to Cape Cod, Massachusetts, U.S.A., Iceland and southern Norway; in Pliocene to England).

Key to the species and subspecies

1. Average ribs number more than 35.....2.
   Average ribs number less than 35.....13.
2. Average H/L ratio 0.95 or more.....3.
   Average H/L ratio less than 0.95.....6.
3. Umbo medium wide; ribs with rather straight shape of slope.....4.
   Umbo wide; ribs rather convex-shaped..... 5.
4. Average B/L ratio about 0.29; ribs 28-35 in number ....*C. ciliatum maruyamense* Kafanov et Savizky, 1982.
   Average B/L ratio about 0.36; ribs 30-40 in number .....*C. ciliatum chikagawaense* (Kotaka, 1950).
5. Average A/L ratio about 0.48; average B/L ratio about

0.38; ribs 44-49 in number.....*C. coosense* (Dall, 1909).
Average A/L ratio about 0.41; average B/L ratio about 0.27; ribs 33-45 in number.....*C. smekhovi* Kafanov et Savizky, 1982.

6. Average ribs number more than 40.....7.
Average ribs number less than 40.....8.
7. Ribs 42-48 in number; average H/L ratio about 0.76 ...*C. ermanense* Sinelnikova in Sinelnikova *et al*., 1976
Ribs 45-52 in number; average H/L ratio about 0.88 .....*C. carlsbergianum* Kafanov, sp. nov.
8. Average H/L ratio less than 0.90.....9.
Average H/L ratio more than 0.90.....10.
9. Average H/L and A/L ratios 0.88 and 0.32 accordingly; shell moderately oblique and faintly bent .....*C. brooksi* (Clark, 1932).
Average H/L and A/L ratios 0.80 and 0.43 accordingly; shell non-oblique and unbent .....*C. zhidkovae* Kafanov in Arkhipova *et al*., [1994].
10. Adult shell minute or small-sized.....11.
Adult shell medium-sized.....12.
11. Average B/L and A/L ratios 0.23 and 0.47 accordingly; ribs 36-44.....*C. ainuanum* (Yokoyama, 1927).
Average B/L and A/L ratios 0.29 and 0.41 accordingly; ribs 35-42.....*C. asagaiense* (Makiyama, 1934).
12. Shell equilateral, non-oblique and unbent; anterior branch of dorsal margin concave; average nymph length is no more than 1/5 of the shell length .....*C. likharevi* Kafanov in Scarlato, 1981.
Shell at least faintly oblique and bent, rather subequilateral; anterior branch of dorsal margin straight or faintly convex; average nymph length is more than 1/5 of the shell length .....*C. ciliatum* (Fabricius, 1780) [Recent subspecies].
13. Ribs 27 or less.....14.
Ribs more than 27.....20.
14. Adult shell minute.....15.
Adult shell small- or medium-sized.....16.
15. Ribs 17-20 in number; average H/L ratio about 0.93 .....*C. kirkerense* (Clark, 1918).
Ribs 21-25 in number; average H/L ratio about 0.90 .....*C. reedi* (Loel et Corey, 1932).
16. Average H/L ratio more than 0.90.....17.
Average H/L ratio less than 0.90.....18.
17. Average B/L and A/L ratios 0.27 and 0.46 accordingly; ribs 22-25.....*C. matchgarense* (Makiyama, 1934).
Average B/L and A/L ratios 0.34 and 0.42 accordingly; ribs 20-26.....*C. yamasakii* (Makiyama, 1934).
18. Average B/L ratio less than 0.25 .....*C. mutuense* (Nomura et Hatai, 1936).
Average B/L ratio more than 0.25.....19.
19. Average B/L and A/L ratios 0.36 and 0.46 accordingly .....*C. sachalinense* (Khramova, 1962).
Average B/L and A/L ratios 0.31 and 0.43 accordingly .....*C. uyemurai* (Kanehara, 1937).
20. Ribs less than 30 in number.....21.
Ribs 30 and more in number.....24.
21. Average H/L ratio more than 1.10 .....*C. moorae* Kafanov, sp. nov.
Average H/L ratio less than 1.10.....22.
22. Average B/L ratio more than 0.30 .....*C. hataii* (Hayasaka, 1956).
Average B/L ratio less than 0.30.....23.
23. Average A/L ratio about 0.45 .....*C. makiyamae* (Kamada, 1962).
Average A/L ratio about 0.49 .....*C. tigilense* (Slodkewitsch, 1938).
24. Average H/L ratio more than 0.95.....25.
Average H/L ratio less than 0.95.....26.
25. Ribs 33-37 in number .....*C. shinjiense* (Yokoyama, 1923).
Ribs 24-32 in number .....*C. yakatagense* (Clark, 1932).
26. Average H/L ratio more than 0.86.....27.
Average H/L ratio less than 0.86.....28.
27. Adult shell medium-sized; umbo wide .....*C. iwatense* (Chinzei, 1959).
Adult shell small-sized; umbo narrow .....*C. obstinatus* (Barinov in Gladenkov *et al*., 1992).
28. Average H/L, B/L and A/L ratios 0.85, 0.25 and 0.42 accordingly; ribs 27-36 in number .....*C. evsseevi* Kafanov et Savizky, 1982.
Average H/L, B/L and A/L ratios 0.82, 0.29 and 0.44 accordingly; ribs 25-33 in number .....*C. schmidti* (Khramova, 1962).

Cliatocardium ciliatum (Fabricius, 1780)[1]

(Pls. 1-6; pl. 7, figs. 1-8)

English: Iceland cockle, hairy cockle; *Japanese*: Kokera-ishikage-gai; *Icelandian*: báruskel; *local in Greenland*: kirksoaursak.

Cardium ciliatum Fabricius, 1780: 410.
Cardium californiense var. comoxense Dall, 1900: 1093.
Laevicardium decoratum (Grewingk): Grant and Gale, 1931, pl. 19, fig. 12.

[1] Synonymy and bibliography herein is given for fossil specimens mainly, for Recent ones see distinct subspecies.

Table 1. Two-variable matrix for paired Comparison: (Student's t-test) of the power function coefficients **b** in four subspecies of *Ciliatocardium ciliatum*.

Variables	Subspecies	II	III	IV
H, L	I	4.27*** (69; 63)	3.10** (69; 69	1.48 (69; 16)
A,L	I	2.26* (69; 63)	1.53 (69; 69)	1.02 (69; 16)
B,L	I	6.16*** (69; 63)	1.87 (69; 69)	0.96 (69; 16)
n,L	I	2.71** (69; 63)	-	0.42 (69; 16)
H, L	II	_	0.24 (69; 63)	0.29 (63; 16)
A, L	II	_	3.44*** (69; 63)	0.36 (63; 16)
B, L	II	_	3.00** (69; 63)	1.76 (63; 16)
n, L	II	_	-	1.56 (63; 16)
H,L	III	_	_	0.10 (69; 16)
A, L	III	_	_	1.50 (69; 16)
B,L	III	_	_	0.07 (69; 16)
n, L	III	_	_	-

Power function is $\mathbf{X} = \mathbf{aL}^{b}$, where **X** are valve heigt **(H)**, length of the valve anterior part **(A)**, valve convexity **(B)** and length of nymph **(n)** accordingly. Significance: *P(0.1, ** P(0.01, ***P(0.001. Subspecies: I - *C. ciliatum ciliatum*; II - *C. ciliatum nordenskioeldi*; III - *C. ciliatum tchuktchense*; IV - *C. ciliatum ochotense*. Degree of freedoms for compared sets are given in brackets. *C. ciliatum pubescens* is not included in this table because its morphometric characters significantly differ from the parameters of normal (Gaussian) distribution.

Papyridea sertunayana Kogan (in litt.): Slodkewitsch, 1938: 405, pl. 82, figs. 3, 3a.

Clinocardium comoxense Dall, 1900: Keen, 1954: 19, pl. 1, figs. 5, 7, 8.

Laevicardium cf. *decoratum* "(Grewingk, 1850)": Ilyina, 1960, pl. 2, fig. 1.

Clinocardium decoratum "Grewingk, 1850": Zhidkova *et al*., 1968, pl. 20, fig. 16.

Clinocardium sachalinense Khramova, 1962: Zhidkova *et al*., 1972, pl. 11, fig. 1.

?Profulvia sertunayana Slodkewitsch, 1938: Kafanov, 1980: 316.

Clinocardium ciliatum padimeicum Merklin and Zarkhidze in Merklin *et al*., 1979: 44, pl. 7, figs. 10, 11.

Ciliatocardium olchovensis Petrov, 1982: 104, pl. 19, figs. 1, 2, 4, 7, 8.

Ciliatocardium ciliatum (Fabricius): Gladenkov *et al*., 1980: 43, pl. 8, figs. 1-3; Kafanov, 1980: 312; Kafanov and Savizky, 1982: 55; Petrov, 1982: 103, pl. 19, figs. 3, 5, 6.

?Ciliatocardium ciliatum (Fabricius): Gladenkov *et al*., 1992, pl. 12, fig. 2.

Bibliography: Chinzei, 1959; Clarke *et al*., 1972; Dall, 1919, 1924a, b; Durham and MacNeil, 1967; Gladenkov, 1972; Grant and Gale, 1931; Grigorenko *et al*., 1967; Hopkins, 1959; Hopkins *et al*., 1965; Iwai and Siobara, 1969; Kafanov, 1981a; Kotaka and Noda, 1967; Kuroda, 1931; Marincovich, 1983; Marincovich and Powell, 1989; Merklin *et al*., 1962; Noda, 1973; Petersen and Kristensen, 1991; Richards, 1962; Schlesch, 1924; Soot-Ryen, 1932; Uozumi, 1962; Zinbo, 1973.

Diagnosis: Shell medium-sized, trigonal-subcircular or trigonal-suborbicular, high (average H/L ratio about 0.87-0.99), slightly subequilateral (average A/L ratio about 0.40-0.43), medium convex (average B/L ratio about 0.29-0.32), faintly oblique and faintly bent, rather thick-walled. Keel twist not present. Ribs 26-44 (34-38 in average) in number, triangular-shaped, with straight or concave shape of slope. Quite often hinge is strongly weakened at the expense of a reduction of a tooth AIII and cardinals. Usually length of nymph is more than 1/5 of the shell length.

Comparison: Recent sibling species, *C. likharevi* Kafanov in Scarlato, 1981, differs by concave anterior branch of hinge margin, by non-oblique and unbent shell and by relatively shorter nymph (in average no more than 1/5 of the shell length).

Taxonomical notes: Pleistocene *Cardium californiense* var. *comoxense* Dall, 1900 (pl. 1, figs. 13-16), *Clinocardium ciliatum padimeicum* Merklin et Zarkhidze in Merklin *et al*., 1979 and *Ciliatocardium olchovensis* Petrov, 1982 (pl. 1, fig. 17) by nothing differ from Recent *Ciliatocardium ciliatum* and should be considered as synonyms of the last. Possible synonym also is *Papyridea sertunayanum* Slodkewitsch, 1938 (pl. 4, fig. 8) described on the deformed shell.

Dall (1900) marks extremely wide variability of *C. ciliatum* and does not consider possible to establish any discrete groups inside this species. However, elementary statistical analysis of main conchometric parameters (Table 1) permits separate five groups, to which quite approach criteria of subspecies rank taxa: nominative subspecies, *C. ciliatum nordenskioeldi* Kafanov, 1981, *C. ciliatum ochotense* Kafanov, 1981, *C. ciliatum pubescens* (Couthouy, 1838) and *C. ciliatum tchuktchense* Kafanov in Scarlato, 1981. Pleistocene *C. ciliatum dawsoni* (Stimpson, 1863) can be considered also as separate subspecies and others two chronosubspecies are submitted by Pliocene *C. ciliatum chikagawaense* (Kotaka, 1950) and Miocene *C. ciliatum maruyamense* Kafanov et Savizky, 1982. Following key may be used for determination of Recent and Pleistocene subspecies:

1. Average H/L ratio about 0.88-0.95; umbo moderately high and wide; if external valve surface is corroded that is usual on umbonal area only.....2.
   Average H/L ratio about 0.93-0.96; umbo low and wide (if high that tapering); external valve surface is strong corroded.....4.
2. Posteroventral corner is not expressed; shell rather equilateral

.....*C. ciliatum pubescens* (Couthouy, 1838).

Posteroventral corner expressed in a different degree; shell subequilateral.....3.

3. Slightly curved posterior branch of hinge margin smoothly passes in posterior margin of valve; average A/L ratio about 0.41; average B/L ratio about 0.31 .....*C. ciliatum ciliatum* (Fabricius, 1780).

Almost straight posterior branch of hinge margin passes in posterior margin of valve with an appreciable corner; average A/L ratio about 0.43; average B/L ratio about 0.30 ....*C. ciliatum tchuktchense* Kafanov in Scarlato, 1981.

4. Posteroventral corner well expressed, slightly pointed and extended backward; umbo high and narrow, well marked by anterior umbonal cavity; average B/L ratio about 0.22 .....*C. ciliatum dawsoni* (Stimpson, 1863).

Posteroventral corner rounded and extended downward; umbo low and wide, not clearly marked by anterior umbonal cavity; average B/L ratio more than 0.22.....5.

5. Ribs flattened, wide; ciliated periostracal fringes on the ribs are poorly advanced and on the medial area almost always are absent .....*C. ciliatum ochotense* Kafanov, 1981.

Ribs rather high, narrow, pointed, concave-shaped; ciliated periostracal fringes on the ribs are well advanced and also on the medial area .....*C. ciliatum nordenskioeldi* Kafanov, 1981.

Geographical distribution (Fig. 1): One of the most usual Bivalvia species in cold (Arctic Ocean) and temperate waters of the northern hemisphere. Southern limits of distribution: North Atlantic - east Finnmarken, Norway, southwest coast of Färöer Islands, Denmark, south Iceland, south Greenland and Cape Cod, Massachusetts, U.S.A.; North Pacific - East Korea Bay, Tajima, Hyogo Prefecture, Japan, Otsuchi Bay, northeastern Honshu, Japan, Commander and Aleutian Islands, Puget Sound, Washington, U.S.A.

Geochronological distribution: The earliest fossil occurrences of *C. ciliatum* are lower Middle Miocene Uglegorsk Horizon (Aleksandrovskaya and/or Sertunayskaya Suite) of west Sakhalin, Russia. In West Kamchatka it is known not earlier than middle Miocene Etolonskaya Suite (Grigorenko *et al*., 1967). It is reported also from Miocene Ogawara Formation of Aomori Prefecture, Honshu. *Ciliatocardium ciliatum maruyamense* Kafanov et Savizky, 1982 is distributed in upper Miocene deposits of Sakhalin and *C. ciliatum chikagawaense* (Kotaka, 1950) is the usual representative of Pliocene Omma fauna in Japan. In Eastern Kamchatka *C. ciliatum* is known from Pliocene Ust'-Limimtevayamskaya Suite of Karaginsky Island. Kanehara's (1937) data for Oligocene Iwaki Formation of Northeast Honshu are erroneous.

Analogous data for Pacific coast of North America belongs only for Pliocene Beringian strata of Pribilof Islands, Alaska, U.S.A. (Grant and Gale, 1931) though similar forms are known from upper Miocene Tachilni Formation of southwest Alaska (Marincovich, 1983). It is common also in Pliocene and Pleistocene deposits of Chukotka Peninsula, Arctic coast of Russia, Alaska, Iceland (Tjörnes Crag) and England (Icenian).

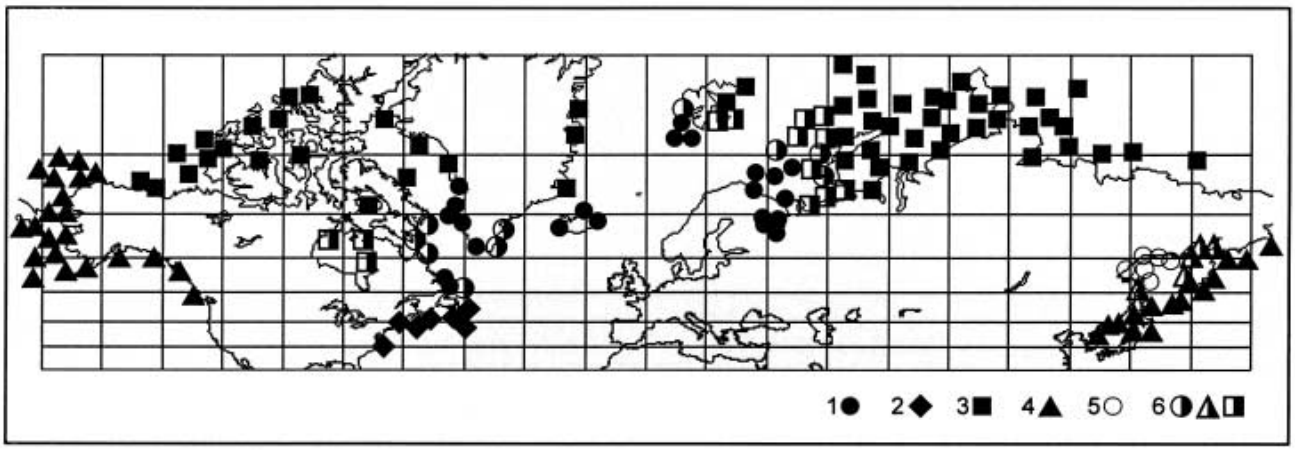


Fig 1. Geographical distribution of Recent *Ciliatocardium ciliatum* (Fabricius, 1780). Subspecies: 1 - *C. ciliatum ciliatum* (Fabricius. 1780), 2 - *C. ciliatum pubescens* (Couthouy, 1838), 3 - *C. ciliatum nordenskioeldi* Kafanov, 1981, 4 - *C. ciliatum tchuktchense* Kafanov in Scarlato, 1981, 5 - *C. ciliatum ochotense* Kafanov, 1981, 6 - specimens from the intergradation zone between subspecies.

Ciliatocardium ciliatum ciliatum (Fabricius, 1780)

(Pl. 1, figs. 1-11, 18; pl. 2, figs. 1-13)

Cardium ciliatum Fabricius, 1780: 410; Römer, 1869: 43 (part.), Taf. 7, Fig. 5, 6 non Taf. 10, Fig. 1-3; Mörch, 1870: 27 (part.); Leche, 1878:21 (part.); Sars, 1878: 46, pl. 5, figs. 4a, b; Herzenstein, 1885: 652; Posselt, 1895: 70 (part.?); Posselt and Jensen, 1898: 57 (part.?); Friele and Grieg, 1901: 33 (part.); Knipowitsch, 1902: 93 (part.); Hägg, 1905: 51 (part.); Odhner, 1910: 18; Jensen, 1912: 79, pl. 3, fig. 10 (juv.); Odhner, 1915: 118 (part.); Grieg, 1924: 7 (part.); Johnson, 1926: 24 (part.); Thiele, 1928: 577, 621 (part.); Pirozhnikov, 1937: 83, pl. 38, fig. 1; Madsen, 1949: 63; Thorson, 1951: 80; Óskarsson, 1952: 78, text-fig. 69 (reproduced from: Sars, 1878, pl. 5, fig. 4); Ockelmann, 1958: 118 (part.?); Petersen, 1978, text-fig. 1C.

Cardium islandicum Chemnitz, 1782: 200, pl. 19, figs. 195, 196, nonbinom. [Official index..., 1958: 5, Direction 1].

Cardium islandicum Bruguière, 1789: 222; Gmelin, 1791: 3252; Hancock, 1846: 336 (part.?); Middendorff, 1849: 38 (part.?); Packard, 1867: 278; Smith, 1877: 141 (part.?); Kobelt, 1888: 367 (part.); Rogers, 1920: 358 (part.).

Cardium edule, non Linnaeus, 1758: Mohr, 1786: 128; Jeffreys, 1864: 287.

Cardium icelandicum "Gmelin": Wood, 1825: 26, pl. 5, fig. 27; Sowerby, 1841b: 2, no. 19; Reeve, 1845: sp. 54, pl. 11.

?*Cardium boreale* Broderip et Sowerby, 1829: 368 non Reeve, 1845: sp. 131, pl. 22.

?*Cardium arcticum* Sowerby, 1841a: 106; Sowerby, 1841b: 2, no. 27, fig. 26.

Cardium (*Serripes*) *islandicum* Bruguière: Adams and Adams, 1858: 456.

Cardium hayesii Stimpson, 1864: 142; Packard. 1867: 278, pl. 7, fig. 14.

Cardium (*Cerastoderma*) *ciliatum* Fabricius: Adams and Adams, 1858: 456; Dall, 1900: 1096 (part.); Dall, 1901: 386 (part.); Whiteaves, 1901: 128 (part.); McLean, 1939: 162, pl. 24, figs. 1, 2; Filatova, 1948: 432 (part. non pl. 109, fig. 1).

Cardium (*Cerastoderma*) *ciliatum* Bruguière: Dautzenberg and Fischer, 1912: 448 (part.; comprehensive synonymy until 1902).

Clinocardium ciliatum (Fabricius): Keen, 1936: 120 (part.); LaRocque, 1953: 63 (part.); Keen, 1954: 20 (part.); Soot-Ryen, 1958: 22 (part.?); Bousfield, 1960: 28 (part.), pl. 6, fig. 70; Allen, 1965: 938 (part.); Abbott, 1968: 228, text-fig. 6?; Nordsieck, 1969: 98, pl. 15, fig. 54.30; Voskuil, 1989: 273, fig. 24.

Corculum (*Keenocardium*) *ciliatum* (Fabricius): Fischer-Piette, 1977: 134 (part.).

Ciliatocardium ciliatum ciliatum (Fabricius): Kafanov, 1981a: 49, figs. 2a, b.

Ciliatocardium ciliatum (Fabricius): Golikov and Scarlato, 1977: 368 (part.); Naumov *et al*., 1987: 247, fig. 154.

Bibliography: Ecology, life cycle, morphology, distribution, fisheries: Andrews, 1972; Brøgger, 1901; Brotskaya and Zenkevich, 1939; Brotskaya *et. al*., 1963; Clarke, 1974; Dall, 1924b; Derjugin, 1915, 1928; Fedyakov, 1986; Filatova, 1957; Gorbunov, 1952; Jensen, 1901; Kaufman, 1974, 1977; Kuznetsov, 1963, 1970; Kuznetsov, 1960, 1961, 1963; Messjatzaew, 1930, 1931; Miloslavskaya, 1958a, b; Petersen, 1968, 1978; Powles, 1965; Spärck, 1933, 1936, 1937; Thorson, 1933, 1934, 1936, 1957; Tseeb, 1964; Tsikhon-Lukanina, 1987; Turpaeva, 1948, 1953; Vibe, 1939, 1950; Zatsepin, 1962; Zatsepin and Filatova, 1961; Zenkevich, 1947, 1951, 1963; Zenkevich and Brotskaya, 1937; Zhirmunsky, 1969.

Etymology: The name is derived from the new Latin *cilia*, eyelashes.

Type-materials: *Cardium ciliatum* Fabricius, 1780. Lectotype (designated by Kafanov, 1980: 312) and paralectotype are stored in ZMK (reg. no. absent). Type locality: Greenland (most possibly, southwest). Lectotype dimensions: L = 51.8; H = 47.6; B = 17.1; A = 21.0.

Cardium islandicum Bruguière, 1789 is based on the nonbinominal name of Chemnitz (1782). Type locality: Iceland. Dall (1900) marks that many old authors attributed authorship of this species to Linnaeus and quite often even with the link to 12th edition of "Systema Naturae", where such name is not mentioned. Tryon's (1873: 1975) indication on "*Cardium islandicum* Linnaeus, edit. 12, p. 1124 "concerns to *Cardium pectinatum* Linnaeus, 1758.

Cardium arcticum Sowerby, 1841. Possible syntype - BMNH no. 1975618 (Pl. 1, figs. 9-11; pl. 4, fig. 10). Type locality: "Arctic seas".

Cardium hayesii Stimpson, 1864. Type materials are lost; Dance (1966) reports that Stimpson's collection was destroyed at the Chicago fire in 1871. Type locality: Disko Island, west Greenland.

Description (see also Table 2): Shell medium-sized (maximum to 65 mm), trigonal-subcircular or trigonal-suborbicular, high (average H/L ratio about 0.95), slightly subequilateral (average A/L ratio about 0.41), medium convex (average B/L ratio about 0.31), faintly oblique but unbent, rather thick-walled. Posterior branch of hinge margin smoothly passes in posterior margin of valve; posteroventral corner is poorly expressed and usually not expressed down- or backward. Growth rings well marked. Umbo marked mainly by anterior umbonal cavity, wide and medium height, often slightly corroded. Ribs 32-38 (34-36 in average) in number, rather low and wide. On the medial

area ribs are not bent, regularly-triangular in cross-section, separated by narrower intercostal spaces. Become closer to anterior area ribs increase height and intercostal spaces extend. The most forward four ribs are pleased bent, widely placed and are shared by by 1.5-2 times wider intercostal spaces. Last two ribs on the escutcheon area have character of not clear wrinkled folds. Ciliated periostracal fringes on the ribs are poorly advanced. As a rule, the hinge is not reduced. Lunula lengthened, slightly pressed.

Comparison: The most similar *C. ciliatum tchuktchense* Kafanov in Scarlato, 1981 differs by following characters: almost straight posterior branch of hinge margin passes in posterior margin of valve with an appreciable corner; average A/L ratio about 0.43 (versus 0.41 in *C. ciliatum ciliatum*); average B/L ratio about 0.30 (versus 0.31).

Taxonomic notes: The majority of the authors considers *Cardium boreale* Broderip et Sowerby, 1829 non Reeve, 1845 as a synonym of *Cardium ciliatum* Fabricius. However, because the original description by Broderip and Sowerby (1829) is very brief and ambiguous, and the type specimen, never illustrated, has been lost the status of this species remains doubtful (see: Nomina dubia).

Ecology: Commonly inhabits lower intertidal and subtidal zones, from 0 up to 700 m preferably on silts, sandy silts and sands but often occurs on mixed soils and on pebbles. Most requently distributes on depth 30-150 m at near-bottom temperature + 1-3 ℃ during August and September. In European sub-Arctic it frequently inhabits the extremely large depths (Soot-Ryen, 1932) that most likely is caused by transport activity of sea ice (Fig. 2). It prefers salinity 33-35‰ though in White Sea maintains considerably lowered salinity (up to 24‰) and abnormal high near-bottom temperature (up to 16 ℃ in Onega Bay).

Near Iceland it is a mass species in *Yoldia hyperborea* community (45-162 m on soft grounds). In fjords *C. ciliatum* includes here in *Macoma calcarea* community (2-50 m on soft grounds). At southern Iceland is rather rare and inhabits fjords mainly. At east Greenland it is common in *Macoma calcarea* community where reaches average biomass 32.4 g/m² (maximum up to 134 g/m²). At Murmansk Coast of the Barents Sea prevails in *C. ciliatum - Arctica islandica* community (10-60 m on muddy sands) and is characteristic species in *Strongylocentrotus droebachiensis - Astarte crenata - Nicomache lumbricalis* community. In structure of main bottom communities of Barents Sea (*Nuculana pernula - Astarte borealis*; *C. ciliatum - Astarte*

Table 2. Statistical values of basic morphometric characters in Recent *Ciliatocardium ciliatum ciliatum* (Fabricius, 1780).

N = 71; y = L = 33.0 ± 1.9; σ_y = 16.3 ± 1.4; As_y = + 0.001; E_y = − 0.614;

Parameters	H	A	B	n
x	31.5±1.9	13.2±0.7	10.4±0.6	8.9±0.7
σ_x	15.9±1.3	6.1±0.5	5.3±0.4	5.7±0.5
As_x	+0.031	+0.013	+0.188	+0.272
E_x	-0.487	-0.499	-0.568	-0.439
r	0.998±0.000***	0.995±0.001***	0.992±0.002***	0.984±0.004***
r_{ln}	0.999±0.000***	0.997±0.001***	0.996±0.001***	0.993±0.002***
a	1.190	1.988	3.889	7.720
b	0.976±0.005	1.072±0.010	0.969±0.010	0.730±0.010
x/y	0.95±0.00	0.41±0.00	0.31±0.00	0.24±0.01
$\sigma_{x/y}$	0.03±0.00	0.02±0.00	0.02±0.00	0.05±0.00
$As_{x/y}$	+0.204	-0.202	+0.256	+0.228
$E_{x/y}$	-0.237	-0.637	-0.415	-0.263

Notation admitted here and in tables 3-7 is as follows: **N** - sampling volume; **y(L)** and **x** (H, A, B, n) - values of the argument and functions (mean ± SD); **As** and **E** - coefficients of asymmetry and excess; for significant differences of **As** and **E** from the parameters of normal (Gaussian) distribution and for significance of **r** and $\mathbf{r_{ln}}$: *P(0.1, ** P(0.01, ***P(0.001; **r** - paired Pearson's correlation coefficient between the values of **x** and **y**; $\mathbf{r_{ln}}$ - paired Pearson's correlation coefficient between the logarithms of **x** and **y**; **a** and **b** - constants of the power functions **ln y** = **ln a** + **b**•**ln x**; quotation of the type **x/y** = 0.89 ± 0.00 denotes that SD(0.005.

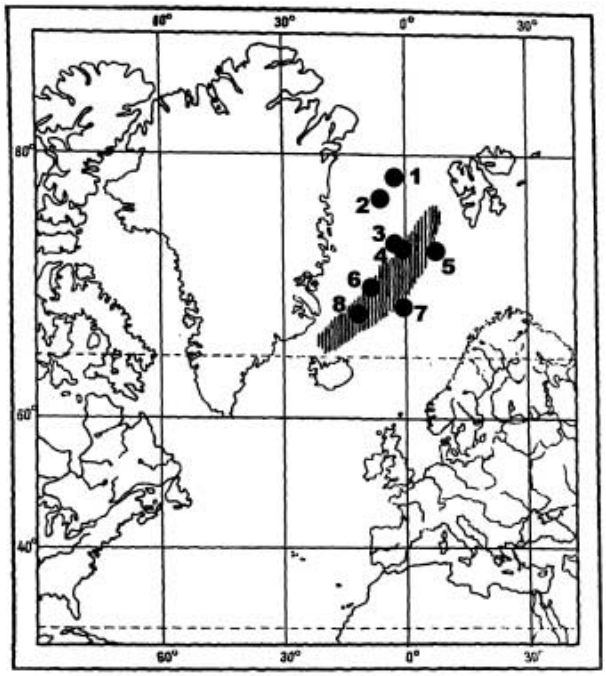


Fig 2. The maximal depths of a finding of empty valves of *Ciliatocardium ciliatum* (Fabricius, 1780) in Greenland Sea and adjacent waters.

The area of thawing of ice in places of meeting of warm and cold currents (schematically according Lisitsyn, 1961) is shaded. Depths (in m): 1—2754; 2—1447; 3—3145; 4—2968; 5—2224; 6—2320; 7—2886; 8—2715.

borealis; *Portlandia arctica*, etc.) it prevails on biomass (in average 38.5 g/m^2) and density (in average 8 specimens /m^2) on depth 0-100 m. In White Sea is usual in internal sites of inlets (6-22 m on silts) in *Nuculana pernula* - *Arctica islandica* - *C. ciliatum* - *Astarte elliptica* community complex.

One of the main components in a diet of walruses, whales and of many benthophagous fishes: halibuts, flounders, haddock, wolffishes and other. It is quite edible for the man (on taste reminds *Spisula sachalinensis*) but is not used.

Distribution (Fig. 1): Southwestern (to north up to the Polar circle) coast and southeastern extremity of Greenland, northeastern coast of Newfoundland Island, Canada, Iceland, southwest coast of Färöer Islands, Denmark, north Norway (to south up to east Finnmarken), southwest Spitzbergen, southwest part of Barents Sea (from the southern extremity of West Spitzbergen up to Svyatoy Nos Cape, Kola Peninsula, Russia).

Wide zone of intergradation with *C. ciliatum nordenskioeldi* occupies central and southeastern parts of Barents Sea, southeastern and northwestern coasts of West Spitzbergen and Baydaratskaya Inlet of Kara Sea. On the American coast northern border of distribution of *C. ciliatum ciliatum* is not known precisely, but at northeastern Labrador, Canada, specimens of a transitive type are distributed.

Materials: 254 lots (more than 950 specimens): ZIsp, CAS, LACMNH.

Ciliatocardium ciliatum dawsoni (Stimpson, 1863)

(Pl. 1, fig. 12; pl. 4, figs. 6, 7)

Cardium dawsoni Stimpson, 1863: 58, text-fig.
Ciliatocardium ciliatum dawsoni (Stimpson, 1863): Kafanov, 1981a: 51, fig. 2B.

Etymology: The name is derived in the honour of Sir John William Dawson (1820-1899), Canadian geologist who made numerous contributions to paleobotany and extended the knowledge of Canadian geology.

Type-material: It follows from original description that the type-material was stored at Museum of Smithsonian Institution [USNM] however it is absent nowadays here (J. Rosewater, pers. comm., Nov. 17, 1973). Besides Dance (1966) reports that Stimpson's collection was destroyed at the Chicago fire in 1871. Type locality: "on the beach at Cape Hope, on the southeast side of Hudson's Bay, having in all probability been washed out of a Pleistocene deposit". Original figure dimensions: L = 41.5; H = 38.8; B = 12.7.

Description (from: Stimpson, 1863: 58-59): "Shell subovate, oblique, very inequilateral, and somewhat angular posteriorly; beaks small and much elevated; hinge thin; teeth weak, especially the posterior ones; ribs about thirty-five in number, in the anterior part of the shell narrower than their interspaces, in the middle and posterior parts broader and more flattened; ventral margin crenulated".

Comparison: This form appreciablly differs from others subspecies of *C. ciliatum* by shell-shape markedly angular posteriorly (see Key for subspecies).

Taxonomic notes: I had two left valves received from CAS and labelled: "CAS no. 34343. *Clinocardium* cf. *californiense* (Deshayes), Arctic coast of Alaska, 71 °31 ′20 ″N 156 °23 ′00 ″W, about 169 m, G. D. Hanna, Aug. 14 1954" and "CAS no. 35052. Deadman Island, off Point Barrow, Sh. Sovalik, M. Brewer and G. D. Hanna, June 21 1957". These shells quite correspond to the original description of *Cardium dawsoni* and its image. Taking into account essential morphological differences of this form *C. ciliatum dawsoni* (Stimpson, 1863) can be considered as separate subspecies characteristic for Pleistocene deposits of Arctic coast of North America.

Materials: 2 lots (2 specimens): ZIsp.

Ciliatocardium ciliatum nordenskioeldi Kafanov, 1981

(Pl. 3, figs. 1-4; pl. 5, figs. 1-13)

Cardium ciliatum Fabricius: Mörch, 1870: 27 (part.); Leche, 1878: 21 (part.); Leche, 1883: 443 (part.); Pfeffer, 1886: 9; Friele and Grieg, 1901: 33 (part.); Knipowitsch, 1902: 93 (part.); Knipowitsch, 1903: 52 (part.?); Hägg, 1905: 51 (part.); Odhner, 1915: 118 (part.); Grieg, 1924: 7 (part.); Thiele, 1928: 621 (part.).
Cardium islandicum Bruguière: Kobelt, 1888: 367 (part.).
Cardium (*Cerastoderma*) *islandicum* Bruguière: Dautzenberg and Fischer, 1912: 448 (part.);
Ciliatocardium ciliatum (Fabricius): Golikov and Scarlato, 1977: 368 (part.); Naumov and Fedyakov, 1990: 403.
Clinocardium ciliatum (Fabricius): Lubinsky, 1980: 38 (part?), pl. 8, fig. 1.
Ciliatocardium ciliatum nordenskioeldi Kafanov, 1981a: 52, figs. 2D, Zh-I.

Bibliography: Ecology, life cycle, morphology, distribution, fisheries: Filatova, 1957; Gorbunov, 1946; Messjatzaew, 1931; Popova, 1948.

Etymology: The name is derived in the honour of Nils

Otto Gustaf Nordenskjöld (1869-1928), Swedish geographer and explorer whose expedition to the Arctic was distinguished by the volume of its scientific findings.

Type-material: Holotype (reg. no. 1/200156) and paratypes (reg. nos. 200157-200273) in ZIsp. Type locality: Laptev Sea, Komsomol'skoy Pravdy Islands, between Angreya Island, 76 °50 'N 110 °40 'E and Samuila Island, 77 °25 'N 106 °45 'E, depth 37 m, mud, near-bottom temperature −1.2°C; leg. E. E. Arngold, r/v "Vaygach", August 13(26), 1913.

Holotype dimensions: L = 40.3; H = 38.1; B = 11.7; A = 16.1.

Description (see Table 3): Shell medium-sized (usually not more than 50mm in length), suborbicular, high (average H/L ratio about 0.96), subequilateral (average A/L ratio about 0.42), medium convex, faintly oblique and faintly bent, thin-walled, often corroded and even perforated especially at umbonal area. Keel twist absent. Growth rings well marked, numerous. Umbo low, wide, blunt, badly designated by umbonal cavities. Ribs 27-39 (32-34 in average) in number, thin, not enough bent, concave-shaped in cross-section, widely placed, wrinkled, bearing distinct longitudinal rows of periostracal fringes or of spike-form tubercles in juvenille specimens. Hinge plate narrow. Teeth, especial *AI*, *3a* and *4b*, are essentially weakened. In area of cardinal teeth additional semiinternal ligament is present. The tooth *PI* is almost equal to nymph length. Internal surface of valve Brilliant, with clear negative ribs. Extremely rare specimens from western part of East Siberian Sea have a small and convex shell perforated at umbonal area and rather large spike-form tubercles on the ribs.

Comparison: The most similar *C. ciliatum ochotense* Kafanov, 1981 differs by shell-outline, by wide and flattened ribs; ciliated periostracal fringes on the ribs are poorly advanced and on the medial area almost always are absent among this subspecies.

Ecology: The range of vertical distribution makes from 9 up to 293 m however most frequently inhabits soft bottom on depth 20-40 m. Subfossil valves, most probable transported by ice, were found in Laptev Sea (77 °25 'N 118 °17 'E) on depth 869 m. The typical specimens are found out only at constantly negative near-bottom temperatures: from −0.4 up to −1.7°C in Kara Sea; from −1.2 up to −1.7°C in Laptev Sea; from −0.8 up to −1.8°C in northeastern part of Barents Sea. The range of salinity makes from 32 up to 35‰: from 32.3 up to 34.8‰ in Kara Sea, from 26.2 up to 34.3‰ in Laptev Sea, from 32.4 up to 4.4‰ in northeastern part of Barents Sea. In comparison with Barents Sea in Kara and Laptev Seas it loses its significance in bottom communities.

Table 3. Statistical values of basic morphometric characters in Recent *Ciliatocardium ciliatum nordenskioeldi* Kafanov, 1981.

N = 65; y = L = 18.8 ± 1.6; σ_y = 12.8 ± 1.1; As_y = + 0.317; E_y = − 0.225;

Parameters	H	A	B	n
x	18.1±1.5	7.8±0.6	5.8±0.5	4.5±0.5
σ_x	12.4±1.1	5.0±0.4	3.7±0.3	3.7±0.3
As_x	+0.315	+0.439	+0.344	+0.236
E_x	-0.248	-0.281	-0.210	-0.787
r	0.998±0.000***	0.997±0.001***	0.995±0.001***	0.980±0.004***
r_{1x}	0.999±0.000***	0.998±0.000***	0.996±0.001***	0.980±0.005***
a	1.040	2.122	2.860	6.382
b	0.989±0.005	1.047±0.009	1.080±0.012	0.807±0.020
x/y	0.96±0.00	0.42±0.00	0.32±0.00	0.22±0.01
$\sigma_{x/y}$	0.03±0.00	0.02±0.00	0.03±0.00	0.05±0.00
$As_{x/y}$	+0.047	+0.147	-0.207	+0.052
$E_{x/y}$	-0.380	-0.017	-0.490	-0.387

Distribution (Fig. 1): One of the most usual Bivalvia species on the Arctic Ocean shelf: northeastern part of Barents Sea, Kara, Laptev and East Siberian Seas, northwestern part of Chukchi Sea, Beaufort Sea, Canadian Arctic Archipelago, Baffin and Hudson Bays, Labrador Sea.

Material: 116 lots (560 specimens): ZIsp.

Ciliatocardium ciliatum ochotense Kafanov, 1981

(Pl. 3, figs. 5-8; pl. 5, figs. 14-18)

Cardium ciliatum Fabricius: Ushakov, 1953: 264 (part.); Scarlato, 1955: 193 (part., non pl. 51, fig. 12).
Ciliatocardium ciliatum ochotense Kafanov, 1981a: 54, figs. 3A-G.
Clinocardium ciliatum (Fabricius): Volova and Scarlato, 1980: 67, text-fig. 63.

Bibliography: Ecology, life cycle, morphology, distribution, fisheries: Kun and Mikulich, 1954; Pasternak, 1957; Savilov, 1961; Ushakov, 1953; Vinogradov and Neyman, 1969; Vinogradova, 1954; Volova and Scarlato, 1991.

Etymology: The name is derived from the type-locality, Okhotsk Sea.

Type-material: Holotype (reg. no. 1/200366) and paratypes (reg. nos. 200367-200372) in ZIsp. Type locality: north coast of Okhotsk Sea, west from Tauyskaya Inlet, 58 °41 'N 147 °45 'E, depth 121 m, mud; leg. F. A. Derbek, r/v "Okhotsk", September 4, 1912.

Holotype dimensions: L = 48.1; H = 45.0; B = 13.9; A = 18.3.

Description (see Table 4): Shell medium-sized, trigonal-suborbicular, high (average H/L ratio about 0.94), subequilateral (average A/L ratio about 0.40), medium convex (average B/L ratio about 0.29), faintly oblique and faintly bent, thin-walled, strongly corroded and quite often perforated on the umbonal area. Growth rings smoothed. Umbo low, rather wide, slightly pointed, badly designated by umbonal cavities. Ribs 30-38 (34-35 in average) in number, flattened-triangular in cross section, wrinkled. Longitudinal rows of periostracal fringes on top of ribs are usually present on the anterior and posterior valve areas only. Hinge plate rather narrow. Teeth, especial cardinal, are essentially weakened and frequently are completely reduced. In area of cardinal teeth additional semiinternal ligament is developed.

Comparison: The most similar *C. ciliatum nordenskioeldi* Kafanov, 1981 differs by more smoothed shell outlines, by relatively higher, concave-shaped ribs bearing well developed, including on the medial area, longitudinal rows of periostracal fringes.

Ecology: It is distributed mainly on mud, sand and sandy mud on depth from 5 up to 174 m but most frequently inhabits depth 50-120 m reflecting preferring to cold intermediate layer of the Okhotsk Sea water mass. In the basic part of area it is found only at constantly negative near-bottom temperatures: from −0.7 up to −1.8℃. It is usual in *Nuculana pernula* - *Ophiura sarsi* - Polychaeta and *Megayoldia thraciaeformis* - *Macoma calcarea* communities where makes about 6 % (in average about 38.4 g/m²) of total zoobenthos biomass.

Distribution (Fig. 1): Northern and northwestern portions of Okhotsk Sea.

Material: 6 lots (46 specimens): ZIsp.

Table 4. Statistical values of basic morphometric characters in Recent *Ciliatocardium ciliatum ochotense* Kafanov, 1981.

N = 18; y = L = 37.9 ± 2.1; σ_y = 9.0 ± 1.5; As_y = − 0.017; E_y = + 0.755;

Parameters	H	A	B	n
x	35.6±2.1	15.3±0.8	11.1±0.6	9.0±0.7
σ_x	8.7±1.5	3.5±0.6	2.7±0.5	2.8±0.5
As_x	-0.002	-0.056	+0.015	+0.025
E_x	+0.424	+0.688	-0.005	+0.093
r	0.996±0.002***	0.968±0.015***	0.986±0.007***	0.969±0.015***
r_{lin}	0.997±0.001***	0.980±0.010***	0.989±0.005***	0.986±0.007***
a	1.336	2.659	4.066	8.478
b	0.987±0.020	1.036±0.052	1.014±0.039	0.703±0.030
x/y	0.94±0.00	0.40±0.00	0.29 ±0.00	0.23±0.01
$\sigma_{x/y}$	0.02±0.00	0.02±0.00	0.01±0.00	0.03±0.01
$As_{x/y}$	-0.025	+0.088	+0.048	-0.032
$E_{x/y}$	+0.139	-0.815	-0.836	+0.310

Ciliatocardium ciliatum pubescens (Couthouy, 1838)

(Pl. 3, figs. 9-12; pl. 4, fig. 5; pl. 6, figs. 7-12)

Cardium pubescens Couthouy, 1838: 61, pl. 3, fig. 6.

Cardium ciliatum Fabricius: Römer, 1869: 43 (part.), pl. 10, figs. 1, 2 non pl. 7, figs. 5, 6 nec pl. 10, fig. 3; Johnson, 1926: 24 (part.).

Cardium islandicum Bruguière: Gould, 1841: 89, fig. 58; DeKay, 1843: 206, pl. 23, fig. 252; Mighels, 1843: 321; Stimpson, 1851: 19; Stimpson, 1854: 21; Gould, 1870: 139, fig. 58; Dall, 1889: 52; Rogers, 1920: 358 (part.).

Cardium (*Cerastoderma*) *ciliatum* Fabricius: Dall, 1900: 1096 (part.); Dall, 1901: 386 (part.); Whiteaves, 1901: 128 (part.); McLean, 1939: 162 (part.), pl. 24, figs. 1, 2.

Cardium (*Cerastoderma*) *islandicum* Bruguière: Dautzenberg and Fischer, 1912: 448 (part).

Clinocardium ciliatum (Fabricius): Keen, 1936: 120 (part.); LaRocque, 1953: 63 (part.); Keen, 1954: 20 (part.); Abbott, 1960: 403 (part., an pl. 32, fig. e?); Bousfield, 1960: 28 (part.) non pl. 6, fig. 70.

Ciliatocardium ciliatum pubescens (Couthouy, 1838): Kafanov, 1980: 313; 1981: 55, figs. 2G, E.

Etymology: The name is derived from the Latin *pubesco*, to be overgrown by hair.

Type-material: Most likely it is lost. Dance (1966) marks absence of information on Couthouy's private collection and as probable depositaries names USNM and Museum of Comparative Zoology, Harvard University, Cambridge, where nowadays type-specimens of Couthouy are absent (J. Rosewater, pers. comm., July 17, 1974; K. Boss, pers. comm., 20 October, 1974). Type-locality: [near Egg Rock, off Lynn], Massachusetts Bay, Massachusetts, U.S.A.

Original figure dimensions: L = 20.4; H = 17.8; B = 7.0.

Description: Shell medium-sized, orbicular, rather high (average H/L ratio about 0.86) and equilateral (average A/L ratio about 0.44), medium convex (average B/L ratio about 0.34), non-oblique and unbent, thin-walled. Anterior branch of hinge margin inconspicuous, feebly impressed. Posteroventral corner is not expressed. Anterior, ventral and posterior valve margins form a wide correct arch. Growth rings are shown as narrow dark concentric strips. Umbo low, rather wide, very seldom and only slightly corroded. Ribs 36-41 in number, their edges covered with a short, downy ciliation of a dirty brown color. Longitudinal rows of periostracal fringes quite often are absent on the medial valve area however traces of an attachment of these fringes always are kept here. Lunula lengthened and depressed because of what anterior branch of hinge margin is put slightly forward in the comissure plane.

Hinge is a little weakened in comparison with nominative subspecies. Pallial line and muscle scars are poorly distinct because of a strongly brilliant internal surface of valve.

Comparison: In shell-shape *C. ciliatum pubescens* strongly differs from all other subspecies and more all reminds *Ciliatocardium likharevi* Kafanov in Scarlato, 1981. However it is not possible to confuse these forms as the last species is absent in North Atlantic.

Ecology: On southern and southwestern slopes of Great Newfoundland Bank it is found out on depths 105-247 m at near-bottom temperature in August from + 1.6 up to 2.0℃ and salinity from 33.98 up to 34.09‰; in Massachusetts Bay on 79m and + 9.5℃; at Cape Cod on depth about 64m.

Distribution (Fig. 1): Northeastern Atlantic: from southern and southwestern slopes of Great Newfoundland Bank up to Cape Breton Island, along Nova Scotia coast, Maine Bay, Fundy Bay, south up to Cape Cod, Massachusetts, U.S.A. Dall's (1889) indication for Hatteras Cape, North Carolina, U.S.A. have not proved to be true.

Material: 14 lots (36 specimens): Zisp, LACMNH, CAS.

Ciliatocardium ciliatum tchuktchense Kafanov in Scarlato, 1981

(Pl. 4, figs. 1-4; pl. 6, figs. 1-6, 13-15; pl. 7, figs. 1-4)

Cardium islandicum Bruguière: Dall, 1871: 148; Krause, 1885: 27; Rogers, 1920: 358 (part.).

Cardium ciliatum Fabricius: Leche, 1883: 443 (part.); Scarlato, 1955: 193 (part.) non pl. 51, fig. 12.

Cardium (*Cerastoderma*) *ciliatum* Fabricius: Dall, 1900: 1096 (part.); Dall, 1901: 390 (part.); Oldroyd, 1925: 142 (part.) non pl. 19, figs. 8, 8a (reproduced from: Sars, 1878, pl. 5, fig. 4; Kuroda and Koba, 1933: 164 (part.); Gorbunov, 1952: 250.

Cardium (*Cerastoderma*) *islandicum* Bruguière: Dautzenberg and Fischer, 1912: 448 (part.).

Cerastoderma ciliatum (Fabricius): Dall, 1921: 39.

Clinocardium ciliatum (Fabricius): Keen, 1936: 120 (part.); Habe, 1951: 150 (part.); Morris, 1952: 39, pl. 9, fig. 9; LaRocque, 1953: 63 (part.); Keen, 1954: 20 (part.); Kira, 1954: 111, pl. 55, fig. 2; Kira, 1959: 138, pl. 55, fig. 2; MacGinitie, 1959: 176, pl. 26, fig. 4; Kira, 1962: 156 (part.), pl. 56, fig. 2; Kotaka, 1962: 151 (part.), pl. 35, fig. 11; Habe and Ito, 1965: 132, pl. 44, figs. 3, 4; Petrov, 1966: 221, pl. 17, figs. 1, 2, ?3; Habe and Kosuge, 1967: 148, pl. 55, fig. 21; Abbott, 1968: 228 (part.) non text-fig. 6; Kwon *et al*., 1993: 364, pl. 85, figs. 3-1, 2.

Ciliatocardium ciliatum tchuktchense Kafanov in Scarlato, 1981: 343, photo 310, 311; Kafanov, 1981a: 56, figs. 3D-Z; Volova and Scarlato, 1991: 167 (part.).

Clinocardium (*Ciliatocardium*) *ciliatum* (Fabricius): Higo and Goto, 1993: 617 (part.); Coan and Scott, 1997: 13; Higo *et al*., 1999: 474 (part.).

Bibliography: Ecology, life cycle, morphology, distribution, fisheries: Bernard, 1967, 1979; Buyanovsky, 1994; Dall, 1919; Evseev, 1981; Eyerdam, 1960; Feder and Jewett, 1981; Feder *et al*., 1994; Filatova and Barsanova, 1964; Galkin, 1953; Gordeeva, 1948; Habe and Igarashi, 1967; Ito, 1967; Kafanov, 1978a, b, 1979, 1981b; Keen, 1937; Klimova, 1974; Kulichkova, 1955; Kun and Mikulich, 1954; Kuroda and Habe, 1952; Kuroda and Kinoshita, 1951; Kuznetsov, 1961, 1963, 1970; MacGinitie, 1955; McLaughlin, 1963; Neyman, 1960; Pasternak, 1957; Savilov, 1961; Scalkin, 1963; Vinogradov and Neyman, 1969; Vinogradova, 1954; Zenkevich, 1963.

Etymology: The name is derived from the part of area, Chukchi Sea.

Type-material: Holotype (reg. no. 1/200291) and paratypes (reg. nos. 200292-200365) in ZIsp. Type locality: Bering Sea, Provideniya Bight, 67°25'N 173°10'W, depth 22-11 m, mud; leg. E. E. Arngold, r/v "Vaygach", August 6 (19), 1912.

Holotype dimensions: L = 54.9; H = 52.9; B = 16.4; A = 23.3.

Description (see Table 5): Shell medium-sized, angular-subcircular or angular-suborbicular, high (average H/L ratio about 0.95), slightly subequilateral (average A/L ratio about 0.43), medium convex (average B/L ratio about 0.30), faintly oblique and faintly bent, rather thick-walled. Almost straight posterior branch of hinge margin passes in posterior margin of valve with an appreciable corner; posteroventral corner is well expressed and usually situated down- or backward. Growth rings well marked. Umbo

Table 5. Statistical values of basic morphometric characters in Recent *Ciliatocardium ciliatum tchuktchense* Kafanov in Scarlato, 1981.

N = 71; y = L = 34.7 ± 1.4; σ_y = 12.1 ± 1.0; As_y = +0.146; E_y = +0.140;

Parameters	H	A	B
x	33.0±1.4	14.6±0.5	10.3±0.4
σ_x	11.7±1.0	4.6±0.4	3.7±0.3
As_x	+0.229	+0.117	+0.291
E_x	+0.522	+0.118	+0.343
r	0.995±0.001***	0.992±0.002***	0.985±0.004***
r_{in}	0.997±0.001***	0.993±0.002***	0.990±0.002***
a	1.128	1.702	3.828
b	0.988±0.009	1.093±0.015	1.010±0.017
x/y	0.95±0.00	0.43±0.00	0.30 ±0.00
$\sigma_{x/y}$	0.03±0.00	0.03±0.00	0.02±0.00
$As_{x/y}$	-0.358	+0.272	+0.180
$E_{x/y}$	+0.091	+0.522	-0.661

marked mainly by anterior umbonal cavity, wide and medium height, often slightly corroded. Ribs 30-38 (33-35 in average) in number, rather low and wide. Ciliated periostracal fringes on the ribs are poorly advanced and mainly on the posterior area only. As a rule, the hinge is not reduced. Lunula rather small, lengthened, slightly pressed.

Comparison: From the most similar *C. ciliatum ciliatum* it differs by more angular outlines of shell and by relatively more equilateral valves.

Ecology: Off eastern Kamchatka and northern Kurile Islands it meets on depths 40-445 m where often forms *C. ciliatum* community and gives a density 1-16 (3 in average) specimens/m^2 and biomass 0.3-115.0 (41.3 in average) g/m^2 at close to 0 °C near-bottom temperature and salinity 33.0-33.5 ‰.

Distribution (Fig. 1): From East Korea Bay, Japan Sea, Tajima, Hyogo Prefecture, Japan, Otsuchi Bay, northeastern Honshu, Japan, Commander and Aleutian (west to Amchitka Island) Islands, east Kodiak Island, Alaska, Puget Sound, Washington, U.S.A., north- and eastward up to southeastern part of Chukchi Sea and Point Barrow, Arctic coast of Alaska.

Material: 96 lots (more than 550 specimens): ZIsp, LACMNH, CAS, SBMNH.

Ciliatocardium ciliatum chikagawaense (Kotaka, 1950)

(Pl. 7, figs. 5, 6)

Cardium shinjiense "Yokoyama, 1923": Yokoyama, 1926, pl. 34, figs. 17, 18.

Clinocardium chikagawaense Kotaka, 1950: 46, pl. 5, figs. 1-6; Ogasawara, 1977: 114, pl. 11, fig. 15; Iwai, 1960, pl. 1, fig. 10; Hatai *et al*., 1961, pl. 2, fig. 9; Kanno, 1962, pl. 5, fig. 6; Iwai, 1965: 38, pl. 17, figs. 18a-b, 20.

Ciliatocardium ciliatum chikagawaense (Kotaka): Kafanov, 1980: 312.

? Clinocardium chikagawaense Kotaka, 1950: Matsui, 1985: 231, pl. 33, fig. 11.

Clinocardium ciliatum (Fabr.): Ogasawara et al., 1986, pl. 41, figs. ?3, 4; pl. 62, figs. 11a,b.

Non

Clinocardium chikagawaense Kotaka, 1950: Shimamoto and Koike, 1986: 38, pl. 5, figs. 1, 4, 6, 8a-b; pl. 6, fig. 10.

Etymology: The name is derived from the type-locality, Chikagawa.

Type-material: Holotype – IGPS no. 72999. Type-locality: the sea cliff at the outlet of Chikagawa River at Chikagawa, Tanabu-machi, Shimokita District, Aomori Prefecture, Honshu, Japan; Pliocene Hamada Formation.

Holotype dimensions: L = 58.4; H = 58.0; B = 21.0; A = 24.4.

Description: Shell medium-sized, trigonal-suborbicular, high or extended in height (average H/L ratio about 0.99), subequilateral (average A/L ratio about 0.42), convex (average B/L ratio about 0.36), faintly oblique and faintly bent, rather thick-walled. Postero-dorsal margin broadly arched, long, extending to prolonged posterior margin, than sharply merging into rather narrowly rounded ventral margin. Antero-dorsal margin not shouldered, roundly protruding into anterior margin. Angle of antero- and postero-dorsal margins at umbo is about 114°. Growth rings are distinct in later stage of growth but undistinct in young stages. Umbo tapering, moderate high, markedly incurved and directed anteriorly. Ribs 30-40 in number, wrinkled, crossed by numerous fine concentric growth lines. Ribs mostly straight, sharp edged, broader than flatt-bottomed intercostal spaces sometimes shallowly excavated. Ligament area low, and narrow. Lunule circumscribed and heart-shaped. Cardinal teeth situated nearer to anterior laterals than to posterior. Recurved tooth *3b* stronger than *3a*. The tooth *AI* much stronger than *PI*. Muscle scars distinct, anterior one more oval than quadratic posterior one.

Comparison: This subspecies resembles Recent *Ciliatocardium ciliatum* (Fabricius, 1780) in many respects but can be distinguished by the more angularly or postero-ventrally elongated shell outline and by markedly incurved and directed anteriorly umbo.

Distribution: It is one of the most characteristic representstives of the Pliocene so-called Omma fauna in North Japan. Honshu: Hamada, Narusawa and Daishaka Formations of Aomori Prefecture; Sawane Formation of Niigata Prefecture; Shibikawa and Sasaoka Formation of the Akita oil-field. Setana Formation of Hokkaido.

Ciliatocardium ciliatum maruyamense Kafanov et Savizky, 1982

(Pl. 7, figs. 7, 8)

? Laevicardium (*Cerastoderma*) *shinjiense* (Yok.): Ilyina, 1954 [1957]: 223, pl. 16, figs. 6, 7, 8, 8a.

Ciliatocardium ciliatum maruyamense Kafanov and Savizky, 1982: 56, pl. 5, figs. 4, 5.

Non

Ciliatocardium ciliatum marujamensis Kafanov: Gladenkov et al., 1992, pl. 3, fig. 8.

Etymology: The name is derived from the type-locality, Maruyamskaya Suite.

Type-material: Holotype - PIN no. 28/3962. Type-locality: Malyi Takoy River, Dolinsk District, Sakhalin, Russia; lower sub-suite of Maruyamskaya Suite (stratotypical section), upper Miocene.

Holotype dimensions: L = 43.2; H = 41.0; B = 12.5; A = 15.7.

Description (see Table 6): Shell medium-sized, trigonal-suborbicular, high (average H/L ratio about 0.96), subequilateral (average A/L ratio about 0.42), medium convex (average B/L ratio about 0. 31), faintly oblique and faintly bent, rather thick-walled. Growth rings smoothed. Umbo medium height and medium wide, slightly marked by anterior umbonal cavity only. Ribs 28-35 in number (more often 29-32), rather wide and low, appreciablly bent on all external surface of valve. On anterior area ribs are a little placed, on posterior one pulled together and smoothed. Intercostal spaces are some narrower than ribs.

Comparison: From Recent North Pacific *C. ciliatum tchuktchense* Kafanov in Scarlato, 1981 it differs by relatively lesser average ribs number (29-32 agains 33-35) and by main conchometric parameters in regressions of H, B and A agains L (compare Tables 5 and 6). Paired comparison of regression coefficients shows significant statistical differences at highest significance level (P = 0.999). *Ciliatocardium ciliatum chikagawaense* well distinguishes by much higher shell.

Distribution: Upper Miocene lower-subsuite of Maruyamskaya Suite in South Sakhalin.

Material: 16 lots (32 specimens): GIN, VNIGRI, MGRI.

Table 6. Statistical values of basic morphometric characters in *Ciliatocardium ciliatum maruyamense* Kafanov et Savizky, 1982.

N = 25; y = L = 40.7 ± 0.9; σ_y = 4.6 ± 0.6; As_y = − 0.536; E_y = − 0.108;

Parameters	H	A	B	n
x	39.2±1.1	17.0±0.4	12.5±0.3	11.7±0.4
σ_x	5.4±0.8	1.8±0.3	1.6±0.2	2.1±0.3
As_x	-0.462	-0.132	-0.438	+0.399
E_x	-0.648	-0.084	+0.499	-0.717
r	0.994±0.001***	0.990±0.002***	0.985±0.004***	0.983±0.005***
r_{ix}	0.997±0.001***	0.993±0.002***	0.990±0.002***	0.990±0.003***
a	2.460	2.776	5.551	10.402
b	0.765±0.060	0.948±0.117	0.789±0.079	0.554±0.082
x/y	0.96±0.01	0.42±0.00	0.31 ±0.00	0.29±0.01
$\sigma_{x/y}$	0.04±0.01	0.02±0.00	0.01±0.00	0.03±0.00
$As_{x/y}$	+0.153	+0.343	-0.187	+0.352
$E_{x/y}$	-0.394	-0.749	+0.645	-0.203

Ciliatocardium likharevi Kafanov in Scarlato, 1981

(Pl. 7, figs. 9-16)

Cardium ciliatum (Fabricius): Scarlato, 1955, pl. 51, fig. 12.

Ciliatocardium likharevi Kafanov: Scarlato, 1981: 344, photo 312; Kafanov, 1981a: 58, text-figs. 1A; 4A-G.

Clinocardium (*Ciliatocardium*) *ciliatum* (Fabricius): Higo and Goto, 1993: 617 (part.).

Non

Ciliatocardium likharevi Kafanov.: Volova and Scarlato, 1991: 167.

Etymology: The name is derived in the honour of well-known Russian malacologist Prof. Iliya M. Likharev (Zoological Institute, Russian Academy of Sciences).

Type-material: Holotype- ZIsp no. 1/200274. Type-locality: Japan Sea, Tatar Strait, off Rakuma (now Antonovo Village), Sakhalin, Russia, depth 45-40 m, sand.

Holotype dimensions: L = 43.2; H = 41.0; B = 12.5; A = 15.7.

Description (see Table 7): Shell medium-sized, suborbicular or ellipsoid, high (average H/L ratio about 0.90), equilateral (average A/L ratio about 0.44), medium convex (average B/L ratio about 0.30), non-oblique and unbent, rather thick-walled. Short anterior branch of hinge margin is clearly concave and is put forward to the valves comissure plane. Growth rings usually smoothed. Umbo tapering, moderate wide, well marked at least by anterior umbonal cavity. Ribs 33-40 (36-37 in average) in number, rather low, with almost straight shape of slope. Three most forward ribs are shortened, strong flattened and in cross section have almost rounded form. Ribs covered by numerous concentric periostracal wrinkles. Hinge plate rather wide. The teeth *AI* and *AIII* misses under some corner, the last one is considerably weakened. The teeth *2* and *4b* settle down to each other under a corner approximately 90 °. The straight line nymph is equal to length of a tooth *PI*. Lunula precise, lanceolate.

Comparison: From *C. ciliatum* (Fabricius, 1780) it differs by equilateral, non-oblique and unbent shell, by concave anterior branch of dorsal margin and by relatively shorter nymph (in average no more than 1/5 of the shell length).

Taxonomical notes: The taxonomic independence of this true sibling species is strictly proved by the statistical analysis at its joint sites with *C. ciliatum tchuktchense* (see Kafanov, 1981a).

Ecology: It meets on depths from 33 m (Aniwa Bay) up

Table 7. Statistical values of basic morphometric characters in *Ciliatocardium likharevi* Kafanov in Scarlato, 1981.

N = 25; y = L = 20.7 ± 2.1; σ_y = 9.8 ± 1.5; As_y = + 0.411; E_y = + 0.629;

Parameters	H	A	B	n
x	18.7±2.0	9.1±0.9	6.1±0.6	3.8±0.5
σ_x	8.9±1.4	4.2±0.6	2.8±0.4	2.1±0.3
As_x	+0.357	+0.369	+0.364	+0.481
E_x	+0.447	+0.495	+0.575	+0.562
r	0.999±0.000***	0.995±0.002***	0.994±0.003***	0.981±0.008***
r_{ln}	0.999±0.000***	0.993±0.003***	0.988±0.005***	0.969±0.013***
a	1.080	2.244	3.388	6.664
b	0.976±0.012	1.018±0.029	1.023±0.037	0.818±0.048
x/y	0.90±0.00	0.44±0.00	0.30±0.00	0.18±0.00
$\sigma_{x/y}$	0.02±0.00	0.02±0.00	0.02±0.00	0.02±0.00
$As_{x/y}$	+0.378	-0.208	+0.201	-0.112
$E_{x/y}$	-0.472	-0.055	-0.377	-0.295

to 117 m (South Kurile shallow-water) on mud and, less often, on sand at Augist near-bottom temperature from -0.3°C (Aniwa Bay) up to 12.8 °C (South Kurile shallow-water).

Distribution: Japan Sea: off south Primorye Territory, including Peter the Great Bay, southwestern Sakhalin, Russia; Okhotsk Sea: Aniwa and Terpeniya Bays; South Kurile shallow-water. Fresh empty valves are found off Nagasaki, Kyushu.

Material: 22 lots (26 specimens): ZIsp, Museum of Institute of Marine Biology (Vladivostok City).

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Explanation of Plate 1

Figs. 1-11, 18. *Ciliatocardium ciliatum ciliatum* (Fabricius, 1780).
Lectotype of *Cardium ciliatum* Fabricius, 1780 - ZMK, without reg. no.; left valve exterior (fig. 1) and interior (fig. 2), right valve exterior (fig. 3) and interior (fig. 4). Greenland; Recent.
Paralectotype of *Cardium ciliatum* Fabricius, 1780 - ZMK, without reg. no.; left valve exterior (fig. 5) and interior (fig. 6), right valve exterior (fig. 7) and interior (fig. 8). Greenland; Recent.
Possible syntype of *Cardium arcticum* Sowerby, 1841 - BMNH no. 1975618; left valve exterior (fig. 9), right valve exterior (fig. 10) and interior (fig. 11); "Arctic seas"; Recent.
Original figure reproduction (Chemnitz, 1782, Taf. 19, Fig. 195) of *Cardium islandicum* Bruguière, 1789; right valve exterior (fig. 18); Iceland (?); Recent.

Fig. 12. *Ciliatocardium ciliatum dawsoni* (Stimpson, 1863).
Original figure reproduction (Stimpson, 1863: 58, text-fig.) of *Cardium dawsoni* Stimpson, 1863; Cape Hope, on the southeast side of Hudson's Bay, Arctic Canada; Pleistocene (?).

Figs. 13-17. *Ciliatocardium ciliatum* (Fabricius, 1780).
Lectotype of *Cardium californiense* var. *comoxense* Dall, 1900 - USNM no. 427772; left (fig. 13) and right (fig. 14) valve exterior, left (fig. 15) and right (fig. 16) valve interior; Vancouver Island, British Columbia, Canada; Pleistocene.
Holotype of *Ciliatocardium olchovensis* Petrov, 1982 - GIN no. 23/3829; external cast of left valve (fig. 17); Pamyatnyi Stream, Kamchatskiy Peninsula, east Kamchatka, Russia; lower sub-suite of Ol'khovskaya Suite, Eopleistocene.

All figures in natural size.

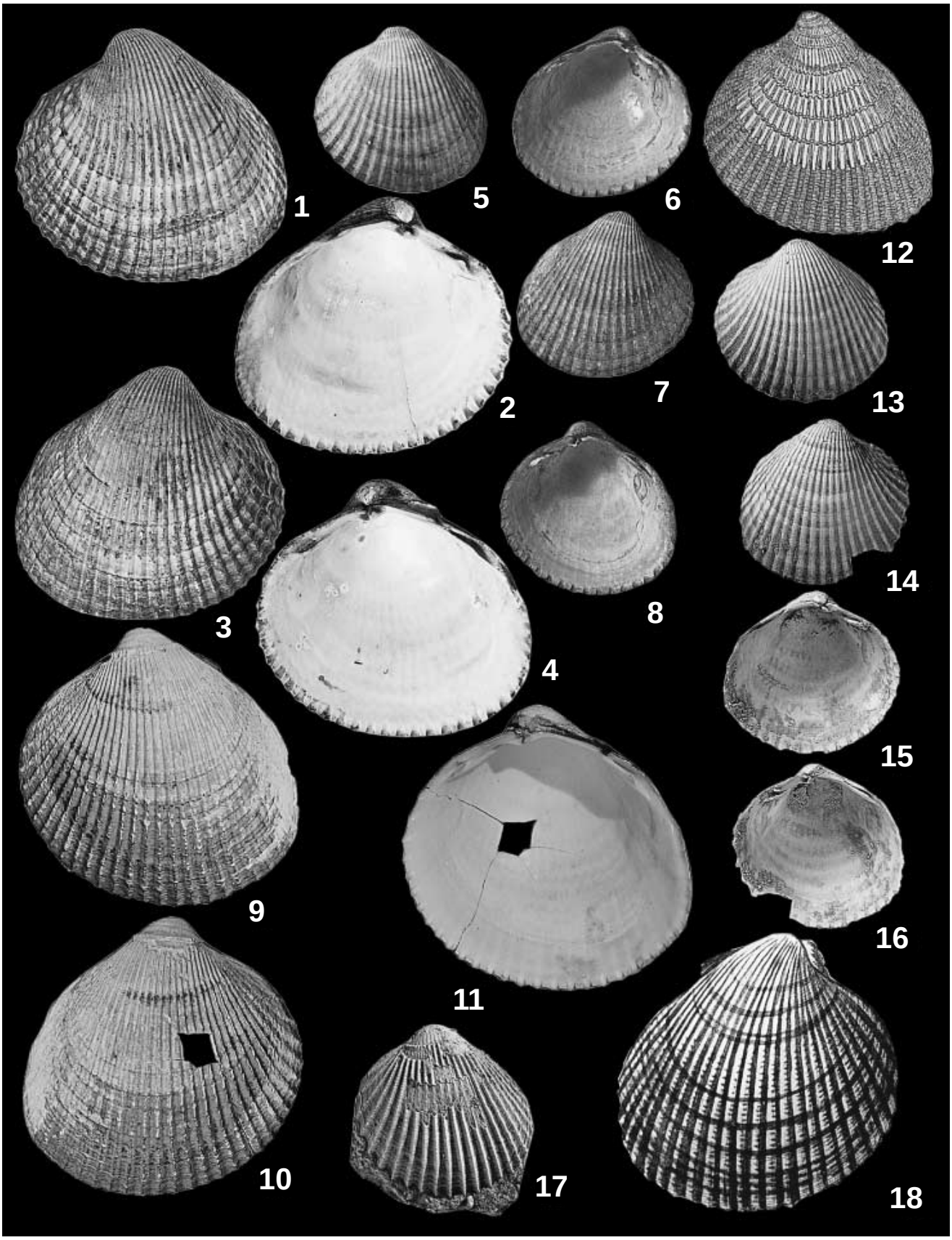

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Plate 2

Figs. 1-13. *Ciliatocardium ciliatum ciliatum* (Fabricius, 1780).
Iceland; ZIsp - cat. no. 1; left valve exterior (fig. 1) and interior (fig. 2), right valve exterior (fig. 3) and interior (fig. 4).
White Sea, off Belaya Inlet, depth 14 m, muddy sand; ZIsp - cat. no. 126; left valve exterior (fig. 5) and interior (fig. 6), right valve exterior (fig. 7) and interior (fig. 8).
Barents Sea, 70 °58 'N 41 °25 'E, depth 79 m, pebbles; ZIsp - cat. no. 67; right valve exterior (fig. 9) and interior (fig. 10), left valve interior (fig. 11).
Barents Sea, 69 °36.5 'N 32 °13.5 'E, depth 162 m; ZIsp - cat. no. 60; right (fig. 12) and left (fig. 13) valves exterior.

All figures in natural size.

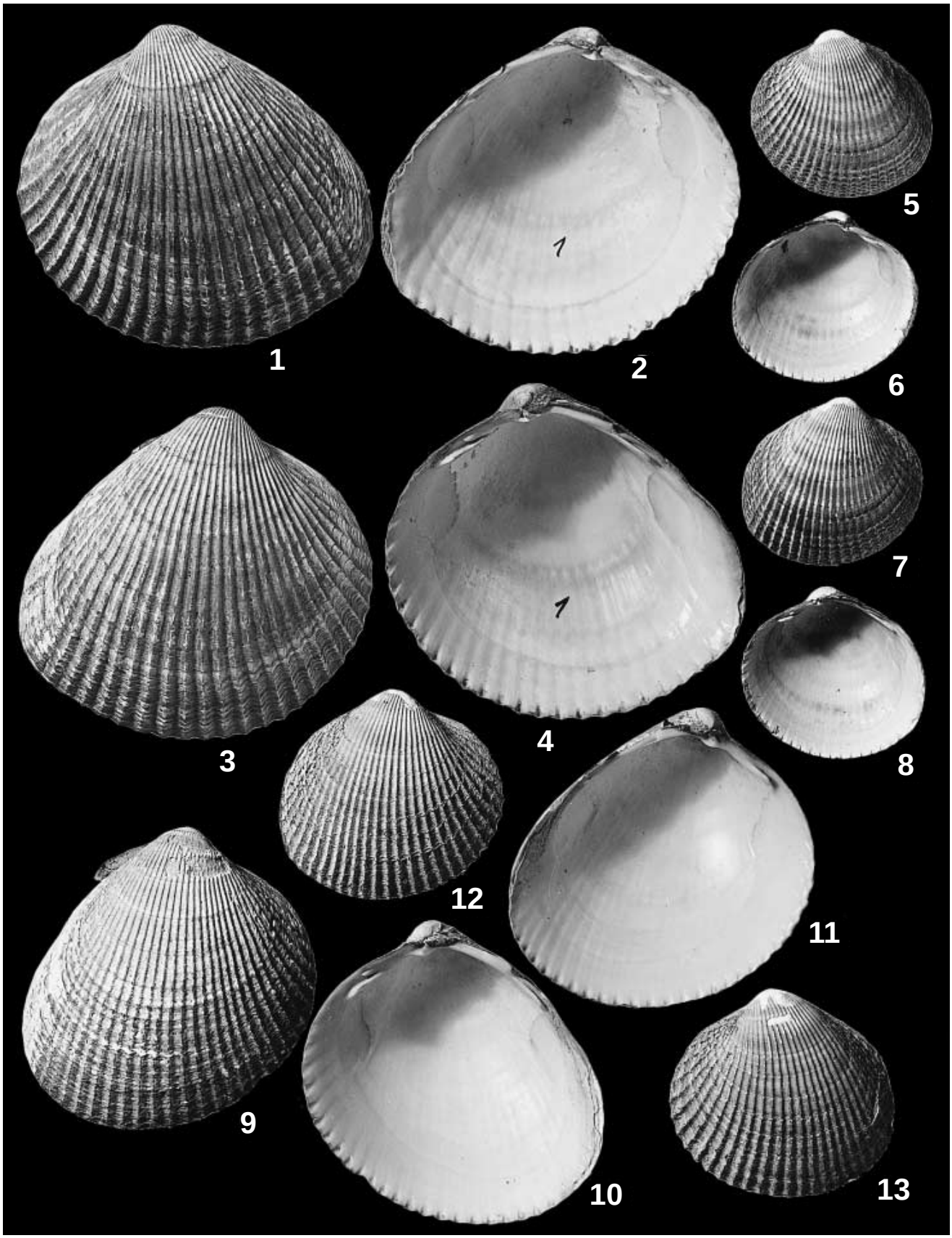

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Plate 3

Figs. 1-4. *Ciliatocardium ciliatum nordenskioeldi* Kafanov, 1981.
Holotype - ZIsp no. 1/200156; left valve exterior (fig. 1) and interior (fig. 2), right valve exterior (fig. 3) and interior (fig. 4); Laptev Sea, Komsomol'skoy Pravdy Islands, between Angreya Island and Samuila Island, depth 37 m, mud.

Figs. 5-8. *Ciliatocardium ciliatum ochotense* Kafanov, 1981.
Holotype - ZIsp no. 1/200366; left valve interior (fig. 5) and exterior (fig. 6), right valve exterior (fig. 7) and interior (fig. 8); north coast of Okhotsk Sea, west from Tauyskaya Inlet, depth 121 m, mud.

Figs. 9-12. *Ciliatocardium ciliatum pubescens* (Couthouy, 1838).
Off Newfoundland, east Canada, 43°07.5′N 50°22.5′W, depth 43 m; ZIsp - cat. no. 1; right valve exterior (fig. 9) and interior (fig. 10), left valve exterior (fig. 11) and interior (fig. 12).

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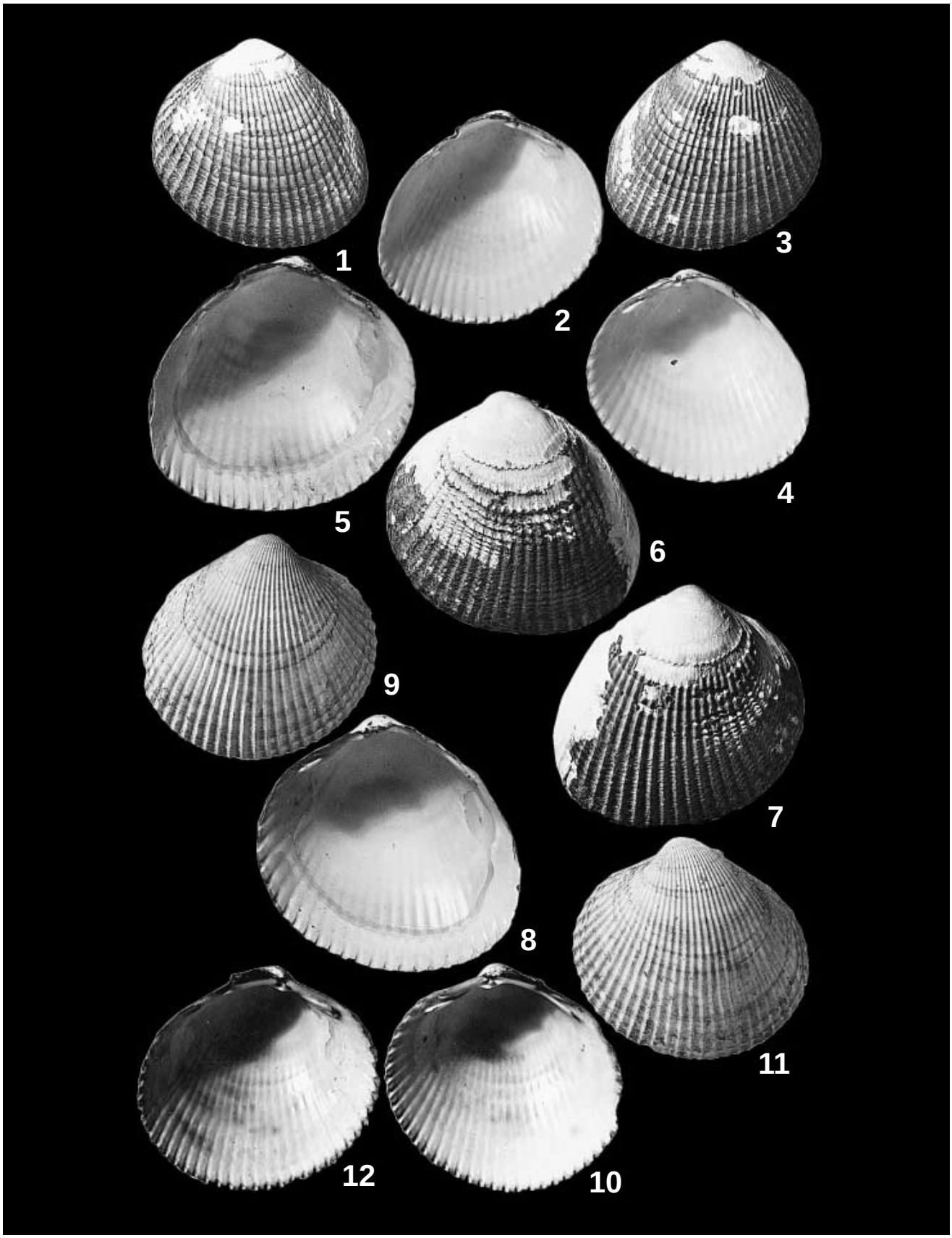

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Plate 4

Figs. 1-4. *Ciliatocardium ciliatum tchuktchense* Kafanov in Scarlato, 1981.
Chukotka Peninsula, Russia, Provideniya Bight, depth 22-11 m, mud; paratype - ZIsp cat. no. 2; left valve exterior (fig. 1) and interior (fig. 2), right valve interior (fig. 3) and exterior (fig. 4).

Fig. 5. *Ciliatocardium ciliatum pubescens* (Couthouy, 1838).
Original figure reproduction (Couthouy, 1838: 61, pl. 3, fig. 6) of *Cardium pubescens* Couthouy, 1838; Massachusetts Bay, Massachusetts, U.S.A.

Figs. 6-7. *Ciliatocardium ciliatum* cfr. *dawsoni* (Stimpson, 1863).
Arctic coast of Alaska, 71°31'20"N 156°23'W, Pleistocene (?); ZIsp no. 1/13466 (former CAS no. 34343); left valve exterior (fig. 6) and interior (fig. 7).

Figs. 8-9. *Ciliatocardium ciliatum* (Fabricius, 1780).
Holotype of *Papyridea sertunayanum* Slodkewitsch, 1938 - CNIGRM no. 185/5294; deformed external cast of right valve (fig. 8); between the mouthes of Noyami and Malyi Sertunay Rivers, Aleksandrovsk-Sakhalinsky District, Sakhalin, Russia; middle Miocene Aleksandrovskaya and/or Sertunayskaya Suite.
CNIGRM no. 142/5294; right valve exterior (fig. 9); the same locality as fig. 8.

Fig. 10. *Ciliatocardium ciliatum ciliatum* (Fabricius, 1780).
Possible syntype of *Cardium arcticum* Sowerby, 1841 - BMNH no. 1975618; left valve interior; “Arctic seas”; Recent.

All figures in natural size.

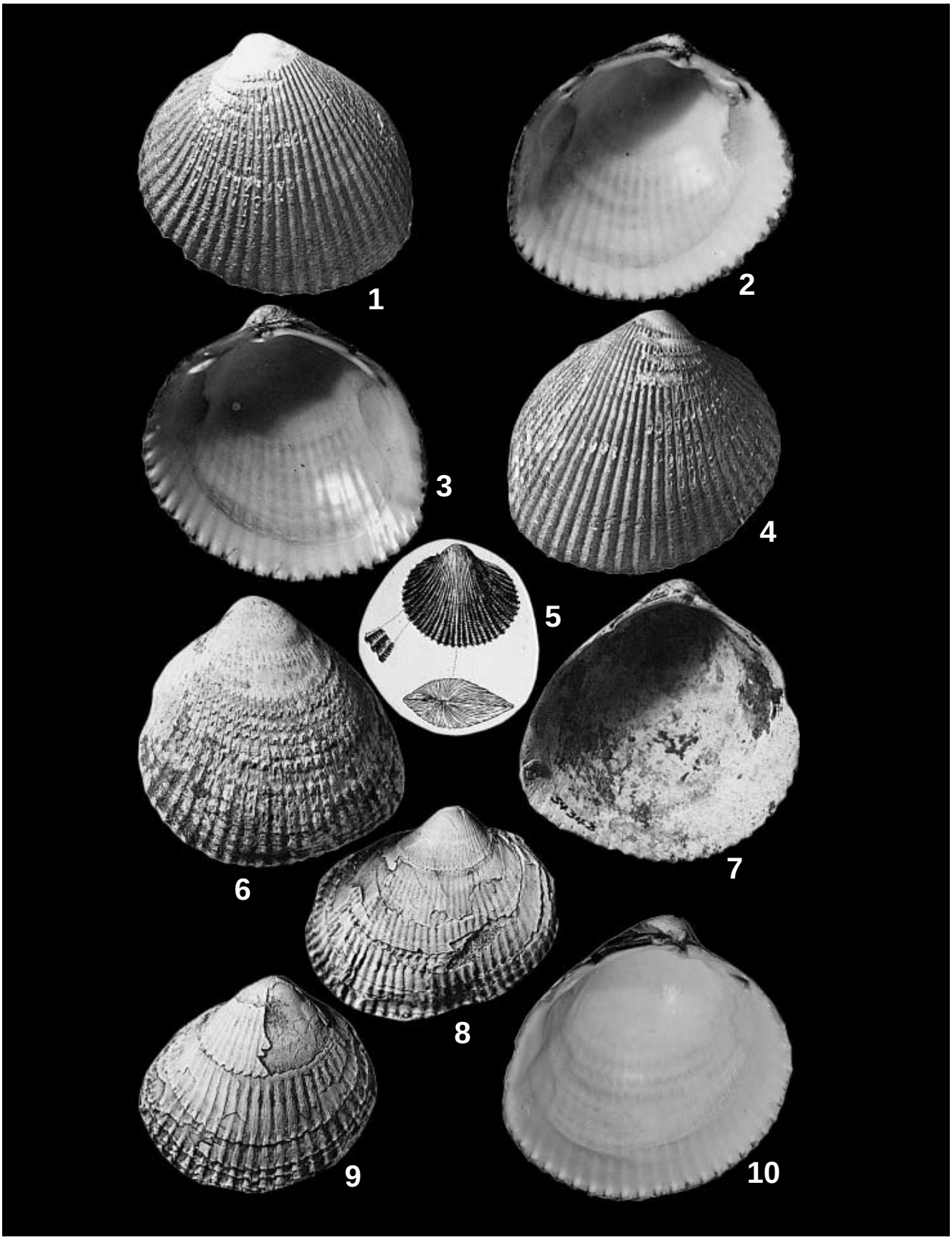

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Plate 5

Figs. 1-13. *Ciliatocardium ciliatum nordenskioeldi* Kafanov, 1981.

Laptev Sea, Komsomol'skoy Pravdy Islands, between Angreya Island and Samuila Island, depth 37 m, mud; ; paratype - ZIsp cat. no. 10; left valve exterior (fig. 1) and interior (fig. 2), right valve exterior (fig. 3) and interior (fig. 4).

Laptev Sea, off Severnaya Zemlya Archipelago, depth 40 m; paratype - ZIsp cat. no. 45; left (fig. 5) and right (fig. 6) valves exterior.

Central part of Barents Sea, depth 65 m; paratype - ZIsp cat. no. 4; left (fig. 7) and right (fig. 8) valves exterior, left (fig. 9) and right (fig. 10) valves interior.

Kara Sea, off entrance of Karskie Vorota Strait; paratype - ZIsp cat. no. 41; right valve exterior (fig. 11) and interior (fig. 12), left valve exterior (fig. 13).

Figs. 14-18. *Ciliatocardium ciliatum ochotense* Kafanov, 1981.

Okhotsk Sea, Nagaeva Bight; paratype - ZIsp cat. no. 8; right valve exterior (fig. 14).

Okhotsk Sea, Nagaeva Bight; paratype - ZIsp cat. no. 6; right valve exterior (fig. 15) and interior (fig. 16), left valve exterior (fig. 17).

Northwestern coast of Okhotsk Sea; paratype - ZIsp cat. no. 7; left valve exterior (fig. 18).

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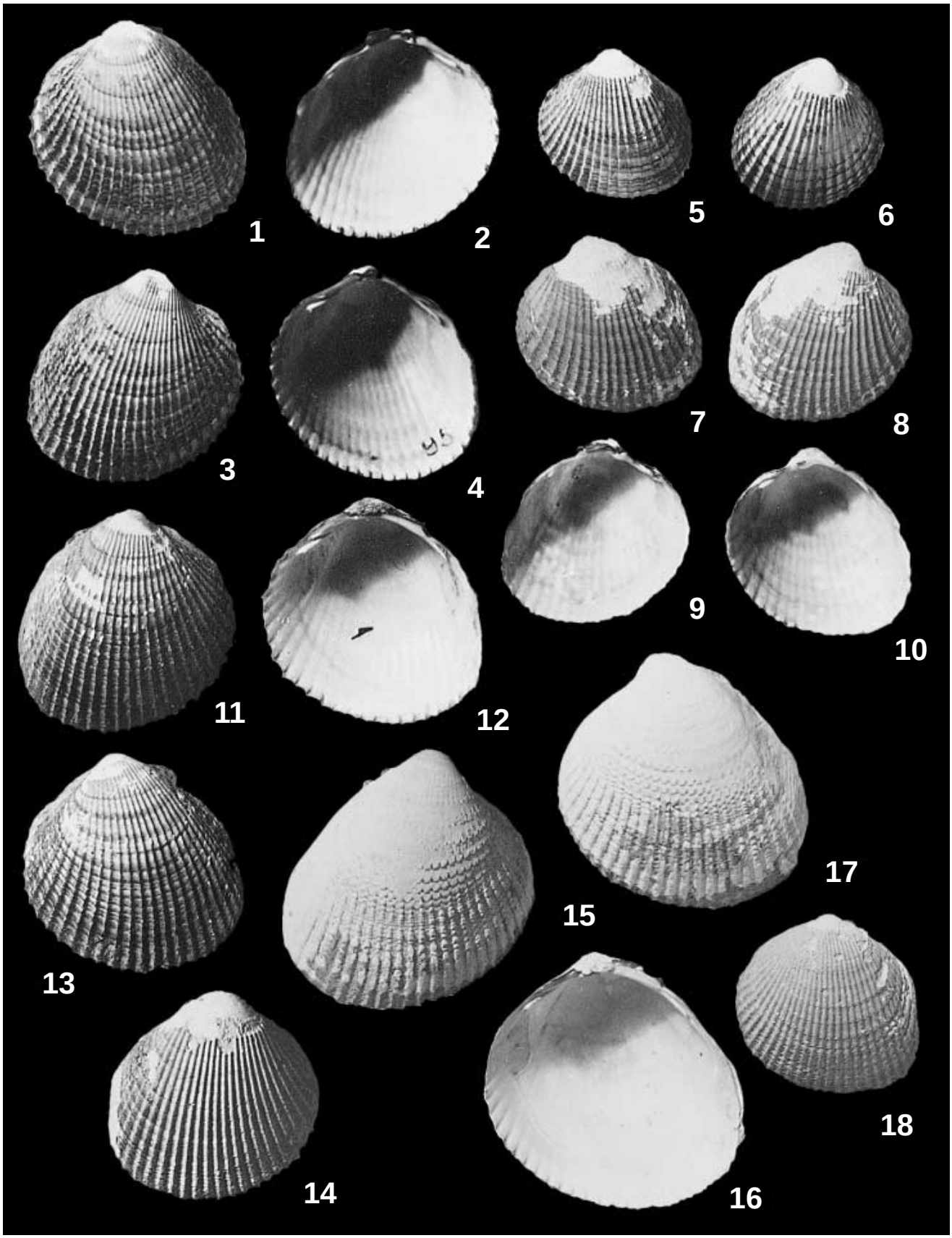

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Plate 6

Figs. 1-6, 13-15. *Ciliatocardium ciliatum* tchuktchense Kafanov in Scarlato, 1981.
Holotype - Zisp no. 1/200291; left valve exterior (fig. 1) and interior (fig. 2), right valve exterior (fig. 3) and interior (fig. 4).
Bering Sea, Provideniya Bight, depth 22-11 m; paratype - ZIsp cat. no. 43; left (fig. 5) and right (fig. 6) valves exterior.
Bering Sea, Bristol Bay; paratype - ZIsp cat. no. 149; left (fig. 13) and right (fig. 14) valves exterior, right valve interior (fig. 15).

Fig. 7-12. *Ciliatocardium ciliatum pubescens* (Couthouy, 1838).
Off Newfoundland, 44 °56.4 'N 49 °01.7 'W, east Canada; ZIsp cat. no. 4; left (fig. 7) and right (fig. 8) valves exterior.
Off Newfoundland, 43 °07.5 'N 50 °22.5 'W, east Canada; ZIsp cat. no. 1; left valve exterior (fig. 9) and interior (fig. 10), right valve exterior (fig. 11) and interior (fig. 12).

All figures in natural size.

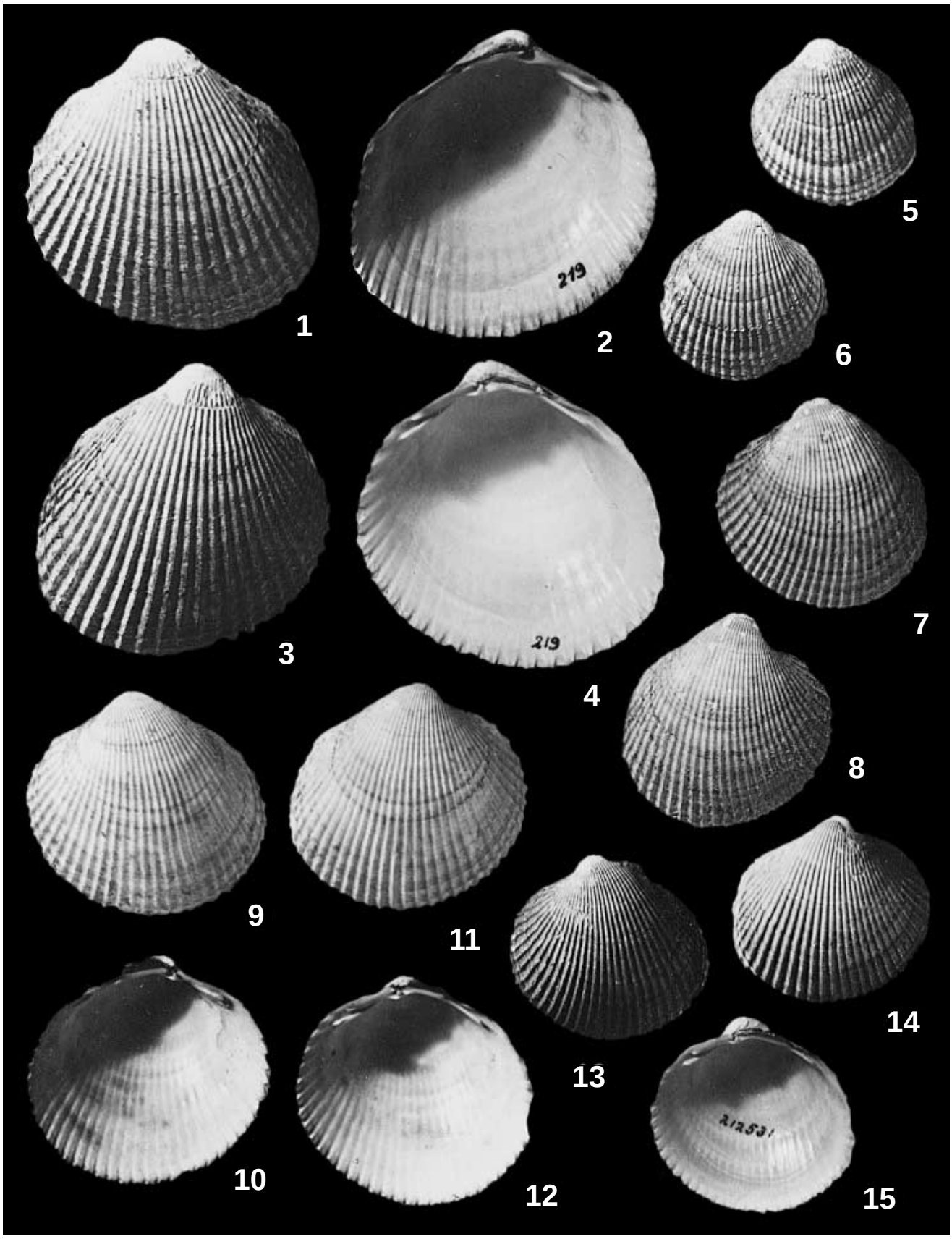

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Plate 7

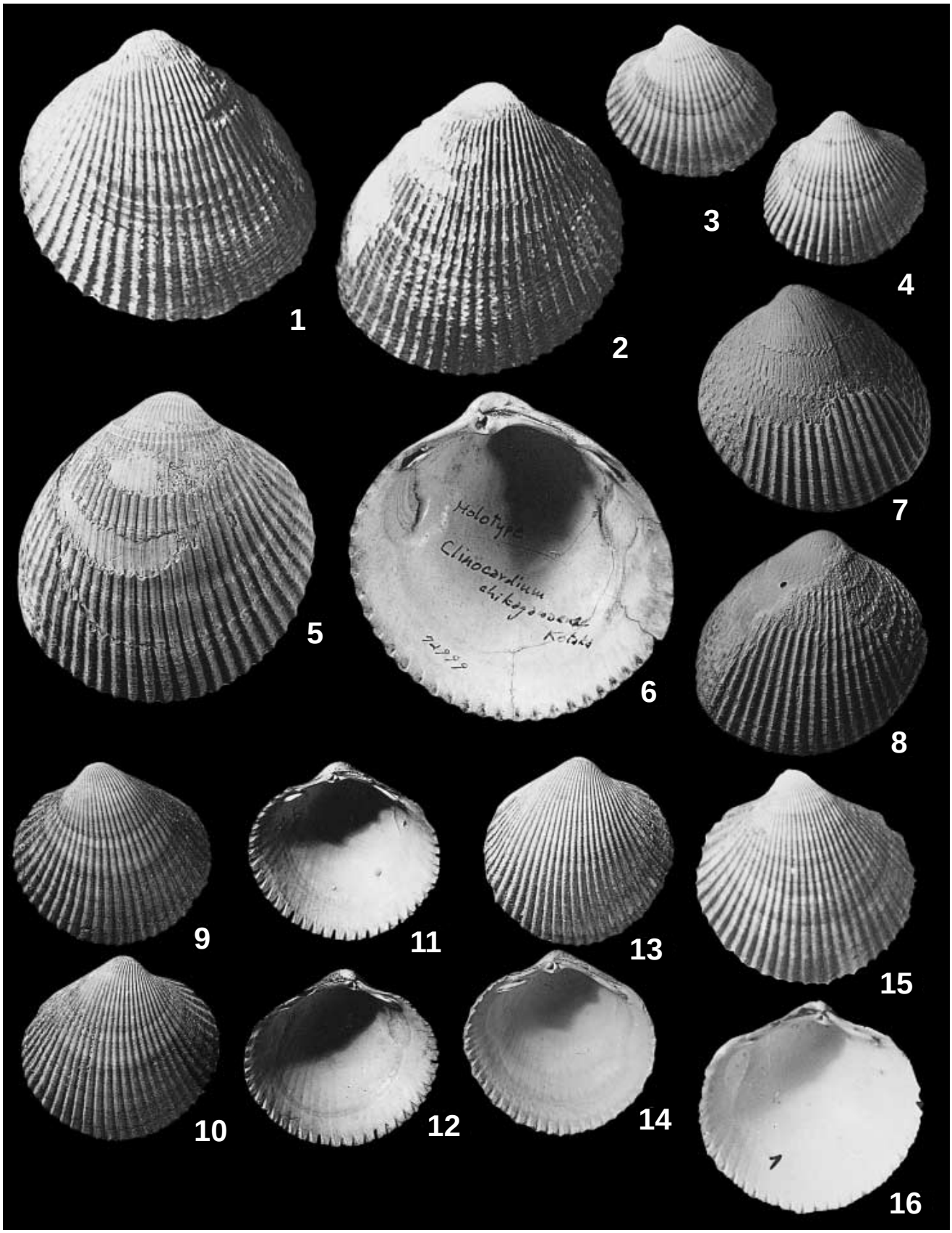
Figs. 1-4. *Ciliatocardium ciliatum tchuktchense* Kafanov in Scarlato, 1981.
Okhotsk Sea, southern Sakhalin, southwestern part of Terpeniya Bay, depth 40 m; paratype - ZIsp cat. no. 96; left (fig. 1) and right (fig. 2) valves exterior.
Bering Sea, Anadyrskiy Bay, depth 25 m; paratype - ZIsp cat. no. 43; left (fig. 3) and right (fig. 4) valves exterior.

Figs. 5-6. *Ciliatocardium ciliatum chikagawaense* (Kotaka, 1950).
Holotype of *Clinocardium chikagawaense* Kotaka, 1950 - IGPS no. 72999; right valve exterior (fig. 5) and interior (fig. 6); the sea cliff at the outlet of Chikagawa River at Chikagawa, Tanabu-machi, Shimokita District, Aomori Prefecture, Honshu, Japan; Pliocene Hamada Formation.

Figs. 7-8. *Ciliatocardium ciliatum maruyamense* Kafanov et Savizky, 1982.
Holotype - PIN no. 28/3962; external cast of left (fig. 7) and right (fig. 8) valves; Malyi Takoy River, Dolinsk District, Sakhalin, Russia; lower sub-suite of Maruyamskaya Suite (stratotypical section), upper Miocene.

Figs. 9-16. *Ciliatocardium likharevi* Kafanov in Scarlato, 1981.
Holotype - ZIsp no. 1/200274; left (fig. 9) and right (fig. 10) valves exterior, right (fig. 11) and left (fig. 12) valves interior; Japan Sea, Tatar Strait, off Rakuma (now Antonovo Village), Sakhalin, Russia, depth 45-40 m, sand.
Off Nagasaki, Kyushu, Japan; paratype - ZIsp cat no. 22/200290; right valve exterior (fig. 13) and interior (fig. 14).
South Kurile shallow-water, between Kunashir and Shikotan Islands; paratype - ZIsp cat. no. 8; left valve exterior (fig. 15) and interior (fig. 16).

All figures in natural size.


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