Bulletin of the Mizunami Fossil Museum, no. 29 (2002), p. 1-18 , 3 pls., 1 fig., 4 tables.

# Recent and fossil Clinocardiinae (Bivalvia, Cardiidae) of the World. VI. Genus *Ciliatocardium* Kafanov, 1974 (part II)

Alexander I. Kafanov

Institute of Marine Biology, Far East Branch of the Russian Academy of Sciences,
17 Palchevsky Str., Vladivostok 690041, Russia <kafanov@mail.primorye.ru>

**Abstract**

*Ciliatocardium ainuanum* (Yokoyama, 1927), *C. asagaiense* (Makiyama, 1934), *C. brooksi* (Clark, 1932), *C. carlsbergianum* Kafanov, sp. nov., *C. coosense* (Dall, 1909), *C. ermanense* (Sinelnikova in Sinelnikova *et al*., 1976), *C. evsseevi* Kafanov et Savizky, 1982, *C. hataii* (Hayasaka, 1956), *C. iwatense* (Chinzei, 1959), ?*C. kirkerense* (Clark, 1918), *C. makiyamae* (Kamada, 1962), *C. matchgarense* (Makiyama, 1934), *C. moorae* Kafanov, sp. nov., *C. mutuense* (Nomura et Hatai, 1936), *C. obstinatus* (Barinov in Gladenkov *et al*., 1992), *C. reedi* (Loel et Corey, 1932), *C. sachalinense* (Khramova, 1962), *C. schmidti* (Khramova, 1962), *C. shinjiense* (Yokoyama, 1923), *C. smekhovi* Kafanov et Savizky, 1982, *C. tigilense* (Slodkewitsch, 1938), *C. uyemurai* (Kanehara, 1937), *C. yakatagense* (Clark, 1932), *C. yamasakii* (Makiyama, 1934) and *C. zhidkovae* Kafanov in Arkhipova *et al*., [1994] are described from Paleogene and Neogene deposits of Japan, Russian Far East (Sakhalin Kamchatka and Koryak Upland) and the Pacific coast of North America. The lectotype is established for *Cardium* (*Cerastoderma*) *coosense* Dall, 1909.

*Key words*: Recent, fossil, Clinocardiinae, Bivalvia, Cardiidae, *Ciliatocardium*

## *Ciliatocardium ainuanum* (Yokoyama, 1927)

(Pl. 1, figs. 1-3)

*Cardium ainuanum* Yokoyama, 1927b, 202, pl. 51, figs. 5-7.
*Clinocardium ainuanum* (Yokoyama): Makiyama, 1959, pl. 62, figs. 5-7 (holotype reproduced).
*Ciliatocardium ainuanum* (Yokoyama): Kafanov, 1980, 312.
?*Laevicardium* (*Papyridea*) *harrimani* (Dall): Noda, Y., 1992, 71.

*Etymology*: The name, most probably, is derived from the ainu, former aborigen inhabitants of Hokkaido and Kurile Islands or from Ainonai Formation in Eastern Hokkaido.

*Type-material and type-locality*: Lectotype (designated as "holotype" by Hatai and Nisiyama, 1952, 35) and paralectotypes are stored in UMUT no. CM26358 (lectotype), no. CM26356 and CM26357 (paralectotypes). Type-locality: Sankebetsu, Haboro-machi, Tomamae District, Teshio Province, Hokkaido, Japan; Miocene Haboro Formation.

Lectotype dimensions: L = ca. 34.3; H = ca. 32.1; B = ca. 7.8; A = ca. 16.2.

*Description*: Shell small (up to 40 mm), subcircular, high (average H/L ratio about 0.94), equilateral (average A/L ratio about 0.47), medium or moderately convex (average B/L ratio about 0.23), non-oblique and unbent, rather thin-walled. Valve rounded in front, obliquely subtruncate behind, broadly arched at ventral margin.

Beak not distinguished by anterior and/or posterior umbonal cavities and posterior slope of beak forms rather regular arch with posterior branch of hinge margin. Beak low-sized, tapering. Surface with straight radiating ribs about forty in number. Ribs separated by V-shaped interspaces which are equal to ribs breadth. Among well-preserved shells (e.g. lectotype) ribs, in their bend, are backwardly directed in convexity.

*Comparison*: Most similar *C. asagaiense* (Makiyama, 1934) differs by more convex and more inequilateral shell (average B/L and A/L ratios are 0.24 and 0.23, 0.43 and

0.47 accordingly).

*Taxonomic notes*: As Yokoyama (1927b) pointed out, although the specimens are not rare in the type-locality, they are all incomplete, many being decorticated.

Uozumi *et al*. (1966) noted that this species was referred to the genus *Papyridea*, and that *Papyridea ainuanum* (Yokoyama) indicated an Early Miocene age in Japan. This attribution is undoubtedly erroneous because *Papyridea* (*Profulvia*) characters (gaping of shell; ribs, in their bend, are forwardly directed in convexity; opisthogyrate or almost orthogyrate beak) differ well from those in *C. ainuanum*.

*Distribution*: The true *C. ainuanum* are known from the type-locality only - Miocene Haboro Formation in Hokkaido.

### *Ciliatocardium asagaiense* (Makiyama, 1934)

(Pl. 1, figs. 4, 5)

*Cardium shinjiensis* Yokoyama: Yokoyama, 1924, 16, pl. 3, figs. 13-15.

*Cardium* (*Cerastoderma*) *asagaiense* Makiyama, 1934, 139 (an part?), pl. 5, figs. 20, 22, 23.

*Clinocardium asagaiense* (Makiyama): Hirayama, 1955, 97 (part.), pl. 2, figs. 2, 3, 5-9, 23; Kamada, 1962, 101, pl. 10, figs. 8-14; Honda, 1981, 131; Oyama *et al*., 1960, 177, pl. 54, figs. 3a-d; Gladenkov *et al*., 1987, pl. 10, figs. 1, 11, 19.

*Clinocardium shinjiense* (Yokoyama): Hirayama, 1955, 96, pl. 2, figs. 4, 10.

?*Laevicardium* (*Cerastoderma*) cf. *asagaiense* Mak. : Krishtofovich, [1957], pl. 16, fig. 3.

*Laevicardium* (*Cerastoderma*) *salvationemense* Laut. MS: Krishtofovich, [1957], pl. 16, figs. 7, 9, 10.

*Clinocardium salvationemense* (Lautenschläger): Khramova, 1962, 438, pl. 1, figs. 8-12.

? *Clinocardium* cf. *asagaiense* (Makiyama): Ilyina, 1963, 49, pl. 14, figs. 3-5.

*Ciliatocardium asagaiense* (Makiyama): Kafanov, 1980, 312.

? *Clinocardium asagaiense* (Makiyama): Devjatilova and Volobueva, 1981, 75, pl. 27, figs. 3-6.

*Ciliatocardium asagaiense* (Makiyama): Kafanov and Savizky, 1982, pl. 5, figs. 15-17; Arkhipova *et al*., [1994], 205, pl. 33, figs. 6, 9, 11, 18, 19; Gladenkov *et al*., 1999, pl. 4, figs. 5, 9.

*Etymology*: The name is derived from the type-locality – Asagai Formation.

*Type-materials and type-localities*: *Cardium* (*Cerastoderma*) *asagaiense* Makiyama, 1934 – holotype is stored in Institute of Geology and Mineralogy, Kyoto University, no. 350011. Type-locality: Taira, Yotsukura, Iwaki District, Fukushima Prefecture, Honshu, Japan; Oligocene Shiramizu Group, Asagai Formation.

Holotype dimensions: L = ca. 22.1; H =20.6; B = ca. 6.4; A = 9.1.

*Clinocardium salvationemense* Lautenschläger in Khramova, 1962–holotype is stored in CNIGRM no. 84/6197. Type-locality: Sea coast near Spasennyi Point, Aleksandrovsk-Sakhalinskiy District, Sakhalin, Russia; Oligocene Gennoyshinskaya Suite.

Holotype dimensions: L = 16.6; H = 13.6; B = 4.8; A = 6.8.

Table 1. Statistical values of basic morphometric characters in *Ciliatocardium asagaiense* (Makiyama, 1934).

N = 56; y = L = 16.1±0.7; sy = 5.4±0.5; Asy = +0.724; Ey = –0.469;

| Parameters | H | A | B |
|---|---|---|---|
| x | 14.8±0.7 | 6.9±0.3 | 3.8±0.2 |
| $б_x$ | 5.3±0.5 | 2.6±0.2 | 1.3±0.1 |
| $As_x$ | +0.858 | +0.829 | +1.050* |
| $E_x$ | −0.270 | −0.159 | −0.242 |
| r | 0.986±0.004*** | 0.965±0.009*** | 0.915±0.022** |
| $r_{ln}$ | 0.985±0.004*** | 0.968±0.007*** | 0.914±0.021** |
| a | 1.305 | 2.935 | 4.511 |
| b | 0.934±0.004 | 0.881±0.008 | 0.950±0.009 |
| x/y | 0.91±0.01 | 0.43±0.01 | 0.24±0.00 |
| $б_{x/y}$ | 0.05±0.00 | 0.04±0.00 | 0.03±0.00 |
| $As_{x/y}$ | −0.287 | +0.034 | −0.541 |
| $E_{x/y}$ | +0.305 | −0.984 | −0.374 |

Notation admitted here and in tables AA 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 $\mathbf{ln\ y = ln\ a + b \cdot ln\ x}$; quotation of the type **x/y** = 0.89±0.00 denotes that SD<0.005.

*Description* (see Table 1): Shell small-sized or minute, trigonal-suborbicular, moderately high (average H/L ratio about 0.91), slightly inequilateral (average A/L ratio about 0.43), medium convex (average B/L ratio about 0.24), faintly oblique, unbent, rather thin-walled. Posterior flexure represented by an obtuse ridge extending from the beaks to the postero-ventral corner, the area behind the ridge is slightly depressed but not deflexed as in *Keenocardium californiense*. Incremental striae and growth rings are ill-defined.

Beak slightly distinguished by anterior umbonal cavity, moderate high and medium wide. Sculpture consisting of 35 to 40 radial ribs, which are elevated, narrow, rounded

at the tops and separated by interspaces of about equal breadth.

*Comparison*: Most similar *C. ainuanum* (Yokoyama, 1927) differs by more flattened and more equilateral shell (average B/L and A/L ratios are 0.23 and 0.24, 0.47 and 0.43 accordingly). Posterior flexure represented by an obtuse ridge is indistinguishable among *C. ainuanum*. Another similar species, *C. makiyamae* (Kamada, 1962) differs by more obliquely trigonal outline of the shell and by fewer ribs number.

*Taxonomic notes*: Makiyama (1934, 140) falls this species into "Species group of *Cardium* (*Cerastoderma*) *californiense* Deshayes" and also writes: "The real features of the sculpture were known by some outer casts. The models of these show the ribs are narrower and more elevated than in *C. californiense.* Yokoyama has assigned this form to his *C. shinjiense,* a Japanese Neogene species very closely related to *C. ciliatum* Fabricius, 1780... The sculpture type is not of *C. ciliatum* group, but decidedly *C. californiense*". However, already Hirayama (1955) pointed out that *C. asagaiense* can be subdivided into three varieties represented by the features of radial ribs and interspaces, and Kamada (1962) described two new subspecies, *Clinocardium asagaiense makiyamae* and *C. a. arakawae*, differing by the structure of radial ribs. The latter is assigned as separate species in *Keenocardium* (Kafanov, 1974).

Marking essential proximity of *Clinocardium salvationemense* to *Ciliatocardium asagaiense*, Khramova (1962) supposes that the first differs by very small-sized shell and by diverse stratigraphical position. It is true synonym of *C. asagaiense*.

*Distribution*: It is common species of Oligocene Asagai Formation in Fukushima Prefecture, Japan. In Sakhalin it is rather wide distributed in Paleogene upper part of Krasnopol'evskaya, Machigarskaya, Takaradayskaya, Gastellovskaya, Arakayskaya and Gennoyshinskaya Suites marking Shebunin and Lesogor stratigraphical horizons. Similar forms are reported from lower part of Pakhachinskaya Suite in Eastern Kamchatka.

*Materials seen*: 67 samples, 109 specimens (PIN, GIN, VNIGRI, CNIGRM).

### *Ciliatocardium brooksi* (Clark, 1932)

(Pl. 1, fig. 11)

*Cardium* (*Papyridea*) *brooksi* Clark, 1932: 812, pl. 18, fig. 5.

non *Cardium* (*Cerastoderma*) *ciliatum brooksi* MacNeil in MacNeil *et al*., 1943: 91, pl. 15, fig. 14.

*Clinocardium brooksi* (Clark): Addicott *et al*., 1971, Fig. 4*f* (holotype reproduced).

? *Ciliatocardium brooksi* (Clark): Kafanov, 1980, 312.

*Etymology:* "This species is named in honor of Dr. A. H. Brooks, who has contributed much valuable work on the geology of Alaska" [e.g. Brooks, 1906].

*Type-material and type-locality*: Holotype – UCMP no. 30402. Type-locality: Yakataga District (about 60° N), Gulf of Alaska, Alaska, U.S.A.; Pool Creek Formation, Upper Oligocene and/or Lower Miocene.

Holotype dimensions: L = 35.6; H = 31.5; B = 7.8; A = 11.3.

*Description*: Shell small or medium-sized, semiquadrate, moderately high (average H/L ratio about 0.88), subequilateral (average A/L ratio about 0.32), medium or moderately convex (average B/L ratio about 0.22), moderately oblique and faintly bent, rather thin-walled. Surface with the line of greatest convexity extending from the beaks to the lower part of the rounded posterior end. Incremental lines and growth rings (about 3) very fine.

Beak wide, medium height, marked by small anterior umbonal cavity. Apical angle about 113°. Surface sculptured by about 32 prominent radial ribs with interspaces averaging about equal to the width of the ribs. The ribbing is somewhat finer on posterior area and becomes obsolete on the posterior dorsal margin; the ribs appear to have been originally V-shaped, coming to a sharp edge, and probably were somewhat spinose. On the anterior and anterior part of medium areas the ribs are hardly curved.

*Comparison*: Most similar *C. zhidkovae* Kafanov in Arkhipova *et al*., [1994] differs by shell outlines, by non-oblique and unbent valves and by straightened ribs.

*Distribution*: Upper Oligocene and/or Lower Miocene Pool Creek Formation in Gulf of Alaska coasts, USA.

*Materials seen*: 4 samples, 6 specimens (UCMP).

### *Ciliatocardium carlsbergianum* Kafanov, sp. nov.

(Pl. 1, fig. 10)

*Etymology*: This species is named in honor of world-known The Carlsberg Breweries, Denmark. Carlsberg is more than magnificent beer. The grants of Carlsberg Foundation, set up in 1876, cover a wide spectrum in science including marine biology. So, due to financial support of Carlsberg Foundation famous Dana-Expedition was organized in 1928.

*Type-material and type-locality*: Holotype – VNIGRI no. 152/825. Type-locality: Krinka River, Makarov District,

Sakhalin, Russia; Miocene Maruyamskaya Suite, Member III.

Holotype dimensions: L = 54.8; H = 48.3; B = 12.6; A = 23.7.

*Description*: Shell medium-sized, suborbicular, moderately high (average H/L ratio about 0.88), rather equilateral (average A/L ratio about 0.43), medium or moderately convex (average B/L ratio about 0.23), faintly oblique, unbent, rather thin-walled. Anterior branch of hinge margin, anterior and ventral valve margins form regular semi-oval. Growth rings well defined.

Beak low-sized, narrow, slightly marked by anterior and posterior umbonal cavities. Ribs 45-52 in number, widely triangular in cross-section, almost straightened on all valve surface, separated by interspaces almost equal to ribs breadth.

*Comparison*: Most similar *C. ciliatum* (Fabricius, 1780) differs by fewer ribs number and by valve outlines.

*Distribution*: Known from the type-locality only.

*Materials seen*: 4 samples, 7 specimens (VNIGRI, CNIGRM).

### *Ciliatocardium coosense* (Dall, 1909)

(Pl. 1, figs. 8, 9)

*Cardium* (*Cerastoderma*) *coosense* Dall, 1909, 118, pl. 13, figs. 3, 4.
*Cardium coosense* Dall: Arnold, [1910], 30.
*Laevicardium* (*Cerastoderma*) *corbis* (Martyn) *var. coosense* (Dall): Grant and Gale, 1931, 308.
*Cerastoderma coosense* (Dall): Weaver, [1943], 158.
*Clinocardium coosense* (Dall): Keen, 1954, 21.
*Keenocardium coosense* (Dall): Kafanov, 1980, 309.
*Clinocardium* (*Clinocardium*) *coosense* (Dall): Moore, 1998, 37.

**Non**

*Clinocardium coosense* (Dall): Addicott, 1978, text-figs. *u, v, x;* Volobueva *et al*., 1992, 53, pl. 15, figs. 2-4.

*Etymology*: After the type-locality – Coos Bay.

*Type-material and type-locality*: Boss *et al*. (1968, 2) write concerning of the Dall's types: "When illustrations or information concerning type-specimens were published by Dall subsequently to the original introduction of a taxon, we have cited these references following the entry [l. c., 88: USNM 153933]. For many of his species, Dall never referred to a type-specimen, and we have made little effort to ascertain this information, nor have we designated lectotypes... The exacting tasks of the assignation of primarily types and the illustration of typical specimens are left to specialists concerned with the taxonomy of each particular group". Dr. Miroslav G. Harasewych, curator of Division of Mollusks, National Museum of Natural History, Smithsonian Institution, sent me the photograph of the referred specimen and wrote in his letter of October 21, 1987: "There are 3 syntypes of *Cardium coosense* Dall, 1909. Please, designate the specimen in the photograph as lectotype".

Lectotype (herein designated) – USNM no. 153933. Type-locality: Coos Bay, Oregon, U.S.A.; "Miocene" [Empire Formation].

Lectotype dimensions: L = 48.5; H = 49.5; B = 18.3; A = 23.2.

*Description*: Shell medium-sized, suborbicular, slightly extended in height (average H/L ratio about 1.02), equilateral (average A/L ratio about 0.48), moderately convex (average B/L ratio about 0.38), non-oblique and unbent, moderately thick-walled. Anterior dorsal slope short, with a cordate smooth polished space in front of them; posterior slope longer, with an elongate, rather narrow lanceolate escutcheon inclosing the ligamental nymphs (in the figured specimen 11.5 mm. long). Surface with a well-marked polished dark-brown periostracum which is frequently preserved in the fossils. Growth rings well defined.

Beak medium height, wide, marked by anterior and posterior umbonal cavities. External sculpture of about 45 (44 to 49) radial ribs separated by narrower, partly channeled interspaces. The ribs on the anterior third of the shell are subangular, and the interspaces narrower, those on the posterior and middle areas are flatter with the interspaces wider and more distinctly channeled. All the ribs are crossed by more or less evident incremental lines. The valve margins are slightly crenulated by the sculpture.

*Comparison*: Most similar *C. smekhovi* Kafanov et Savizky, 1982 differs by inequilateral and flattened shell and by fewer ribs number.

*Distribution*: Miocene Empire Formation of Oregon; Miocene and Pliocene Etchegoin and Purisima Formations, Pliocene and Pleistocene Merced Formation and Wildcat Group in California, USA.

*Materials seen*: 4 samples, 7 specimens (UCMP).

### *Ciliatocardium ermanense* (Sinelnikova in Sinelnikova et al., 1976)

(Pl. 1, figs. 6, 7)

*Clinocardium ermanensis* Sinelnikova in Sinelnikova *et al*., 1976, 38, pl. 6, figs. 1, 18.
*Ciliatocardium ermanense* (Sinelnikova in Sinelnikova *et al*.): Kafanov, 1980, 312.

*Etymology*: After the type-locality–Ermanovskaya

Suite.

*Type-material and type-locality*: Holotype (possibly missing) – GIN no. 3666/388 (mould) and no. 3666/290 (impress). Type-locality: key section near Enemten Rocks, Tigil'skiy District, Western Kamchatka, Russia; the base of Ermanovskaya Suite, Upper Miocene.

*Description*: Shell small-sized, trigonal-suborbicular, moderately high (average H/L ratio about 0.76), subequilateral (average A/L ratio about 0.42), medium convex (average B/L ratio about 0.25), non-oblique and unbent, rather thin-walled. Anterior branch of hinge margin, anterior and anterior half of ventral margins form almost regular semi-circular arch. Posterior margin is little pointed and exended backward. Growth rings ill-expressed.

Beak moderately high, medium wide, not marked almost by anterior or posterior umbonal cavities. Ribs 42-48 in number, weakly curved, triangular in cross-section, separated by little narrower interspaces. Tooth are typical for the genus.

*Comparison*: Most similar *C. carlsbergianum* sp. nov. differs by higher and in another outlined shell.

*Distribution*: Known from the type-locality only.

*Materials seen*: 2 samples, 3 specimens (GIN).

### *Ciliatocardium evsseevi* Kafanov et Savizky, 1982

(Pl. 1, figs. 12-16)

*Ciliatocardium evsseevi* Kafanov et Savizky, 1982, 54, pl. 5, figs. 6-9.

*Laevicardium* (*Cerastoderma*) *makarovi* Evseev, [1994], 83, pl. 15, figs. 2-9.

? *Ciliatocardium yamasakii* (Makiyama): Gladenkov *et al*., 1999, pl. 4, figs. 8, 13.

*Etymology*: This species is named in memory of Russian geologist and paleontologist Konstantin P. Evseev.

*Type-materials and type-localities*: Holotype of *Ciliatocardium evsseevi* Kafanov et Savizky, 1982–PIN no. 24/3962. Type-locality: 1 km upstream of the Chernigovka River mouth, Makarov District, Sakhalin, Russia; lower part of Oligocene Gastellovskaya Suite.

Holotype dimensions: L = 23.7; H = 20.1; B = 6.6; A = 9.9.

Lectotype of *Laevicardium* (*Cerastoderma*) *makarovi* (Evseev, [1994, pl. 15, fig. 9], possibly missing; designated by Kafanov *et al*., 2000, 37) – CNIGRM coll. 7378. Type-locality: left inflow of Shiritori [Makarovka] River, Makarov District, Sakhalin; late Eocene and Oligocene Takaradayskaya Suite.

Table 2. Statistical values of basic morphometric characters in *Ciliatocardium evsseevi* Kafanov et Savizky, 1982.

N = 20; y = L = 22.2±1.2; sy = 5.2±0.8; Asy = +0.797*; Ey = +1.135**;

| Parameters | H | A | B |
|---|---|---|---|
| x | 20.6±1.1 | 9.4±0.5 | 6.3±0.4 |
| б x | 4.8±0.8 | 2.4±0.4 | 1.7±0.3 |
| Asx | +0.504 | +0.882** | +0.803** |
| Ex | +0.712 | +1.009* | +1.106* |
| r | 0.978±0.010** | 0.932±0.030** | 0.953±0.026** |
| rln | 0.978±0.004** | 0.922±0.012** | 0.950±0.017** |
| a | 1.262 | 3.289 | 4.816 |
| b | 0.948±0.012 | 0.953±0.020 | 0.833±0.082 |
| x/y | 0.93±0.01 | 0.42±0.01 | 0.28±0.01 |
| б x/y | 0.05±0.01 | 0.04±0.01 | 0.02±0.00 |
| Asx/y | +1.073** | +0.164 | −0.248 |
| Ex/y | +0.252 | −0.803 | −1.639** |

*Description* (see Table 2): Shell small-sized, trigonal-suborbicular, high (average H/L ratio about 0.93), subequilateral (average A/L ratio about 0.42), medium convex (average B/L ratio about 0.28), faintly oblique and faintly bent, rather thin-walled. Anterior branch of hinge margin, anterior and anterior half of ventral margins form almost regular semi-circular arch. Posterior margin is little pointed and expended backward. Growth rings (2-4) ill-expressed.

Beak moderate height, tapering, slightly marked by anterior umbonal cavity. Ribs 27-36 in number, straightened, triangular in cross-section and somewhat rounded at the tops, separated by interspaces of rather equal breadth. The tooth AII are well advanced. Nymph is about 0.22-0.36 of the valve lenght.

*Comparison*: Most similar *C. schmidti* (Khramova, 1962) differs by more convex valve and by fewer ribs number.

*Taxonomic notes*: *Laevicardium* (*Cerastoderma*) *makarovi* (Evseev, [1994] is true synonym of this species which description was published in the paper unsuitable for public use.

*Distribution*: Oligocene and late Eocene of south Sakhalin, Russia: Arakayskaya, Kholmskaya, Gastellovskaya, Porechenskaya and Takaradayskaya Suites.

*Materials seen*: 31 samples, 48 specimens (CNIGRM, VNIGRI, PIN).

### *Ciliatocardium hataii* (Hayasaka, 1956)

(Pl. 1, fig. 17)

*Clinocardium hataii* Hayasaka, 1956, 18, pl. 2, figs. 3a, b; Noda and Masuda, 1968, 4, pl. 1, figs. 6, 10.
*Ciliatocardium hataii* (Hayasaka): Kafanov, 1980, 312.

*Etymology*: In honour of eminent Japanese paleontologist Prof. Kotora Hatai.

*Type-material and type-locality*: Holotype – IGPS no. 77375. Type-locality: cliff of Takesegawa River west of Takakura, Futaba District, Fukushima Prefecture, Honshu, Japan; Pliocene Ishiguma Formation.

Holotype dimensions: L = 54.7; H = 57.8; B = 19.7; A = 24.9.

*Description*: Shell medium-sized, trigonally ovate in outline, extended in height (average H/L ratio about 1.06), equilateral (average A/L ratio about 0.46), moderately convex (average B/L ratio about 0.36), non-oblique and unbent, rather thin-walled. Shell more or less ventricose posteriorly. Anterior branch of hinge margin nearly straight, extending to rather narrowly rounded anterior margin, then smoothly merging into broadly arched ventral margin. Posterior margin truncated, shorter than the anterior, and postero-ventral corner somewhat angulated. Angle of anterior and postero-dorsal margins at umbo about 97°. Growth rings ill-developed.

Beak prominent, clearly marked by anterior and posterior umbonal cavities, medium height and medium wide. Ribs 24-28 in number, narrower than flat-bottomed interspaces. Ribs roof-like, triangular in cross-section, slightly concave towards the anterior side except on posterior part. Posterior slope smooth, provided merely with several fine threads. Lunule elongately ovate.

*Comparison*: This species well distinguished by shell outlines, and no similar forms are known.

*Distribution*: Pliocene of Honshu, Japan (Fukushima and Miyagi Prefectures): Ishiguma and Gobanshoyama Formations.

### *Ciliatocardium iwatense* (Chinzei, 1959)

(Pl. 1, fig. 18)

*Clinocardium iwatense* Chinzei, 1959, 125, pl. 11, figs. 9, 10.
*Ciliatocardium iwatense* (Chinzei): Kafanov, 1980, 313.

*Etymology:* After the type-locality–Iwate Prefecture.

*Type-material and type-locality*: Holotype – UMUT no. CM8572. Type-locality: near Ochiai, Kintaichi-mura, Ninohe District, Iwate Prefecture, Honshu, Japan; Pliocene Kubo Formation.

*Description*: Shell medium-sized (up to 75 mm), obliquely rounded-oval or "fan-shaped" in outline, high (average H/L ratio about 0.87), equilateral (average A/L ratio about 0.47), medium convex (average B/L ratio about 0.23), non-oblique and unbent, thick-walled. Anterior branch of hinge margin not shouldered, rounded, gently arcuared and gradually continues to the anterior and then to the ventral margins. Posterior branch of hinge margin weakly curved; ventral margin broadly arched, long, extending to prolonged posterior end. Posterior end protruded and forms nearly a right angle. Inner margin crenulated.

Beak prominent but not marked by anterior or posterior umbonal cavities, moderate height, wide. Apical angle about 105 to 110°. Ligamental area deeply excavated. Surface ornamented with 30 to 32 sharply edged radial ribs, being regularly imbricated by many concentric growth lines, some growth rings are well marked on the dorsal half of the shell surface; rib-interspaces shallow and rounded, also wrinkled by growth increments. Hinge thick and strong, typical for the genus.

*Comparison*: This species well distinguished by shell outlines, and no similar forms are known.

*Distribution*: Pliocene Kubo Formation in Iwate Prefecture, Honshu, Japan.

### ?*Ciliatocardium kirkerense* (Clark, 1918)

(Pl. 3, figs. 1, 2)

*Cardium kirkerensis* Clark, 1918, 140, pl. 12, fig. 5.
*Acanthocardia*? (*Acanthocardia*?) *kirkensis* [sic!] Clark: Moore, 1998, 3, pl. 3, fig. 2.

*Etymology*: After the type-locality – Kirker Tuff.

*Type-material and type-locality*: Holotype – UCMP no.11165. Type-locality: west of Kirker's Creek, Diablo Quadrangle, Contra Costa County, California, U.S.A.; Kirker Tuff, Oligocene.

Plastoholotype dimensions: L = 10.1; H = 9.8; B = 3.5; A = 4.7.

*Description*: Shell minute, trigonal-suborbicular, high (average H/L ratio about 0,.93), equilateral (average A/L ratio about 0.47), medium convex (average B/L ratio about 0.31), faintly oblique and faintly bent, rather thin-walled. Anterior branch of hinge margin very slightly concave; posterior branch of hinge margin straight, about equal in length to the anterior slope. Anterior margin broadly and regularly rounded; posterior margin broadly subtruncate; the lower angle of the truncation being obscure. Growth lines rather fine.

Beak slightly marked by posterior umbonal cavity only, moderate high, tapering. Surface sculptured by from

seventeen to twenty (19-20 in holotype) V-shaped, nodose, radial ribs, with interspaces averaging somewhat wider than the width of the ribs. Ribs triangular in cross-section with slightly rounded tops covered by numerous close set tiles concave from top to bottom.

*Comparison*: Most similar *C. reedi* (Loel et Corey, 1932) differs by relatively large ribs number and less high valves. As Clark (1918, 140) pointed out "This species appears to be quite unique, differing from any of the known Recent or fossil cardiums of the West Coast."

*Taxonomic notes*: The generic position of this species is not completely clear. The cross sections of ribs resemble those in *Trachycardium sagaseri* Adegoke, 1969. However, comparing with typical *Trachycardium*, ?*C. kirkerense* has not imbricating scales along posterior side of ribs and the posterior valve margin is not serrated. *Clinocardium nuttallii* (Conrad, 1837) has on ribs top a similar tiles but they are convexed hill up. Following Slodkewitsch (1938, 399), I do not exclude a possibility that the subsequent study of a representative material of good safety will show identity of *Cardium kirkerensis* Clark, 1918 and *Cardium* (*Acanthocardia*) *reedi* Loel et Corey, 1932.

*Distribution*: Known from the type-locality only.

*Materials seen*: 1 sample, 1 specimen (UCMP).

### *Ciliatocardium makiyamae* (Kamada, 1962)

(Pl. 3, figs. 3, 4)

*Clinocardium asagaiense makiyamae* Kamada, 1962, 104, pl. 10, figs. 18-21.

*Ciliatocardium makiyamae* (Kamada): Kafanov, 1980, 313; Arkhipova *et al*., [1994], 203, non pl. 34, fig. 3 (as stated).

**Non**

*Ciliatocardium asagaiense makiyamae* (Kamada): Gladenkov *et al*., 1999, pl. 4, figs. 14, 15, 17, pl. 8, fig. 11.

*Etymology*: The title is the most probable descends from incorrect Latin notation of a name of eminent Japanese paleontologist Prof. Jiro Makiyama (in this case correct title should be *makiyamai*).

*Type-material and type-locality*: Holotype – IGPS no. 15800. Type-locality: Nabezuka, Nirono-machi, Joban coal-field, Honshu, Japan; Oligocene Asagai Formation.

Holotype dimensions: L = 26.4; H = 26.3; B = 6.8; A = 11.8.

*Description*: Shell medium-sized, trigonal-suborbicular, high (average H/L ratio about 1.0), equilateral (average A/L ratio about 0.45), medium convex (average B/L ratio about 0.26), non-oblique and unbent, rather thin-walled. Anterior margin rounded and passing into ventral margin without any demarcation; posterior margin broadly arched. Growth rings ill-expressed.

Beak slightly marked by anterior and posterior umbonal cavities, moderate high and medium wide. Ribs 26-30 in number, a little rounded on tops and separated by interspaces of nearly equal breadth.

*Comparison*: Most similar *C. tigilense* (Slodkewitsch, 1938) differs by higher shell.

*Taxonomic notes*: See above for *C. asagaiense* (Makiyama, 1934).

*Distribution*: Oligocene Asagai Formation in Joban coal-field, Honshu, Japan, and upper part of Gastellovskaya Suite in south Sakhalin, Russia.

*Materials seen*: 9 samples, 12 specimens (VNIGRI, PIN, CNIGRM).

### *Ciliatocardium matchgarense* (Makiyama, 1934)

(Pl. 2, fig. 7; Pl. 3, fig. 9)

*Cardium* (*Cerastoderma*) *matchgarense* Makiyama, 1934, 137, pl. 5, figs. 30, 31.

*Clinocardium matchgarense* (Makiyama): Oyama *et al*., 1960, 178, pl. 54, figs. 4a, b (holotype reproduced); Khramova, 1962a, pl. 1, figs. 4a-b, 5; Gladenkov *et al*., 1999, pl. 4, figs. 6, 7, 10-12, 16.

*Ciliatocardium matchgarense* (Makiyama): Kafanov, 1980, 313; Kafanov and Savizky, 1982, pl. 5, fig. 14; Arkhipova *et al*., [1994], 203, pl. 36, fig. 7a, b non pl. 34, figs. 1, 2 (as stated).

*Etymology*: The name is derived from the type-locality - Matchigar (correct – Monchigar) Village.

*Type-material and type-locality*: Holotype – Institute of Geology and Mineralogy, Kyoto University, no. 100007. Type-locality: sea coast, near Matchigar [Monchigar], Schmidt Peninsula, Okha District, Sakhalin, Russia; Oligocene "Marie Formation" [Vengeriyskaya Suite].

Holotype dimensions: L = 33.0; H = 32.5; B = 9.0; A = 15.1.

*Description*: Shell medium-sized, trigonal-suborbicular, high (average H/L ratio about 0.98), equilateral (average A/L ratio about 0.46), medium convex (average B/L ratio about 0.27), non-oblique and unbent, rather thin-walled. Ventral margin is regular and equilateral. Anterior and posterior margins are equally rounded and insensibly pass down to the regularly arched ventral margin. Anterior branch of hinge margin is straight and much shorter then the gently arched posterior branch. There is no angulations or truncation along the whole shell margins. There is an ill-defined posterior depressed area bounded by a very blunt ridge which extends from the beak to the posterior end. The ribs are feeble in this area

in many examples. Growth periods are well-marked by lamellae, near which the shell substance in more resistant to erosion.

Beak low-sized, relatively narrow, slightly marked by anterior umbonal cavity only. Ribs 22-25 in number, straightened on medial area, convex-shape in cross-section.

*Comparison*: Most similar *C. yamasakii* (Makiyama, 1934) differs by valve proportions: average B/L and A/L ratios are 0.34 and 0.42 accordingly in *C. yamasakii* where as 0.27 and 0.46 in *C. matchgarense.*

*Distribution*: Oligocene and late Eocene Arakayskaya, Machigarskaya and Gastellovskaya Suites of Sakhalin, Russia.

*Materials seen*: 14 samples, 21 specimens (VNIGRI, GIN, PIN, CNIGRM).

### ***Ciliatocardium moorae* Kafanov, sp. nov.**

(Pl. 3, figs. 5, 6)

*Etymology*: In honour of American paleontologist Dr. Ellen J. Moore.

*Type-material and type-locality*: Holotype – CNIGRM no. 138/5294. Type-locality: between Noyami and Malyi Serutay Rivers, Aleksandrovsk-Sakhalinskiy District, Sakhalin, Russia; Miocene Sertunayskaya and/or Aleksandrovskaya Suite.

Holotype dimensions: L = 43.6; H = 51.7; B = 12.1; A = 22.0.

*Description*: Shell medium-sized, trigonal-suborbicular, extended in height (average H/L ratio about 1.19), equilateral (average A/L ratio about 0.50), medium convex (average B/L ratio about 0.28), non-oblique and unbent, rather thick-walled. Slightly convex anterior branch of hinge margin forms a regular arc with anterior valve margin. Posterior slope of umbo passes into posterior branch of hinge margin and further into posterior valve margin. Ventral margin is markedly produced downward. Carina is lacking.

Beak marked by anterior umbonal cavity, moderate high, tapering. There are 29-30 ribs curved backwards almost the valve surface and separated by equally wide interspaces. In cross-section ribs are roof-like. Valve surface is covered by numerous coarse growth striae. Teeth of right valve have structure typical for the genus. Nymphe is shortened. Escutcheon and lunule are undistinguishable. Negative radial sculpture is well defined.

*Comparison*: There are no similar forms among other *Ciliatocardium* species. It is known only from the type-material whose clearly distinct diagnostic characters have allowed description of a new species on the basis of single specimen.

*Distribution*: Known from the type-locality only.

*Materials seen*: 1 sample, 1 specimen (CNIGRM).

### ***Ciliatocardium mutuense* (Nomura et Hatai, 1936)**

(Pl. 3, fig. 10)

*Cardium* (*Clinocardium*) *mutuense* Nomura et Hatai, 1936, 279, pl. 33, fig. 11.

*Clinocardium mutuense* (Nomura et Hatai): Kanno and Ogawa, 1964, pl. 1, fig. 15.

*Ciliatocardium mutuense* (Nomura et Hatai): Kafanov, 1980, 313.

*Etymology*: The name is derived from the type-locality – Mutu Province.

*Type-material and type-locality*: Holotype – SHM no. 8799. Type-locality: Komatazawa, Aiuti-mura, Mutu Province, Honshu, Japan; Miocene Isomatsu Formation.

Holotype dimensions: L = 36.0; H = 30.8; B = 7.0; A = 15.9.

*Description*: Shell small-sized, subcircular or slightly transversely elongate oval, rather moderate high (average H/L ratio about 0.86), equilateral (average A/L ratio about 0.44), moderately convex (average B/L ratio about 0.19), non-oblique and unbent, thin-walled. Anterior and posterior margins rounded, the former being apparently slightly broader then the other; hinge margin nearly straight, subequally descending from beak, angle about 110° ; basal margin making regular semicircular curve.

Beak small, moderate high, wide, not very prominent, turned inwards and possibly forwards. Surface with about 25 subequal ribs, apparently rounded on the tops. Interspaces slightly narrower or at least equal to ribs in breadth.

*Comparison*: Most similar *C. sachalinense* (Khramova, 1962) differs by more convex shell and by valve outlines.

*Distribution*: Miocene Isomatsu Formation in Honshu and Takinoue Formation in Hokkaido, Japan.

### ***Ciliatocardium obstinatus* (Barinov in Gladenkov *et al.*, 1992)**

(Pl. 3, figs. 14, 15)

*Clinocardium obstinatus* Barinov in Gladenkov *et al.*, 1992, 123, pl. 1, figs. 7, 16, 20, 20a.

*Etymology*: From *"obstinatus"* (Lat.), persistent, obstinate.

*Type-material and type-locality*: Holotype – GIN no. 8751/37. Type-locality: southwest coast of Karaginsky

Island, 12 km south of Yun'yun'vayam River, Eastern Kamchatka, Russia; Miocene Pestrotsvetnaya Suite, Layer 10.

Holotype dimensions: L = 26.0; H = 23.0; B = 12.2; A = 6.0.

*Description*: Shell small-sized, triangular-suborbicular, high (average H/L ratio about 0.88), equilateral (average A/L ratio about 0.47), medium convex (average B/L ratio about 0.23), faintly oblique and faintly bent, thin-walled. Anterior branch of hinge margin, anterior and ventral margins form rather regular semi-circular arc. Posterior branch of hinge margin passes into posterior margin under some angle. Growth rings well defined.

Beak marked by anterior and posterior umbonal cavities, moderate high and narrow. Ribs 28-33 in number, roof-shaped in cross-section, separated by some narrower interspaces.

*Comparison*: Most similar *C. iwatense* (Chinzei, 1959) differs by some greater ribs number and by more wide beak.

*Distribution*: Known from the type-locality only.

### ***Ciliatocardium reedi*** **(Loel et Corey, 1932)**

(Pl. 2, figs. 8-11; Pl. 3, fig. 11)

*Cardium* (*Acanthocardia*) *reedi* Loel et Corey, 1932, 213, pl. 37, fig. 3.

*Cardium corbis* Mart.: Khomenko, 1933, 15, pl. 2, figs. 2-4.

*Acanthocardia reedi* (Loel et Corey): Slodkewitsch, 1938, 398, pl. 80, figs. 3 (original figure reproduced), 4-12.

*Cardium* (*Acanthocardia*) *snatolensis* Krishtofovich, 1947, 74, pl. 8, figs. 7, 7a; Krishtofovich and Ilyina, 1961, pl. 5, figs. 1, 1a.

*Acanthocardia snatolensis* "Krishtofovich sp. nov.": Korobkov, [1959], 221, pl. 59, fig. 10.

*Ciliatocardium snatolense* (L. Krishtofovich): Kafanov, 1980, 313.

? *Acanthocardia snatolensis* L. Krishtofovich: Gladenkov *et al*., 1991, pl. 37, figs. 5, 6, 7a, b; Gladenkov *et al*., 1991, pl. 37, figs. 5, 6, 7a, b.

*Acanthocardia* (*Acanthocardia*) *reedi* (Loel et Corey): Moore, 1998, 1, pl. 3, fig. 1.

*Etymology*: In honour of American geologist R. D. Reed.

*Type-materials and type-localities*: *Cardium* (*Acanthocardia*) *reedi* Loel et Corey, 1932: holotype – UCMP no. 31772. "The Vaqueros-Temblor transition zone at Anderson Creek, La Panza Mountains, with a transitional faunule including *Turritella inezana altacorona* n. var., and *T. ocoyana* s.s.", San Luis Obispo County, California, U.S.A.; Vaqueros Formation, Oligocene and Miocene.

Holotype dimensions: L = 14.1; H = 12.7; B = 4.2; A = 6.4.

*Cardium* (*Acanthocardia*) *snatolensis* L.Krishtofovich, 1947: holotype – CNIGRM no. 78/5610. Type-locality: sea coast near the Ilinyshka River, Tigil'skiy District, Western Kamchatka; Eocene Snatol'skaya Suite.

Holotype dimensions: L = 16.6; H = 13.3; B = 4.8; A = 7.4.

*Description*: Shell minute, suborbicular, high (average H/L ratio about 0.90), equilateral (average A/L ratio about 0.45), medium convex (average B/L ratio about 0.30), faintly oblique but unbent, rather thick-walled. Growth rings not distinguished.

Beak slightly marked by both umbonal cavities, moderate high and medium wide. Surface sculptured by 21-25 sharply triangular ribs separated by interspaces of same breadth. The ribs noticeably curve on the anterior valve area.

*Comparison*: Most similar ?*C. kirkerense* (Clark, 1918) differs by higher shell and by smaller ribs number.

*Taxonomic notes*: *Cardium* (*Acanthocardia*) *snatolensis* by nothing differs from *Cardium* (*Acanthocardia*) *reedi*. The greatest doubts can produce only differences in a stratigraphical position of these species as first is spread only in Paleogene deposits whereas the second is indicated for "Vaqueros-Temblor transition zone". Last years however majority of the experts (see: Addicott and Poore, 1982; Gladenkov, 1988) is bended to judgement about Paleogene age at least of lower part of Vaqueros Formation in California. Our data about distribution of *Cardium* (*Acanthocardia*) *snatolensis* support this point of view.

*Distribution*: Oligocene Vaqueros Formation in California, USA (data for Miocene Temblor Formation are doubtful). Paleogene Snatol'skaya Suite in Western Kamchatka and Aluginskaya Suite in Eastern Kamchatka, Russia.

*Materials seen*: 9 samples, 14 specimens (UCMP, VNIGRI, CNIGRM, PIN, GIN, UCMP).

### ***Ciliatocardium sachalinense*** **(Khramova, 1962)**

(Pl. 2, figs. 1, 2)

*Clinocardium sachalinense* Khramova, 1962, 437, pl. 1, figs. 6a-b, 7a-b.

? *Ciliatocardium sachalinense* (Khramova): Kafanov, 1980, 313.

*Ciliatocardium sachalinense* (Khramova): Arkhipova, [1994], 205, pl. 34, figs. 5a, b.

**Non**

*Clinocardium sachalinense* Khram.: Zhidkova *et al*., 1968, 102, pl. 17, figs. 1, 1a; pl. 36, fig. 5; pl. 44, fig. 6; Zhidkova et al., 1972, 125, pl. 11, fig. 1; pl. 12, fig. 11; pl. 13, fig. 16; pl. 33, figs. 4, 5.

*Etymology*: The name is derived from the type-locality–Sakhalin Island.

*Type-material and type-locality*: Holotype – VNIGRI no. 46/659. Type-locality: Keton River, Poronaysk District, Sakhalin, Russia; the lowermost part of Kurasiyskaya Suite.

Holotype dimensions: L = 30.6; H = 26.6; B = 11.0; A = 14.2.

*Description*: Shell small-sized, triangular-suborbicular, high (average H/L ratio about 0.87), equilateral (average A/L ratio about 0.46), medium convex (average B/L ratio about 0.36), non-oblique and unbent, rather thon-walled. The anterior part of hinge margin short, compounds a common arc with convex anterior margin. The posterior branch of hinge margin is a little larger than anterior one, makes a hardly noticeable broad angle with the widely rounded posterior margin. The ventral margin is moderately convex and continuously bridged with anterior and posterior valve margins. Growth rings infrequent but sharp.

Beak well marked by anterior umbonal cavity, medium height and medium wide. Ribs 22-27 in number, slightly rounded on the tops ans separated by little narrower interspaces.

*Comparison*: Most similar *C. mutuense* (Nomura et Hatai, 1936) differs by more flattened shell and by valve outlines.

*Distribution*: Miocene Sertunayskaya, Kurasiyskaya and lower part of Maruyamskaya Suites of Sakhalin, Russia.

*Materials seen*: 7 samples, 10 specimens (VNIGRI, PIN).

### *Ciliatocardium schmidti* (Khramova, 1962)

(Pl. 2, fig. 3)

*Clinocardium schmidti* Khramova, 1962, 436, pl. 1, figs. 1a-b, 2, 3a-b.

*Ciliatocardium schmidti* (Khramova): Kafanov, 1980, 313; Arkhipova *et al*., [1994], 204, pl. 33, figs. 14a, b, non figs. 12, 13, 20 (as stated).

*Etymology*: The name is derived from the type-locality – Schmidt Peninsula.

*Type-material and type-locality*: Holotype – VNIGRI no. 24/659. Type-locality: north coast of Schmidt Peninsula west of Machigar [Monchigar] Lake, Okha District, Sakhalin, Russia; middle part of Machigarskaya Suite.

Holotype dimensions: L = 32.3; H = 26.7; B = 9.5; A = 14.5.

*Description*: Shell small-sized, suborbicular, moderate high (average H/L ratio about 0.82), rather equilateral (average A/L ratio about 0.44), medium convex (average B/L ratio about 0.29), faintly oblique, unbent, thin-walled. The anterior and posterior valve margins equally rounded and continuously bridged with weak convex ventral margin. Anterior and posterior branches of hinge margin are identical pitched and smoothly pass in anterior and posterior margins. Growth rings ill-expressed.

Beak marked by both umbonal cavities, moderate height, narrow. Ribs 30-33 in number, roof-shaped in cross-section, separated by twice narrower flattened interspaces. On anterior and posterior valve areas ribs are higher and narrower than in medial area where they are as though stretched in cross-section. In medial area ribs bear thread grooves on the crests which one, probably, are traces of cilia affixion. Ribs surface crossed by fine incremental lines.

*Comparison*: Most similar *C. evsseevi* Kafanov et Savizky, 1982 differs by flattened shell and by greater ribs number.

*Distribution*: Oligocene Machigarskaya and lower part of Gastellovskaya Suites of Sakhalin, Russia.

*Materials seen*: 6 samples, 8 specimens (VNIGRI, PIN).

### *Ciliatocardium shinjiense* (Yokoyama, 1923)

(Pl. 3, figs. 12, 13)

*Cardium shinjiensis* Yokoyama, 1923, 7, pl. 2, figs. 6a, b.

? *Cardium shinjiensis* Yokoyama: Yokoyama, 1925, 18, pl. 3, figs. 10, 11.

*Cardium nuttallii* Conrad: Yokoyama, 1926b, 353; Yokoyama, 1927a, 179.

*Cardium nuttalii* [sic!] Conrad: Yokoyama, 1929, 390, pl. 74, fig. 8.

? *Cardium* (*Cerastoderma*) *shinjiense* Yokoyama: Kanehara, 1937, text-fig. 1.

*Laevicardium* (*Cerastoderma*) *shinjiense* (Yok.): Slodkewitsch, 1938, 386 (part.), pl. 78, figs. 2, 2a; Simonova, 1941, 40, pl. 14, figs. 13-15.

? *Clinocardium asagaiense* (Mak.): Hirayama, 1955, 97, pl. 2, figs. 2, 3, 5-9, 23.

*Clinocardium shinjiense* (Yok.): Kamada, 1962, 105, pl. 11, figs. 1, 2.

? *Clinocardium shinjiense* (Yok.): Kaseno and Matsuura, 1965, pl. 13, fig. 10; O'Hara and Nemoto, 1984, pl. 1, fig. 9; Noda, Y., 1992, 73.

*Ciliatocardium shinjiense* (Yokoyama): Kafanov, 1980, 313; Kafanov and Savizky, 1982, pl. 5, figs. 10, 11; Noda, Y., 1992, 73 (synonymy).

**Non**

*Cardium shinjiensis* Yok.: Yokoyama, 1926a, 293, pl. 34, figs. 17, 18.

*Cardium* (*Cerastoderma*) *shinjiense* Yokoyama: Nomura, 1935, 110, pl. 6, fig. 3; Kanehara, 1937, text-fig. 10.

*Clinocardium shinjiense* (Yok.): Hirayama, 1955, p. 96, pl. 2, figs. 4, 10; Ogasawara, 1973, pl. 12, fig. 19; Noda, Y. and Hoyanagi, 1993, text-fig. 9, 1.

*Laevicardium* (*Cerastoderma*) *shinjiense* (Yokoyama): Slodkewitsch, 1938, 386 (part.), pl. 78, figs. 3-6a; Ilyina, [1957], 223, pl. 16, figs. 6, 7, 8, 8a.

*Ciliatocardium* ex gr. *shinjiense* (Yokoyama): Ablaev *et al*., 1990, 53, pl. 7, figs. 12, 16.

*Ciliatocardium shinjiense* (Yokoyama): Gladenkov *et al*., 1987, pl. 10, figs. 2, 6.

*Type-material and type-locality*: Lectotype (designated as "holotype" by Hatai and Nisiyama, 1952, 40) – UMUT no. CM24580. Type-locality: Fujina, Tamayu-mura, Yatsuka District, Shimane Prefecture, Honshu, Japan; Miocene Fujina Formation.

Lectotype dimensions: L = 33.0; H = 32.2; B = 11.8; A = 15.0.

Table 3. Statistical values of basic morphometric characters in *Ciliatocardium shinjiense* (Yokoyama, 1923).

N = 50; y = L = 23.0±0.6; sy = 4.1±0.4; Asy = −0.663*; Ey = +1.212***;

| Parameters | H | A | B |
|---|---|---|---|
| x | 22.2±0.5 | 10.3±0.3 | 7.3±0.2 |
| б x | 3.8±0.4 | 2.0±0.2 | 1.4±0.1 |
| Asx | −0.516 | −0.500 | −0.383 |
| Ex | +1.079*** | +0.964*** | +0.666 |
| r | 0.957±0.003*** | 0.931±0.010*** | 0.931±0.009*** |
| rln | 0.989±0.004*** | 0.961±0.007*** | 0.950±0.011*** |
| a | 1.062 | 2.907 | 3.983 |
| b | 1.031±0.022 | 0.887±0.037 | 0.881±0.042 |
| x/y | 0.96±0.01 | 0.45±0.00 | 0.32±0.00 |
| б x/y | 0.04±0.00 | 0.03±0.00 | 0.02±0.00 |
| Asx/y | −0.025 | −0.586* | +0.153 |
| Ex/y | −0.901*** | −0.284 | −0.197 |

*Description* (see Table 3): Shell small-sized, subcircular, high (average H/L ratio about 0.96), equilateral (average A/L ratio about 0.45), medium convex (average B/L ratio about 0.32), non-oblique and unbent, rather thick-walled. Anterior branch of hinge margin, anterior and ventral margins form almost regular semi-circular arc. Posterior beak slope and posterior branch of hinge margin form almost straight line. Postero-dorsal margin with a noticeable angle. Growth rings rough.

Beak slightly marked by anterior umbonal cavity only, moderate height and medium wide. Ribs 33-37 in number, roof-shaped in cross-section with some rounded tops, separated by interspaces almost equal to ribs breadth or little narrower.

*Comparison*: Most similar *C. ciliatum* (Fabricius, 1780) differs by something oblique and bent, subequilateral and less convex shell.

*Taxonomic notes*: The status of this form receives different interpretation from researchers. This is largely due to extreme confusion leading to misunderstanding of the volume, status, nomenclature and taxonomic relationship between *Clinocardium nuttallii*, *Cilitocardium ciliatum* and *C. shinjiense.*

Having illustrated a specimen of *C. ciliatum*, Yokoyama (1926a) gave on this basis an additional description of *C. shinjiense* from Pliocene deposits of Sado Island, Honshu (Kotaka, 1950, 46, considers this shells as *Clinocardium chikagawaense*), and, in the same year (Yokoyama, 1926b), having mistaken a shell from Sado Island for the description of juvenile *Cardium nuttallii* in Middendorff (1849, pl. 16), had reduced his species to a synonym of the latter.

Later the confusion was further increased because of the fact that in a well-known summary by Grant and Gale (1931, pl. 19, fig. 12), which was followed by numerous American, Russian and Japanese paleontologists, under the name of *Laevicardium decoratum* (Grewingk, 1850), a description was given of *Cardium californiense* var. *comoxense* Dall, which is a local form of *Ciliatocardium ciliatum* (Kafanov, 2001). Slodkewitsch (1936, 1938), followed by Ilyina [1957], erroneously identified *C. decoratum* with *C. shinjiense* and Slodkewitsch (1938, 387) came to a decision that *Cardium decoratum* should be cancelled altogether as "insufficiently clear being inadequately represented and described, and unrestorable due to loss of the original". From International Code of Zoological Nomenclature (1999) standpoint, such a procedure is definitely unacceptable.

Kuroda (1931) and Nomura (1935) consider *C. shinjiense* as a synonym of *C. ciliatum*, however Kanehara (1937) shares these two species follow-up describing still allied *C. uyemurai.*

*Distribution*: True *C. shinjiense* are known from Miocene Fujina and Kokozura Formations of Honshu, Japan and also from Miocene Borskaya and Uranayskaya Suites of Sakhalin, Russia.

*Materials seen*: 7 samples, more than 50 specimens (VNIGRI, CNIGRM, PIN).

### *Ciliatocardium smekhovi* Kafanov et Savizky, 1982

(Pl. 2, figs. 4-6)

*Ciliatocardium smekhovi* Kafanov et Savizky, 1982, 58, pl. 5, figs. 12, 13.

**Non**

*Ciliatocardium* cf. *smekhovi* Kafanov et Savizky: Ablaev *et al*., 1990, 54, pl. 7 (not 6 as stated), figs. 5, 9, 15, 17, 18.

*Etymology*: In honour of Russian geologist E. M. Smekhov.

*Type-material and type-locality*: Holotype – PIN no. 29/3962. Type-locality: Chekhovka River, Kholmsk District, Sakhalin, Russia; upper part of Arakayskaya Suite, Oligocene. Paratypes – PIN no. 31/3962 and 30/3962 (6): Skvortsovka River, Smirnykhov District, Sakhalin, Russia; lower part of Borskaya Suite, Lower Miocene.

Holotype dimensions: L = 44.3; H = 44.9; B = 12.1; A = 18.3.

*Description*: Shell medium-sized, trigonal-suborbicular, high or extended in height (average H/L ratio about 1.01), subequilateral (average A/L ratio about 0.41), medium convex (average B/L ratio about 0.27), faintly oblique and faintly bent, rather thick-walled. anterior branch of hinge margin, anterior and ventral margins form almost regular semi-orbicular arc. Posterior branch of hinge margin straightened and passes in posterior margin with some angle. Medial area rather sharply passes in posterior one forming steep keel twist. Growth rings smoothed.

Beak slightly marked by anterior umbonal cavity, moderate height, wide. Ribs 33-45 in number, narrow and rather low, noticeably curved backward on all valve surface. Interspaces little wider than ribs. On the posterior area ribs are smoothed. Nymph reaches 0.35-0.45 of valve length.

*Comparison*: Most similar *C. coosense* (Dall, 1909) differs by equilateral and more convex shell and by greater ribs number.

*Distribution*: Oligocene upper part of Arakayskaya Suite and Lower Miocene lower part of Borskaya Suite, Sakhalin, Russia.

*Materials seen*: 3 samples, 3 specimens (PIN).

### ***Ciliatocardium tigilense*** **(Slodkewitsch, 1938)**

(Pl. 2, figs. 12-15)

*Laevicardium* (?) *tigilense* Slodkewitsch, 1938, 380, pl. 74, figs. 10, 10a.

*Ciliatocardium tigilense* (Slodkewitsch): Kafanov, 1980, 313.

**Non**

*Keenocardium tigilense* (Slodkewitsch): Gladenkov *et al*., 1984, 210, pl. 49, figs. 12a, b; Gladenkov and Sinelnikova, 1990, 70, pl. 3, fig. 11.

*Etymology*: The name is derived from the type-locality – Tigil District.

*Type-material and type-locality*: Holotype – CNIGRM no. 914/5060. Type-locality: sea coast near the Polovinnaya River mouth, Tigil District, Western Kamchatka, Russia; Middle Miocene Il'inskaya Suite.

Holotype dimensions: L = 15.1; H = 15.3; B = 3.7; A =7.4.

*Description*: Shell minute, subcircular, high or extended in height (average H/L ratio about 1.01), equilateral (average A/L ratio about 0.49), medium convex (average B/L ratio about 0.25), non-oblique and unbent, rather thin-walled. growth rings smoothed.

Beak moderate height, tapering, well marked by anterior and posterior umbonal cavities. Ribs 27-30 in number, almost not curved, triangular in cross-section with slightly rounded tops, separated by narrower interspaces.

*Comparison*: Most similar C. makiyamae (Kamada, 1962) differs by rather oblong shell.

*Distribution*: Middle Miocene Il'inskaya Suite in Western Kamchatka, Russia.

*Materials seen*: 1 sample, 3 specimens (CNIGRM).

### ***Ciliatocardium uyemurai*** **(Kanehara, 1937)**

(Fig. 1; Pl. 3, figs. 16-18)


Fig. 1. *Ciliatocardium uyemurai* (Kanehara, 1937) Original figures of *Cardium* (*Cerastoderma*) *uyemurai* (reproduced from: Kanehara, 1937, text-figs. 6-8); external cast of paired shell left (Fig. 1), in front (Fig. 2) and from above (Fig. 3). "Congi Series; Great Fuhdji, North Karafto [Sachalin]. Pliocene".

*Cardium* (*Cerastoderma*) *uyemurai* Kanehara, 1937, 175, text-figs. 6-8.

*Ciliatocardium uyemurai* (Kanehara): Kafanov, 1980, 313; Kafanov and Savizky, 1982, pl. 5, figs. 1-3.

? *Ciliatocardium uyemurai* (Kanehara): Gladenkov *et al*., 1992, pl. 12, fig. 4.

*Etymology*: This species is named in honor of K. Uyemura, geologist of the Imperial Geological Survey of Japan.

*Type-material and type-locality*: Type-material is missing. According to Hatai and Nisiyama (1952, 19), all Recent and fossil type-specimens in Geological Survey of

Japan were totally destroyed during the World War II. Type locality is given as "Great Fuhdji, north Karafto; sandy shale of the Congi Series, Pliocene". The designation of the type locality is based on the erroneous transliteration of the name of the Bol'shaya Khuzi River in the eastern Sakhalin Mountains. The toponym of "Fuhdji" in Sakhalin is unknown and the geological survey of K. Kanehara covered the eastern part of the Smirnykhov District of east Sakhalin.

Dimensions of figured specimen: L = 48.0; H = 42.4; B = 15.0; A = 20.5.

*Description*: Shell medium-sized, cordately ovate, rather high (average H/L ratio about 0.88) and equilateral (average A/L ratio about 0.43), medium convex (average B/L ratio about 0.31), non-oblique and unbent, thick-walled. Anterior branch of hinge margin rather straight, much shorter than the almost straight posterior branch of hinge margin. Posterior margin angular, while the anterior margin quite smoothly rounded. Ventral margin regularly arcuated, entire. The point of the greatest convexity on the ventral valve edge is sometimes located anteriorly to the ventral axis. Growth lines well-marked by lamellae, near which the shell substance is more compact and resistant to erosion.

Beak well marked by anterior umbonal cavity, moderate height, tapering. Ribs are 22-27, on an average about 23, markedly curved in the medial area of valve. Interspaces are flattened and here are almost equal to ribs in width or even wider. In the anterior area ribs are broadly arranged, straightened, lower than those in the medial area, separated by interspaces which are here about two times wider. In cross-section the ribs are triangular-rounded, with markedly convex slopes. The tops of the ribs bear fine longitudinal crest. Periostracum is wrinkled and covered by numerous irregularly concentric grooves and folds of growth. Growth rings are well defined.

Hinge plate is wide. Tooth *AI* is massive, triangular in shape, thickened, with distinct longitudinal crest on the dorsal plane, which is rare among representatives of the genus. Tooth *AIII* is not large, nodulate. Cardinal teeth of the right valve are markedly varying in size, with 3b being thickened, triangular in outline. Tooth *PI* is triangular, plate-like. On the left valve cardinal teeth barely differ in size, although tooth 2 is slightly larger. Nymphe is fairly wide, not strongly curved or almost straight. Negative sculpture is weakly developed.

*Taxonomic notes*: The suggestion (Savizky, 1978) that this species is conspecific to *C. sachalinense* (Khramova, 1962) is not confirmed (Kafanov and Savizky, 1982).

*Distribution*: One of the largest representatives of the genus, this species has distinct diagnostic characters and may be considered as a zonal form for the Pliocene Pomyr stratigraphical horizon in Sakhalin. Similar forms are also reported for Limimtevayamskaya Suite in Karaginsky Island, Eastern Kamchatka.

*Materials seen*: 11 samples, 18 specimens (PIN, VNIGRI).

### *Ciliatocardium yakatagense* (Clark, 1932)

(Pl. 3, fig. 19)

*Clinocardium yakatagense* (Clark): Keen, 1954, 20; Addicott *et al*., 1971, 20, fig. 4a (holotype reproduced); Kanno, 1971, 66, pl. 8, figs. 1-3.

*Ciliatocardium yakatagense* (Clark): Kafanov, 1980, 313.

*Etymology:* The name is derived from the type-locality–Yakataga District.

*Type-material and type-locality*: Holotype – UCMP no. 30384. Type-locality: Yakataga District (about 60° N), coast of the Gulf of Alaska, Alaska, U.S.A.; upper part of Pool Creek Formation, ?Miocene.

Holotype dimensions: L = 41.7; H = 43.9; B = 7.0; A = 17.8.

*Description*: Shell medium-sized, subtrigonal, extended in height (average H/L ratio about 1.05), rather equilateral (average A/L ratio about 0.43), moderately convex (average B/L ratio about 0.17), non-oblique, faintly bent, rather thick-walled. Ventral side of adult shells surface distinctly ornamented with rugose concentric lines which become less prominent near the anterior and posterior margins. Ventral margin roughly crenulated.

Beak moderate height, narrow, well marked by anterior umbonal cavity.

Surface ornamented with about 24-35 radial ribs witch are regular, rather low, noded by incremental ridges on their surface. Ribs almost obsolete anteriorly and posteriorly. Ribs separated by wide rounded interspaces, also covered by rather coarse, laminated, and somewhat imbricated incremental lines. The radial ribbing on the posterior and anterior dorsal margins appears to have been somewhat spinose.

Each valve with two cardinal teeth, of which the posterior of the right and the anterior of the left are prominent; anterior laterals short, heavy, and strong, but the posterior one rather small and weak compared with the anterior one. Muscle scars prominent.

*Comparison*: Most similar *C. moorae* Kafanov, sp. nov.

differs by shell outlines and by ribbing character.

*Distribution*: Upper part of Miocene (?) Pool Creek Formation in the Gulf of Alaska coasts, Alaska, U.S.A.

*Materials seen*: 3 samples, 4 specimens (UCMP).

### *Ciliatocardium yamasakii* (Makiyama, 1934)

(Pl. 2, fig. 16)

*Cardium* (*Cerastoderma*) *yamasakii* Makiyama, 1934, 138, pl. 5, figs. 21, 24.

*Clinocardium yamasakii* (Makiyama): Oyama *et al.*, 1960, 178, pl. 54, figs. 5a, b (holotype reproduced).

*Ciliatocardium yamasakii* (Makiyama): Kafanov, 1980, 313.

*Type-material and type-locality*: Holotype – Institute of Geology and Mineralogy, Kyoto University, no. 100005. Type-locality: shore of Marie Cape, near Matchigar [Monchigar], Schmidt Peninsula, Okha District, Sakhalin, Russia; Oligocene Vengeriyskaya Suite.

Holotype dimensions: L = 35.6; H = 34.9; B = 12.0; A = 14.9.

*Description*: Shell small-sized, suborbicular, high (average H/L ratio about 0.98), slightly subequilateral (average a/L ratio about 0.42), convex (average B/L ratio about 0.34), non-oblique and unbent, thick-walled. The anterior branch of hinge margin much shorter than posterior one. Margins regularly curved, the curve being an ellipse whose diameters are about 35 and 30 mm in the holotype. Growth rings ill-defined.

Beak low- or moderate-sized, marked by hardly discernible anterior umbonal cavity. Sculpture consisting of 20-26 roof-shaped ribs. The ridges sharp and fissured, generally a little rounded on the ventral area. The interspaces flat, as wide as or very little narrower than the ribs. Incremental lines fine, hair-like, more distinct on the interspaces of the ribs.

*Comparison*: Most similar *C. matchgarense* (Makiyama, 1934) differs in valve proportions.

*Distribution*: Oligocene Vengeriyskaya and Machigarskaya Suites of North Sakhalin, Russia.

*Materials seen*: 2 samples, 2 specimens (VNIGRI).

### *Ciliatocardium zhidkovae* Kafanov in Arkhipova *et al.*, [1994]

(Pl. 3, figs. 7, 8)

*Ciliatocardium zhidkovae* Kafanov in Arkhipova *et al.*, [1994], 204, pl. 33, figs. 15, 16.

*Laevicardium* (*Cerastoderma*) *asagaiense* (Makiyama): Evseev, [1994], 81, pl. 14, figs. 7-12a.

? *Clinocardium* sp.: Gladenkov *et al.*, 1999, pl. 7, fig. 4.

*Etymology*: This species is named in honor of Russian paleontologist and geologist Dr. Lidiya S. Zhidkova.

*Type-material and type-locality:* Holotype – VNIGRI no. 161/825. Type-locality: Gornaya River, Makarov District, Sakhalin, Russia; upper part of Gastellovskaya Suite, Oligocene.

Holotype dimensions: L = 37.8; H = 30.3; B = 8.3; A = 16.3.

Table 4. Statistical values of basic morphometric characters in *Ciliatocardium zhidkovae* Kafanov in Arkhipova *et al.*, [1994].

N = 18; y = L = 35.6±0.9; sy = 3.6±0.6; Asy = −0.505*; Ey = −0.370;

| Parameters | H | A | B |
|---|---|---|---|
| x | 31.4±0.9 | 14.1±0.5 | 8.8±0.3 |
| б x | 4.0±0.7 | 2.3±0.4 | 1.4±0.2 |
| Asx | −0.291 | −0.408 | −0.093 |
| Ex | −1.030** | −0.953* | −0.786 |
| r | 0.786±0.090* | 0.770±0.096* | 0.627±0.143* |
| rln | 0.803±0.081** | 0.809±0.069** | 0.680±0.102* |
| a | 3.796 | 9.585 | 13.602 |
| b | 0.948±0.012 | 0.953±0.020 | 0.833±0.082 |
| x/y | 0.88±0.02 | 0.39±0.01 | 0.25±0.01 |
| б x/y | 0.07±0.01 | 0.04±0.01 | 0.03±0.01 |
| Asx/y | +0.662* | +0.470 | −0.027 |
| Ex/y | −0.345 | −0.226 | −1.191** |

*Description* (see Table 4): Shell small-sized, trigonal-suborbicular, high (average H/L ratio about 0.88), subequilateral (average A/L ratio about 0.39), medium convex (average B/L ratio about 0.25), non-oblique and unbent, rather thick-walled. Lengthy posterior branch of hinge margin derivate almost straight line with posterior margin. Postero-ventral corner (about 55-60°) little pointed and directed backward. Anterior branch of hinge margin, anterior and ventral margins form regular semioval arc. Rather strong keel twist is extended from beak up to postero-ventral corner. Posterior area is impressed a little behind the keel twist. Growth rings strong.

Beak moderate height, tapering, well marked by anterior umbonal cavity. Ribs are 30-40, more often 34-37. On anterior and medial areas they are direct, and behind a keel twist curved a little. Interspaces on anterior and medial areas are a little narrower than ribs and coming nearer to a keel twist they become almost equal to ribs breadth.

*Comparison*: Most similar *Ciliatocardium brooksi* (Clark, 1932) differs by valve proportions and by ribs considerably curved on anterior and medial areas.

*Distribution*: Upper Eocene/Oligocene Takaradayskaya

and Gastellovskaya Suites of Sakhalin, Russia.

*Materials seen*: 13 samples, 21 specimens (VNIGRI, PIN).

## References


Ablaev, A. G., Lyu, Zin Moo, Khudik V. D. and Lyu, Yung Hwa (1990), *Hamheung biota of the Neogene of Korea* (*problems of stratigraphy, ecology, climate*). Far East Branch, Academy of Sciences of the USSR, Vladivostok, 71 p., 9 pls. (in Russian).

Addicott, W. O. (1978), Late Miocene mollusks from the Queen Charlotte Islands, British Columbia, Canada. *[U. S.] Geol. Surv., J. Res.*, **6** (5), 677-690.

Addicott, W. O., Kanno, S., Sakamoto, K. and Miller, D. J. (1971), Clark's Tertiary molluscan types from the Yakataga district, Gulf of Alaska. *[U.S.] Geol. Surv. Profess. Paper*, **750-C**, 18-33.

Addicott, W. O. and Poore, R. (1982), Determination and correlation of the Paleogene/Neogene boundary in coastal basins of northeast portion of Pacific Ocean. *In* V. V. Menner and Yu. B. Gladenkov (eds.), *Neogene of Pacific realm*. Moscow, Geological Institute, Academy of Sciences of the USSR, p. 13-23 (in Russian).

Arkhipova, A. D., Brutman, N. Ya., Zhidkova, L. S., Ivan'shina, L. P., Kafanov, A. I., Korobkov A. I., Kuznetzova V. N., Moiseeva, A. I., Popova, L. A., Pronina, I. G., Remizovsky, V. I., Runeva, N. P., Savizky, V. O., Sal'nikov, B. A., Utkina, A. I., Shainyan, S. Kh. and Schmidt, O. I. (1992 [1994, December 3-9, actual date of release]), *Reference section of Paleogene-Neogene deposits of South-East Sakhalin (Makarov section)*. All-Russia Petroleum Scientific-Research Geological-Exploration Institute, St. -Petersburg, 358 p., 68 pls. (in Russian).

Arnold, R. (1909 [1910]), Paleontology of the Coalinga District, Fresno and Kings Counties, California. *Bull. U.S. Geol. Surv.*, **396**, 1-173, pls. 1-30.

Boss, K. J., Rosewater, J. and Ruhoff, F. A. (1968), *The zoological taxa of William Healey Dall.* Smithsonian Institution Press, Washington, D.C., 427 p.

Brooks, A. H. (1906), The geography and geology of Alaska – A summary of existing knowledge. *[U.S.] Geol. Surv. Profess. Paper*, **45**, 1-327.

Chinzei, K. (1959), Molluscan fauna of the Pliocene Sannohe group of Northeast Honshu, Japan. 1. The faunule of the Kubo formation. *J. Fac. Sci. Univ. Tokyo, Sect. 2*, **12** (1), 103-132, pls. 9-11.

Clark, B. L. (1918), The San Lorenzo Series of middle California. *Univ. Calif. Publ., Bull. Dept. Geol.*, **11** (2), 45-234, pls. 3-24.

Dall, W. H. (1909), Contributions to the Tertiary paleontology of the Pacific Coast. 1. The Miocene of Astoria and Coos Bay, Oregon. *[U. S.] Geol. Surv. Profess. Paper*, **59**, 1-149, 192-278, pls. 1-23.

Devjatilova, A. D. and Volobueva, V. I. (1981), *Atlas of Paleogene and Neogene fauna of the North East of the USSR*. "Nedra" Publ. House, Moscow, 220 p., 55 pls. (in Russian).

Evseev, K. P. (1956 [published under the griff "top secret"; after removal of a signature stamp of "secret", Febr. 25, 1992, the signature stamp "for service usage only" is established; *de facto* the paper was opened for public use Dec. 3-9, 1994 by Arkhipova *et al*. [1994]), Materials on the geology and stratigraphy of Sakhalin (Poronaysk and Makarov Districts). *Matls. All-Union Petroleum Sci. -Res. Geol. -Explor. Inst., New Ser.*, Iss. 5, Paleontology and Stratigraphy, 1-164, pls. 1-25 (in Russian).

Gladenkov, Yu. B. (1988), Marine Neogene stratigraphy of the northern part of the Pacific Belt (Review of the stratigraphical schemes for the Far East of the USSR, North America and Japan). *Transact. Geol. Inst., Acad. Sci. USSR*, **428**, 1-213 (in Russian).

Gladenkov, Yu. B., Barinov, K. B., Basilyan A. E., Bordunov, S. I., Bratzeva, G. M., Zyryanov, E. B., Kuralenko, N. P., Vitukhin D. I., Oreshkina, T. V., Ganzey, S. S., Kiyashko, S. I. and Trubikhin, V. M. (1992), Detailed division of the Neogene of Kamchatka. *Transact. Geol. Inst., Russ. Acad. Sci.*, **478**, 1-208, pls. 1-60 (in Russian).

Glagenkov, Yu. B., Bratzeva, G. M. and Sinelnikova, V. N. (1987), Marine Cenozoic of the Korfa Bay in eastern part of Kamchatka. *In* Yu. M. Pushcharovskiy (ed.), *Essays in geology of the Northwestern sector of Pacific tectonic belt*. "Nauka" Publ. House, Moscow, p. 5-73, pls. 1-16 (in Russian).

Gladenkov, Yu. B., Gladikova, V. M., Kafanov A. I., Konova, L. N., Krishtofovich, L. V., Sinelnikova, V. N. and Popov, S. V. (1984), Marine molluscs. *In* V. V. Menner (ed.), Atlas of fauna and flora of the Neogene sediments of the Far East. Tochilinski Key section of Western Kamchatka. *Transact. Geol. Inst., Acad. Sci. USSR*, **385**, 152-251, 307-324, pls. 27-65 (in Russian).

Gladenkov, Yu. B. and Sinelnikova V. N. (1990), Miocene mollusks and climatic optima in Kamchatka. *Transact. Geol. Inst., Acad. Sci. USSR*, **453**, 1-174, pls. 1-32 (in Russian).

Gladenkov, Yu. B., Sal'nikov, B. A., Barinov, K. B., Brutman, N. Ya., Vitukhin, D. I., Grechin, V. I., Ivan'shina, L. P., Margulis, L. S., Oreshkina, T. V., Radchenko, V. G. and Stupin, S. I. (1999), *Cenozoic ecosystems of the Okhotsk Sea* region. *The Paleogene and Neogene Key section of North Sakhalin (Shmidt Peninsula): stratigraphy, paleogeography, and geological events*. GEOS Publ. House, Moscow, 132 p., 30 pls. (in Russian).

Gladenkov, Yu. B., Sinelnikova, V. N., Shantser, A. E., Tschelebaeva, A. I., Oleinik, A. E., Titova, L. V., Bratzeva, G. M., Fregatova, N. A., Zyryanov, E. V. and Kazakov, K. G. (1991), The Eocene of Western Kamchatka. *Transact. Geol. Inst., Russ. Acad. Sci.*, **467**, 1-184, pls. 1-48 (in Russian with English title and

contents).

Grant, U. S. IV and Gale, H. R. (1931), Catalogue of the marine Pliocene and Pleistocene Mollusca of California. *Mem. San Diego Soc. Nat. Hist.*, **1**, 1-1036, pls. 1-32.

Hatai, K. and Nisiyama, S. (1952), Check list of Japanese Tertiary marine Mollusca. *Sci. Repts. Tohoku Univ., 2nd Ser.* (*Geology*), Spec. vol. no. 3, 1-464.

Hayasaka, S. (1956), Pliocene Mollusca from the Futaba district, Fukushima Prefecture, Japan. *Saito Ho-on Kai Mus. Res. Bull.*, no. 25, 13-21, pl. 2.

Hirayama, K. (1955), The Asagai formation and its molluscan fossils in the northern region, Jôban coal-field, Fukushima Prefecture, Japan. *Sci. Repts. Tokyo Kyoiku Daigaku, Sect. C*, **4**(29), 49-130, pls. 1-5.

Honda, Y. (1981), A new *Clinocardium* from the Omagari Formation of the Ombetsu Group, Kushiro coal field, Eastern Hokkaido. *Transact. Proc. Palaeontol. Soc. Japan, N.S.*, no. 122, 127-134, pl. 15.

Ilyina, A. P. (1954 [published under the griff "top secret"; data of the opening for public use is May 12, 1957]), Molluscs of the Neogene deposits of South Sakhalin. *Transact. All-Union Geol.-Explor. Oil Inst., Spec. Ser.*, fasc. 10, 188-314, pls. 1-30 (in Russian).

Ilyina, A. P. (1963), Molluscs of the Neogene of Kamchatka. *Transact. All-Union Petroleum Sci. -Res. Geol. -Explor. Inst.*, **202**, 1-242, pls. 1-54 (in Russian)

*International Code of Zoological Nomenclature. 4th Edition. Adopted by the International Union of Biological Sciences*. International Trust for Zoological Nomenclature, London, 1999 (Russian traslation: "Nauka" Publ. House, St. -Peterburg, 2000., 222 p.).

Kafanov, A. I. (1974), Composition, taxonomy and evolution of the group Clinocardium (Mollusca, Cardiidae). *Zoologicheskiy Zhurnal [Zool. J.]*, **53**(10), 1466-1476 (in Russian).

Kafanov, A. I. (1980), Systematics of the subfamily Clinocardiinae Kafanov, 1975 (Bivalvia, Cardiidae). Malacologia, **19**(2), 297-328.

Kafanov, A. I. (2001), Recent and fossil Clinocardiinae (Bivalvia, Cardiidae) of the World. V. Genus *Ciliatocardium* Kafanov, 1974 (Part 1). *Bull. Mizunami Fossil Mus.*, no. 28, 139-171, 7pls.

Kafanov, A. I., Ogasawara, K. and Marinkovich, L. jr. (2000), Checklist and bibliography of the Cenozoic marine Bivalvia (Mollusca) of Northeastern Asia (Russian Far East), 1939-1967. *Bull. Mizunami Fossil Mus*, no. 27, 13-107.

Kafanov, A. I. and Savizky, V. O. (1982), A review of Paleogene and Neogene *Ciliatocardium* (Bivalvia, Cardiidae) of Sakhalin. *Paleontologichesky Zhurnal [Paleontol. J.]*, no. 3, 53-61. (in Russian).

Kamada, Y. (1962), Tertiary marine Mollusca from the Joban coal-field, Japan. *Palaeontol. Soc. Japan Spec. Paps.*, no. 8, 1-187, pls. 1-21.

Kanehara, K. (1937), On *Cardium* (*Cerastoderma*) *shinjiense* Yokoyama, with description of a new species, *C. uyemurai*. *Venus*, **7**(4), 173-178 (in Japanese and English).

Kanno, S. (1971), Tertiary molluscan fauna from the Yakataga district and adjacent areas of Southern Alaska. *Palaeontol. Soc. Japan Spec. Paps.*, no. 16, 1-154, pls. 1-18.

Kanno, S. and Ogawa, H. (1964), Molluscan fauna from the Momijiyama and Takinoue districts, Hokkaido, Japan. *Sci. Rep. Tokyo Kyoiku Daigaku, Sec. C*, **8**(81), 269-294, pls. 1-4.

Kaseno, Y. and Matsuura, N. (1965), Pliocene shells from the Omma Formation around Kanazawa City, Japan. *Sci. Repts. Kanazawa Univ.*, **10**(1), 27-62, pls. 1-20.

Keen, A. M. (1954), Five new species and a new subgenus in the pelecypod family Cardiidae. *Bull. Amer. Paleontol.*, **35** (153), 1-24 (311-330), pl. 1(29).

Khomenko, I. P. (1933), On the age of the Tertiary formation along the coast of Korf Gulf, Kamtchatka. *Transact. Far-East Geol. Prosp. Trust*, fasc. 287, 1-32, pls. 1-6 (in Russian with English summary).

Khramova, S. N. (1962), Three new species of the genus *Clinocardium* from Tertiary deposits of Sakhalin *Transact. All-Union Petroleum Sci. -Res. Geol. -Explor. Inst., New Ser.*, fasc. 196. Paleontological collection, 3, 435-440, pl. 1 (in Russian).

Korobkov, I. A. (1949 [1959]), Class Lamellibranchiata. *In* A. N. Ryabinin and A. I. Korobkov (eds.), *Atlas of the leading forms in the fossil faunas of the USSR. Vol. XII. Paleogene.* "Gosgeolizdat" Publ. House, Moscow, p. 152-230, pls. 21-62 (in Russian).

Krishtofovich, L. V. (1947), Stratigraphy and fauna of the Tighil Series of the western coast of Kamchatka. *Transact. All-Union Petroleum Sci. -Res. Geol. -Explor. Inst., New Ser.*, iss. 23, 1-152, pls. 1-22 (in Russian with English title and summary).

Krishtofovich, L. V. (1954 [published under the griff "top secret"; data of the opening for public use is May 12, 1957]), Molluscs of the Tertiary deposits of South Sakhalin (lower suites). *Transact. All-Union Petroleum Sci. -Res. Geol. -Explor. Inst., Spec. Ser.*, fasc. 10, 5-121, 182-187, pls. 1-30 (in Russian).

Krishtofovich, L. V. and Ilyina, A. P. (1961), Biostratigraphy of the Paleogene and Neogene deposits of Tigilsky District of Western Kamchatka. *In The unified stratigraphic schemes of Northeast of the USSR*, "Gostoptekhizdat" Publ. House, Moscow, p. 170-180, pls. 1-20 (in Russian).

Kuroda, T. (1931), Fossil Mollusca. *In*, F. Homma, *Geology of central Shinano.* Pt. 4. Kokin-shoin, Tokyo, p. 1-90, pls. 1-13 (in Japanese).

Loel, W. and Corey, W. H. (1932), The Vaqueros Formation, lower Miocene of California. 1. Paleontology. *Univ. Calif. Publ., Bull. Dept. Geol. Sci.*, **22** (3), 31-410, pls. 4-65.

MacNeil, F. S., Mertie, J. B. jr. and Pilsbry, H. A. (1943), Marine invertebrate faunas of the buried beaches near Nome, Alaska. *J. Paleontol.*, **17**(1), 69-96, pls. 10-16.

Makiyama, J. (1934), The Asagaian Mollusca of Yotukura and Matchgar. *Mem. Coll. Sci. Kyoto Imp.Univ., ser. B,* **10** (2), art. 6, 121-167, pls. 3-7.

Makiyama, J. (1959), Matajiro Jokoyama's Tertiary fossils from various localities in Japan. Pt. III. *Palaeontol. Soc. Japan Spec. Pap.*, no. 5, 1-4, pls. 58-84.

Middendorff, A. T. von. (1849), Beitrage zu einer Malacozoologia Rossica. III. Aufzählung und Beschreibung der zur Meeresfauna Russlands gehörigen Zweischaler. *Mém. l'Acad. Imp. Sci. St. -Pétersbourg. Sci. natur.*, **6**, 1-94, Tafn. 11-21.

Moore, E. J. (1998), Family Cardiidae, *In* E. J. Moore, *Tertiary marine pelecypods of California and Baja California, Chapter F: http://www.e-z.net/~chintimp/Cardiidae.htm,* 21 p., 2 pls.

Noda, H. and Masuda, K. (1968), On the early Miyagian marine fauna from the Ojika Peninsula, Miyagi Prefecture, Japan. *Saito Ho-on Kai Mus. Nat. Hist. Res. Bull.*, no. 37, 1-9, pl. 1.

Noda, Y. (1992), Neogene molluscan faunas from the Haboro coal-field, Hokkaido, Japan. *Sci. Repts. Tohoku Univ., 2nd Ser.,* **62** (1-2), 1-140, pls. 1-16.

Noda, Y. and Hoyanagi, K. (1993), Molluscan fauna from the Miocene Meshikuni Formation on Rebun Island, northern Hokkaido. *Transact. Proc. Palaeontol. Soc. Japan, New Ser.*, no. 172, 311-327.

Nomura, S. (1935), On some Tertiary Mollusca from Northeast Honsyu [sic!], Japan. Pt. 2. Fossil Mollusca from the vicinity of Ogino, Yama-gun, Hukusima-ken. *Saito Ho-on Kai Mus. Nat. Hist. Res. Bull.*, no. 5, 101-130, pl. 5-7.

Nomura, S. and Hatai, K. (1936), A note on some fossil Mollusca from Tsugaru Peninsula, Northeast Japan. *Jap. J. Geol. Geogr.*, **13** (3-4), 277-281, pl. 33.

Ogasawara, K. (1973), Molluscan fossils from the Nishikurosawa Formation, Oga Peninsula, Akita Prefecture, Japan. *In* K. Asano and N. Kitamura (eds.), *Professor Kotora Hatai memorial volume. Sci. Repts. Tohoku Univ., 2nd Ser,* spec. vol. no. 6, 137-155, pls. 12, 13.

O'Hara, S. and Nemoto, N. (1984), Molluscan fossils from the type Goyasu Formation of the Joban coalfield. *J. Coll. Arts Sci. Chiba Univ.*, **B-17**, 45-61, pls. 1, 2.

Oyama, K., Mizuno, A. and Sakamoto, T. (1960), *Illustrated handbook of Japanese Paleogene molluscs.* Geological Survey of Japan, 244 p., 71 pls.

Savizky, V. O. (1978), Representatives of the genus *Ciliatocardium* (Bivalvia) in Cenozoic of Sakhalin. *In* Z. N. Pojarkova (ed.), *Biostratigraphy of the south of the Far East* (*Fanerozoic*). Far East Science Centre, Academy of Sciences of the USSR, Vladivostok, p. 118-120 (in Russian).

Simonova, A. A. (1941), Fauna of the Tertiary strata from south eastern part of Soviet Sakhalin. *Transact. Geol. Oil Inst., New Ser.* fasc. 18, 1-80, pls. 1-25 (in Russian and English for new taxa).

Sinelnikova, V. N., Fotjanova, L. I., Tschelebaeva, A. I., Skiba, L. A., Lupikina, E. G., Tshepalyga, A. L. and Drushchits, Yu. G. (1976), The Mio-Pliocene of the West Kamtschatka [sic!] (The Erman Suite and paleontological data substantiation of its age). *Transact. Geol. Inst., USSR Acad. Sci.*, **294**, 1-280, pls. 1-41 (in Russian with English title and contents).

Slodkewitsch, W. S. (1936), Stratigraphy and fauna of the Tertiary deposits of western coast of Kamchatka. Pt. 1. *Transact. Geol. Oil Inst., Ser. A,* fasc. 79, 1-209, pls. 1-18 (in Russian and English).

Slodkewitsch, W. S. (1938), *Tertiary Pelecypoda from the Far East.* The USSR Academy of Sciences Press, Moscow and Leningrad. Pt. 1. (Paleontology of USSR, vol. 10, pt. 3, fasc. 18), 508 p. (in Russian); Pt. 2. (Paleontology of USSR, vol. 10, pt 3, fasc. 19), 275 p., 104 pls. (in Russian and English).

Uozumi, S., Fujie, T. and Matsui, M. (1966), Neogene molluscan fauna in Hokkaido. Pt. 3. Description of the Ainonai fauna associated with *Desmostylus* cf. *minor* Nagao, from Kitami district, East Hokkaido. *J. Fac. Sci. Hokkaido Univ.*, Ser. 4, **13** (2), 165-183, pls. 14, 15.

Volobueva, V. I., Belaya, B. V., Dolmatova, L. M., Grevtsev, A. V., Minyuk, P. S., Narkhinova, V. E., Polovova, T. P. and Shchiraya, O. A. (1992), *Northeast Asia marine Neogene key section on the Karaginsky Island. Pt. 2. Systematical part.* North East Multidiscipl. Sci. -Res. Inst., Far East Branch, Russ. Acad. Sci., Magadan City, 168 p., 52 pls. (in Russian).

Weaver, C. (1942 [1943]), Paleontology of the marine Tertiary formations of Oregon and Washington. *Univ. Washington Publ. Geol.*, **5**, Part I. Coelenterata, Vermes, Echinodermata, Molluscoidea, Mollusca: Pelecypoda; Scaphopoda, pp. 1-274; part II. Mollusca: Gastropoda; Cephalopoda; Arthropoda, pp. 275-562; part III. Bibliography, faunal colalities, correlation chart, faunal tables, plares, new names, index, p. 563-790.

Yokoyama, M. (1923), On some fossil Mollusca from the Neogene of Izumo. *Jap. J. Geol. Geogr.*, **2** (1), 1-9, pls. 1, 2.

Yokoyama, M. (1924), Molluscan remains from the lowest part of the Jo-Ban coal-field. *J. Coll. Sci. Imp. Univ. Tokyo,* **45** (3), 1-22, pls. 1-5.

Yokoyama, M. (1925), Molluscan remains from the middle part of the Jo-Ban coal-field. *J. Coll. Sci. Imp. Univ. Tokyo,* **45** (7), 1-21, pls. 1-3.

Yokoyama, M. (1926a), Fossil shells from Sado. *J. Fac. Sci. Imp. Univ. Tokyo, Sect. 2,* **1**(8), 249-312, pls. 32-37.

Yokoyama, M. (1926b), Tertiary Mollusca from southern Tôtômi. *J. Fac. Sci. Imp. Univ. Tokyo, Sect. 2,* **1**(9), 313-364, pls. 38-41.

Yokoyama, M. (1927a), Fossil Mollusca from Kaga. *J. Fac. Sci. Imp. Univ. Tokyo, Sect. 2,* **2** (4), 165-182, pls. 47-49.

Yokoyama, M. (1927b), Tertiary shells from the coal-field of Haboro, Teshio. *J. Fac. Sci. Imp. Univ. Tokyo, Sect. 2,* **2**

(4), 191-204, pls. 51, 52.

Yokoyama, M. (1929), Molluscan fossils from Karafto. *J. Fac. Sci. Imp. Univ. Tokyo, Sect. 2,* **2** (9), 369-398, pls. 71-76.

Zhidkova, L. S., Bevz, V. E., Ilyina, A. P., Krishtofovich, L. V., Neverova, T. I., Savizky, V. O. and Scheremetjeva, G. N. (1972), *Atlas of Neogene molluscs of the Kurile Islands.* "Nauka" Publ. House, Moscow, 164 p., 48 pls. (in Russian).

Zhidkova, L. S., Kusina, I. N., Lautenschläger, F. G. and Popova, L. A. (1968), *Atlas of the Upper Miocene and Pliocene molluscs of Sakhalin.* "Nauka" Publ. House, Moscow, 180 p., 50 pls. (in Russian).

Manuscript accepted on April 6, 2002

**Explanation of Plate 1**

Figs. 1-3. *Ciliatocardium ainuanum* (Yokoyama, 1927).
Lectotype (1) and paralectotypes (2, 3) of *Cardium ainuanum* Yokoyama, 1927 − UMUT no. CM26358 (Fig. 1), no. CM26356 and CM26357 (Figs. 2, 3); external casts of right valves (reproduced from: Yokoyama, 1927, pl. 51, figs. 5-7). Sankebetsu, Haboro-machi, Tomamae District, Teshio Province, Hokkaido, Japan; Miocene Haboro Formation.

Figs. 4, 5. *Ciliatocardium asagaiense* (Makiyama, 1934).
Holotype of *Cardium* (*Cerastoderma*) *asagaiense* Makiyama, 1934 − Institute of Geology and Mineralogy, Kyoto University, no. 350011 (fig. 4, ×1.3); external cast of left valve. Taira, Yotsukura, Iwaki District, Fukushima Prefecture, Honshu, Japan; Oligocene Shiramizu Group, Asagai Formation.
Holotype of *Clinocardium salvationemense* Lautenschläger in Khramova, 1962 − CNIGRM no. 84/6197; external cast in rock (Fig. 5). Sea coast near Spasennyi Point, Aleksandrovsk-Sakhalinskiy District, Sakhalin, Russia; Oligocene Gennoyshinskaya Suite.

Figs. 6, 7. *Ciliatocardium ermanense* (Sinelnikova in Sinelnikova *et al*., 1976).
Holotype of *Clinocardium ermanensis* Sinelnikova in Sinelnikova *et al*., 1976 − GIN no. 3666/388 (mould) and 3666/290 (impress); latex Cast of right valve (Fig. 6, ×1.5) and latex Cast of right valve hinge (Fig. 7, ×1.8). Key section near Enemten Rocks, Tigil'skiy District, Western Kamchatka, Russia; the base of Ermanovskaya Suite, Upper Miocene.

Figs. 8, 9. *Ciliatocardium coosense* (Dall, 1909).
Lectotype of *Cardium* (*Cerastoderma*) *coosense* Dall, 1909 − USNM no. 153933; external casts of right (8) and left (9) valves. Coos Bay, Oregon, U.S.A.; "Miocene" [Empire Formation].

Fig. 10. *Ciliatocardium carlsbergianum* Kafanov, sp. nov.
Holotype − VNIGRI no. 152/825; external cast of right valve. Krinka River, Makarov District, Sakhalin, Russia; Miocene Maruyamskaya Suite, Member III.

Fig. 11. *Ciliatocardium brooksi* (Clark, 1932).
Holotype of *Cardium* (*Papyridea*) *brooksi* Clark, 1932 − UCMP no. 30402; external cast of left valve in rock. Yakataga District (about 60° N), Gulf of Alaska, Alaska, U.S.A.; Pool Creek Formation, Upper Oligocene and/or Lower Miocene.

Figs. 12-16. *Ciliatocardium evsseevi* Kafanov et Savizky, 1982.
Holotype (15) − PIN no. 24/3962; external cast of left valve. 1 km upstream of the Chernigovka River mouth, Makarov District, Sakhalin, Russia; lower part of Gastellovskaya Suite, Oligocene. Paratypes−PIN no. 26/3962 (12), no. 30/3962 and 25/3962 (13, 14); external casts of left (12, 13) and right (14)valves. The same locality as holotype. Paratype − PIN no. 27/3962 (16); internal cast of right valve. near Pravda Village, Kholmsk District, Sakhalin, Russia; upper part of Oligocene Arakayskaya Suite.

Fig. 17. *Ciliatocardium hataii* (Hayasaka, 1956).
Holotype of *Clinocardium hataii* Hayasaka, 1956 − IGPS no. 77375; external cast of right valve (×0.9). Cliff of Takesegawa River west of Takakura, Futaba District, Fukushima Prefecture, Honshu, Japan; Pliocene Ishiguma Formation.

Fig. 18. *Ciliatocardium iwatense* (Chinzei, 1959).
Holotype of *Clinocardium iwatense* Chinzei, 1959 − UMUT no. CM8572; external cast of right valve (×0.9). Near Ochiai, Kintaichi-mura, Ninohe District, Iwate Prefecture, Honshu, Japan; Pliocene Kubo Formation.

All figures in natural size, unless otherwise stated.

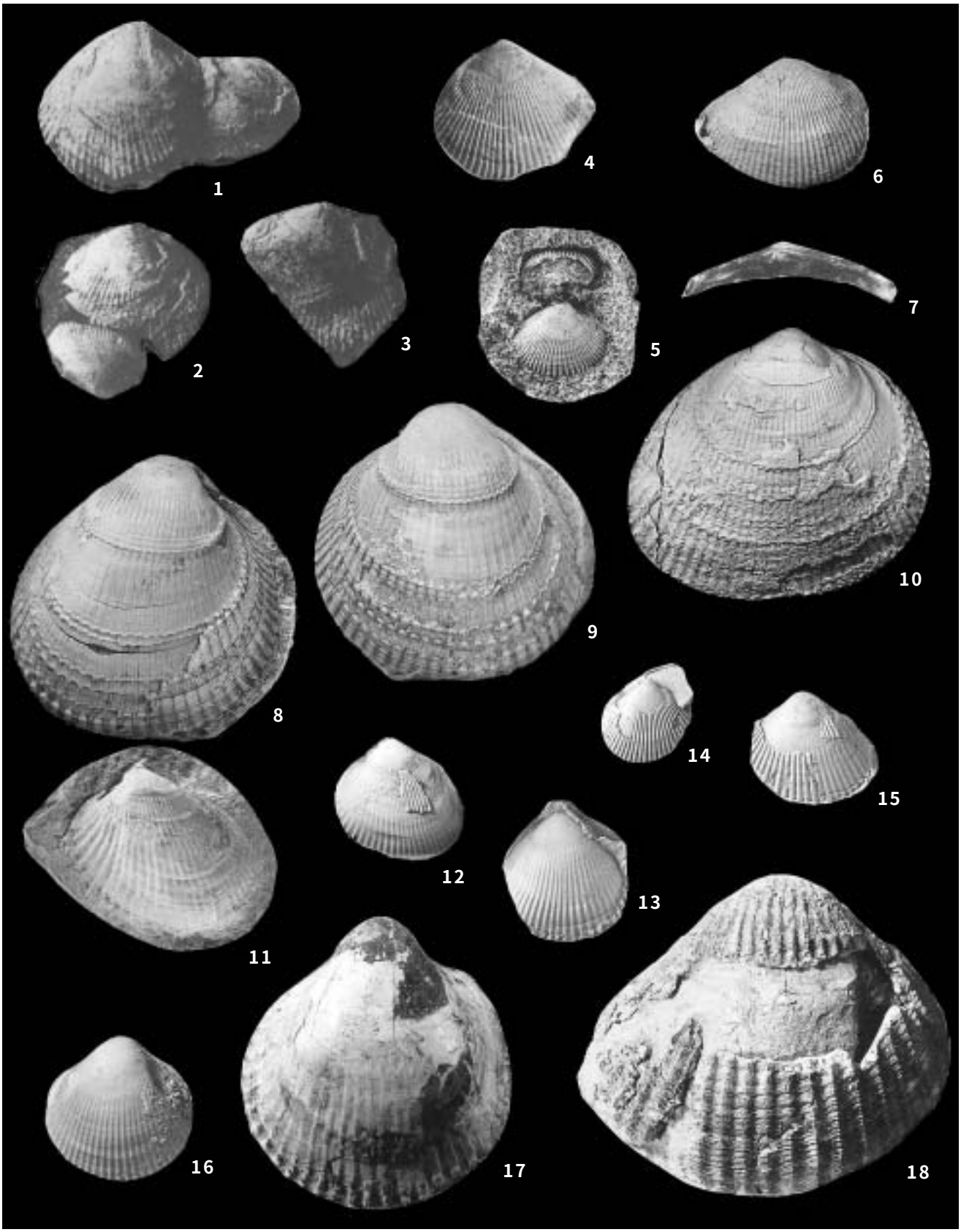

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

**Plate 2**

Figs. 1, 2. *Ciliatocardium sachalinense* (Khramova, 1962).
Holotype of *Clinocardium sachalinense* Khramova, 1962 − VNIGRI no. 46/659; external cast of left (1) and right (2) valves. Keton River, Poronaysk District, Sakhalin, Russia; the lowermost part of Kurasiyskaya Suite.

Fig. 3. *Ciliatocardium schmidti* (Khramova, 1962).
Holotype of *Clinocardium schmidti* Khramova, 1962 − VNIGRI no. 24/659; external cast of left valve. North coast of Schmidt Peninsula west of Machigar [Monchigar] Lake, Okha District, Sakhalin, Russia; middle part of Machigarskaya Suite.

Figs. 4-6. *Ciliatocardium smekhovi* Kafanov et Savizky, 1982.
Holotype − PIN no. 29/3962; external cast of left valve. Chekhovka River, Kholmsk District, Sakhalin, Russia; upper part of Arakayskaya Suite.
Paratypes − PIN no. 31/3962 (5) and 30/3962 (6); external cast of right (5) and left (6) valves. Skvortsovka River, Smirnykhov District, Sakhalin, Russia; lower part of Borskaya Suite.

Fig. 7. *Ciliatocardium matchgarense* (Makiyama, 1934).
External cast of left valve − VNIGRI no. 22/659. North coast of Schmidt Peninsula, Okha District, Sakhalin, Russia; Machigarskaya Suite.

Figs. 8-11. *Ciliatocardium reedi* (Loel et Corey, 1932).
Holotype of *Cardium* (*Acanthocardia*) *snatolensis* L. Krishtofovich, 1947 − CNIGRM no. 78/5610 (×2.0); external cast of paired shell from above (8), in front (9), left (10) and right (11). Sea coast near the Ilinyshka River, Tigil'skiy District, Western Kamchatka; Eocene Snatol'skaya Suite.

Figs. 12-15. *Ciliatocardium tigilense* (Slodkewitsch, 1938).
Holotype of *Laevicardium*(?) *tigilense* Slodkewitsch, 1938 − CNIGRM no. 914/5060; external cast of paired shell left (12), right (13), in front (14) and from above (15). Sea coast near the Polovinnaya River mouth, Western Kamchatka, Russia; Miocene Il'inskaya Suite.

Fig. 16. *Ciliatocardium yamasakii* (Makiyama, 1934).
Holotype of *Cardium* (*Cerastoderma*) *yamasakii* Makiyama, 1934 − Institute of Geology and Mineralogy, Kyoto University, no. 100005; external cast of left valve. Shore of Marie Cape, near Matchigar [Monchigar], Schmidt Peninsula, Okha District, Sakhalin, Russia; Oligocene Vengeriyskaya Suite.

All figures in natural size, unless otherwise stated.

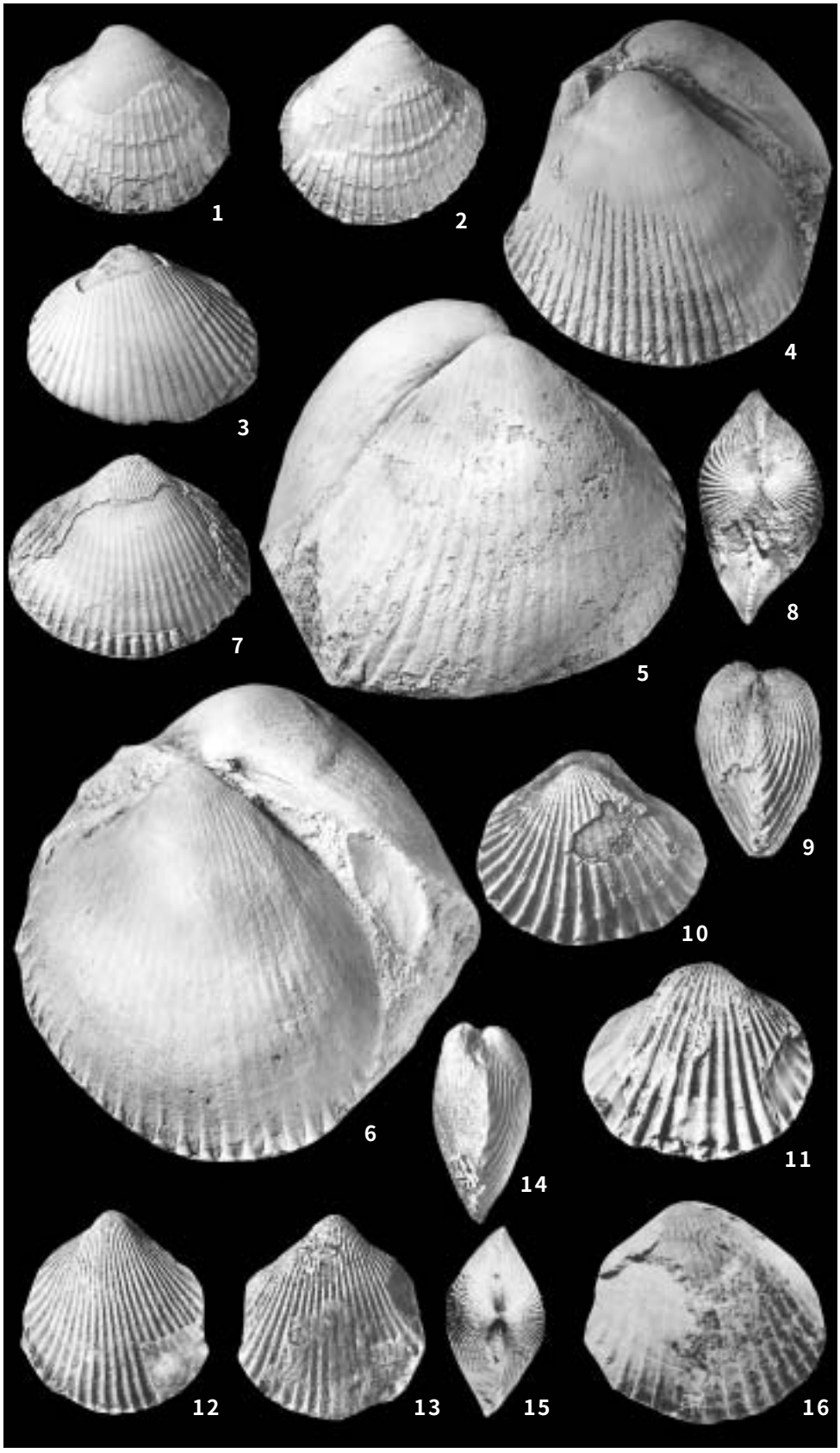

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

**Plate 3**

Figs. 1, 2. *?Ciliatocardium kirkerense* (Clark, 1918).
Holotype of *Cardium kirkerensis* (Clark, 1918) − UCMP no.11165; external cast of left valve in rock (1, ×2.4) and plastoholotype (2, ×2.4). West of Kirker's Creek, Diablo Quadrangle, Contra Costa County, California, U.S.A.; Kirker Tuff, Oligocene.

Figs. 3, 4. *Ciliatocardium makiyamae* (Kamada, 1962).
Holotype of *Clinocardium asagaiense makiyamae* Kamada, 1962 − IGPS no. 15800; external cast of left (3, ×1.3) and right (4, ×1.3) valves. Nabezuka, Nirono-machi, Joban coal-field, Honshu, Japan; Oligocene Asagai Formation.

Figs. 5, 6. *Ciliatocardium moorae* Kafanov, sp. nov.
Holotype − CNIGRM no. 138/5294; external cast of left (5) and right (6) valves. Between Noyami and Malyi Serutay Rivers, Aleksandrovsk-Sakhalinskiy District, Sakhalin, Russia; Miocene Sertunayskaya and/or Aleksandrovskaya Suite.

Figs. 7, 8. *Ciliatocardium zhidkovae* Kafanov in Arkhipova *et al*., [1994].
Holotype (7), external cast of left valve, and paratype (8), external cast of right valve − VNIGRI no. 161/825 and 161a/825. Gornaya River, Makarov District, Sakhalin, Russia; upper part of Gastellovskaya Suite.

Fig. 9. *Ciliatocardium matchgarense* (Makiyama, 1934).
Holotype of *Cardium* (*Cerastoderma*) *matchgarense* (Makiyama, 1934)−Institute of Geology and Mineralogy, Kyoto University, no. 100007; external cast of right valve. Sea coast, near Matchigar [Monchigar], Schmidt Peninsula, Okha District, Sakhalin, Russia; Oligocene "Marie Formation" [Vengeriyskaya Suite].

Fig. 10. *Ciliatocardium mutuense* (Nomura et Hatai, 1936).
Holotype of *Cardium* (*Clinocardium*) *mutuense* Nomura et Hatai, 1936 − SHM no. 8799; external cast of left valve in rock. Komatazawa, Aiuti-mura, Mutu Province, Honshu, Japan; Miocene Isomatsu Formation.

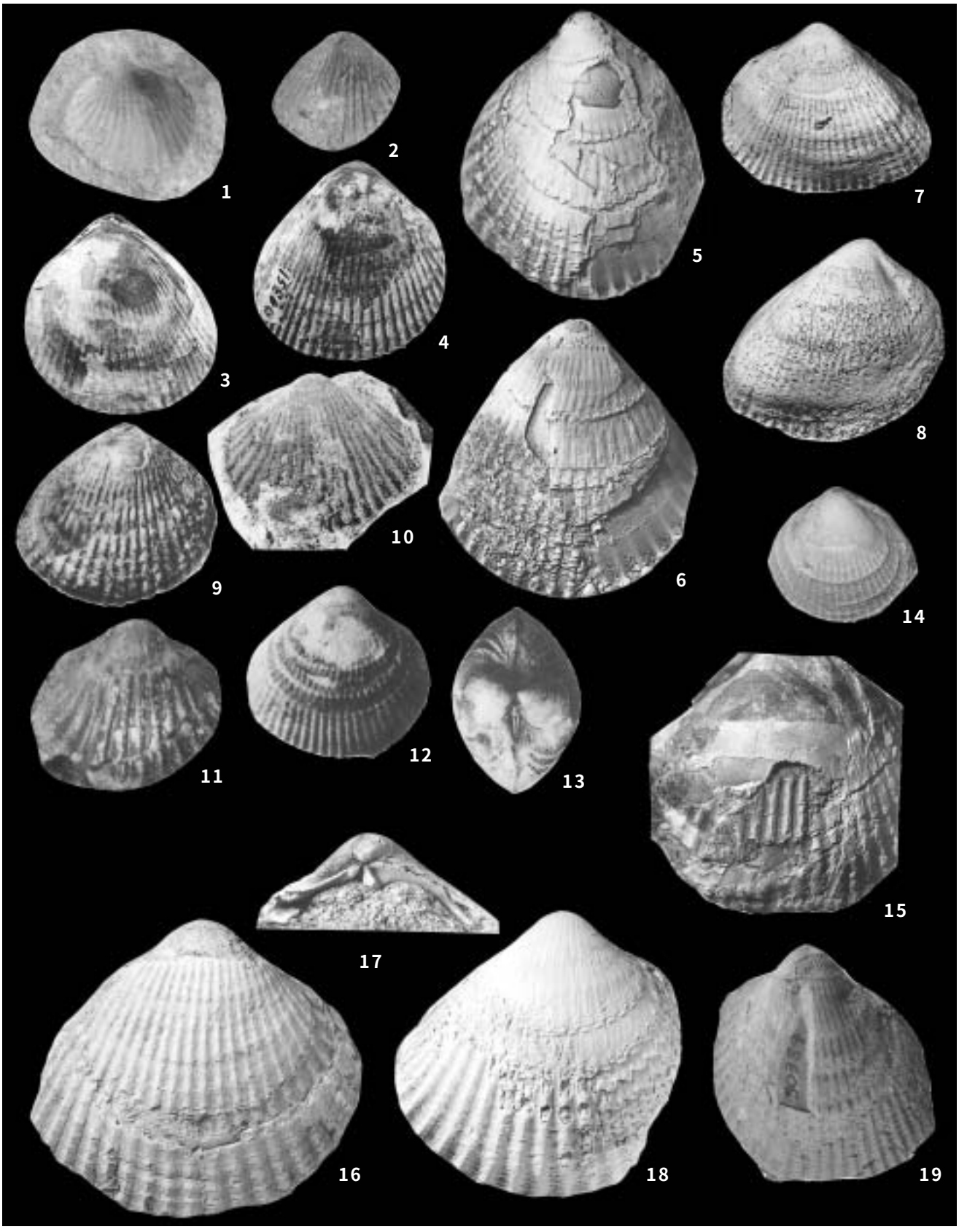
Fig. 11. *Ciliatocardium reedi* (Loel et Corey, 1932).
Holotype of *Cardium* (*Acanthocardia*) *reedi* Loel et Corey, 1932 − UCMP no. 31772; external cast of right valve (× 2.4). "The Vaqueros-Temblor transition zone at Anderson Creek, La Panza Mountains, with a transitional faunule including *Turritella inezana altacorona* n. var., and *T. ocoyana* s.s.", San Luis Obispo County, California, U.S.A.; Vaqueros Formation, Oligocene and Miocene.

Figs. 12, 13. *Ciliatocardium shinjiense* (Yokoyama, 1923).
Lectotype of *Cardium shinjiense* Yokoyama, 1923 − UMUT no. CM24580; external cast of right valve (12) and paired shell from above (13) (reproduced from: Yokoyama, 1923, pl. 2, figs. 6 a, b). Fujina, Tamayu-mura, Yatsuka District, Shimane Prefecture, Honshu, Japan; Miocene Fujina Formation.

Fig. 14, 15. *Ciliatocardium obstinatus* (Barinov in Barinov *et al*., 1992).
Holotype (14) and paratype (15, ×4.0) of *Clinocardium obstinatus* Barinov in Barinov *et al*., 1992 − GIN no. 8751/37 and 8751/37a; external cast of left valve (14) and fragment of the external sculpture (15). Southwest coast of Karaginsky Island, 12 km south of Yun'yun'vayam River, Eastern Kamchatka, Russia; Miocene Pestrotsvetnaya Suite, Layer 10.

Figs. 16-18. *Ciliatocardium uyemurai* (Kanehara, 1937).
PIN no. 32/3962; external cast of right valve (16). Bachinskaya River, Aniwa District, Sakhalin, Russia; Pliocene Maruyamskaya Suite, Member IV. Hinge (17) and external cast of right valve (18). Pobedinka River, Poronaysk District, Sakhalin, Russia; upper part of Maruyamskaya Suite, Pliocene.

Fig. 19. *Ciliatocardium yakatagense* (Clark, 1932).
Holotype of *Cardium* (*Cerastoderma*) *yakatagense* Clark, 1932 − UCMP no. 30384; external cast of left valve. Yakataga District (about 60° N), coast of the Gulf of Alaska, Alaska, U.S.A.; upper part of Pool Creek Formation, ?Miocene.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19