SYSTEMATIC DESCRIPTIONS: ARCHAEOCYATHA

F. Debrenne, A. Yu. Zhuravlev, and P. D. Kruse

Phylum PORIFERA Grant, 1836
Class ARCHAEOCYATHA Bornemann, 1884

[*nom. correct.* Vologdin, 1937b, p. 464, *pro* Archaeocyathinae Bornemann, 1884, p. 706] [=class Archaeocyathinae Taylor, 1910, p. 105; =class Cyathospongia Okulitch, 1935b, p. 88; =class Archaeocyathi R. Bedford & W. R. Bedford, 1936, p. 9; =subphylum Archaeocyatha Vologdin, 1937b, p. 464 (Porifera); =class Pleospongia Okulitch, 1943, p. 1; =phylum Archaeocyatha Okulitch, 1955a, p. 8; =phylum Archaeocyathi Krasnopeeva, 1955, p. 17; =subphylum Euarchaeocyatha Zhuravleva, 1960b, p. 79, *nom. transl.* Zhuravlev & others in Sokolov & Zhuravleva, 1983, p. 6, *ex* class Euarchaeocyathi Zhuravleva, 1960b, p. 79; =Salpingidea Vologdin & Yazmir, 1967, p. 1377; =phylum Archaeocyatha Hill, 1972, p. 2; =Euarchaeocyatha Zhuravleva & Myagkova, 1979, p. 521] [equivalent to superfamily Archaeocyathaceae Simon, 1939, p. 5]

Skeleton nonspiculate, calcareous cup of microgranular microstructure and (with few exceptions) original magnesium calcite composition. Cup generally of archaeocyathan architecture with one or two porous walls bounding inner or central cavity respectively; porous to aporose septa, pseudosepta, taeniae, pseudotaeniae, pseudotaenial network, dictyonal network, syringes, and/or tabulae may form in intervallum; a minority are of chaetetid (intervallum with calicles) or thalamid architecture (cup consisting of successive chambers). Solitary or modular. Secondary calcareous skeleton may be present. [For an explanation of zonal terms used herein, see General Features of the Archaeocyatha, p. 909–912.] *Cambrian (Terreneuvian–Furongian).*

Order MONOCYATHIDA Okulitch, 1935

[*nom. correct.* Okulitch, 1955a, p. 9, *pro* order Monocyathina Okulitch, 1935b, p. 90] [=Archaeolynthida Zhuravleva, 1957, p. 174; =Tectocyathida Vologdin in Vologdin & Yazmir, 1966, p. 948; =suborder Globosocyathina Okuneva, 1969, p. 74; =suborder Monocyathina Debrenne, 1970a, p. 24; =Tecticyathida Vologdin, 1977, p. 93]

Cup one walled, solitary or low modular; pelta may be present. [Within each (sub) order, superfamilies and constituent families are arranged in order of wall type.] *lower Cambrian (Tom.1–Bot.3).*

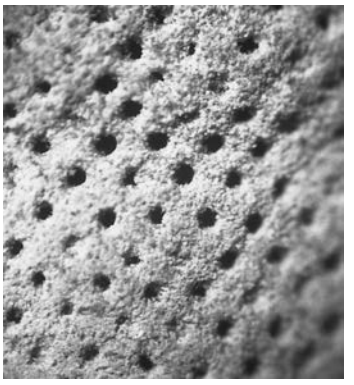
Family MONOCYATHIDAE R. Bedford & W. R. Bedford, 1934

[Monocyathidae R. Bedford & W. R. Bedford, 1934, p. 2] [=Rhabdocnemidae Okulitch, 1943, p. 45, *nom. nov. pro* Rhabdocyathidae Vologdin, 1931, p. 52, invalid family-group name based on junior homonym; =Archaeolynthidae Zhuravleva, 1949, p. 550; =Monocyathinae Zhuravleva, 1963b, p. 74, *nom. transl. ex* Monocyathidae R. Bedford & W. R. Bedford, 1934, p. 2; =Rhabdocyathellidae Zhuravleva, 1963b, p. 114; =Capsolynthidae Okuneva, 1969, p. 75; =Crassicyathidae Vologdin, 1977, p. 79; =Spinicyathidae Vologdin, 1977, p. 103]

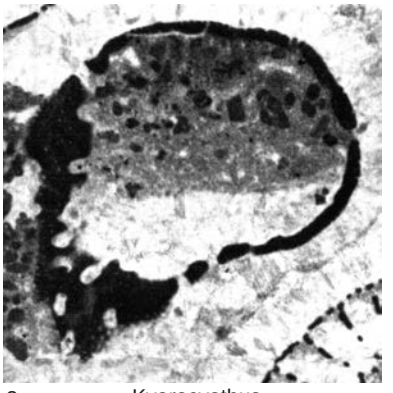
Wall with simple pores. *lower Cambrian (Tom.1–Bot.3).*

Archaeolynthus Taylor, 1910, p. 158 [**Monocyathus porosus* R. Bedford & W. R. Bedford, 1934, p. 2; SD R. Bedford & W. R. Bedford, 1936, p. 20; lectotype, R. Bedford & W. R. Bedford, 1934, fig. 1; Zhuravleva, 1963b, fig. 39d; Hill, 1965, pl. 2,*1;* Debrenne, 1969a, pl. 1,*3;* Debrenne, 1974b, pl. 19,*1;* SD Hill, 1965, p. 52, NHM S4140, London] [=*Ventriculocyathus* Vologdin, 1928, p. 31, *nom. nud.;* =*Ventriculocyathus* Vologdin, 1931, p. 51 (type, *V. caulius,* M), for discussion, see Hill, 1965, p. 63; =*Monocyathus* R. Bedford & W. R. Bedford, 1934, p. 2 (type, *M. porosus,* SD R. Bedford & W. R. Bedford, 1936, p. 20; lectotype, Hill, 1965, pl. 2,*1;* SD Hill, 1965, p. 52, S4140, NHM, London); =*Rhabdocnema* Okulitch, 1937a, p. 252, *nom. nov. pro Rhabdocyathus* von Toll, 1899, p. 45, *non* Brook, 1893, cnidarian (type, *R. sibiricus,* M), for discussion, see Hill, 1965, p. 51; =*Rhabdocyathella* Vologdin, 1937b, p. 474 (type, *R. lebedevae*, M), for discussion, see Hill, 1965, p. 53; =*Capsolynthus* Osadchaya in Zhuravleva & others, 1967, p. 26 (type, *C. helenae,* OD); =*Corticicyathus* Vologdin, 1977, p. 46 (type, *C. aequiporosus,* OD); =*Crassicyathus* Vologdin, 1977, p. 79 (type, *C. canaliculatus,* OD); =*Tegminicyathus* Vologdin, 1977, p. 98 (type, *T. simplex,* OD); =*Tytthocyathus* Vologdin, 1977, p. 98 (type, *T. jenisseicus,* OD); =*Spinicyathus* Vologdin, 1977, p. 103 (type, *S. cipis,* OD), for discussion, see Debrenne, Zhuravlev, & Rozanov, 1989, p. 94; Debrenne, Rozanov, & Zhuravlev, 1990, p. 133]. Wall pores of uniform size. *lower Cambrian (Tom.1–Bot.3):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East, Australia, Antarctica, Morocco, Iberia.——Fig. 524,*1a–b.* **A. porosus* (R. Bedford & W. R. Bedford), Ajax Limestone, Botoman, Ajax Mine, South Australia, Australia, lectotype, NHM S4140; *a,* external

1a Archaeolynthus



1b



2 Kyarocyathus

FIG. 524. Monocyathidae (p. 923–924).

longitudinal view of cup, ×5 (Hill, 1965); *b,* detail of porosity in external tangential view, ×10 (Debrenne, 1974b).

Kyarocyathus KRUSE, 1982, p. 144 [**K. duplus*; OD; holotype, KRUSE, 1982, fig. 7H–J, AM FT.8240, FT.8244, Sydney]. Wall pores of two distinct sizes. *lower Cambrian (Bot.1–Bot.2):* Mongolia, Australia.——FIG. 524,*2. *K. duplus*, Mount Wright Volcanics, Botoman, Mt. Wright, New South Wales, Australia, AM FT.8240, FT.8244, oblique transverse section, ×10 (Kruse, 1982).

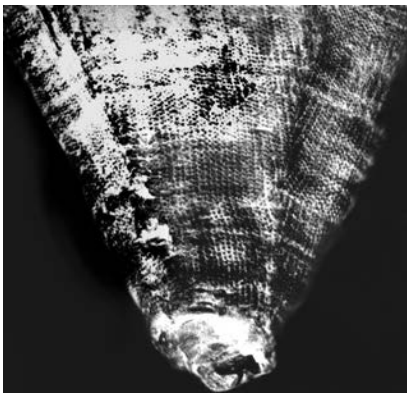
Family PALAEOCONULARIIDAE Chudinova, 1959

[Palaeoconulariidae CHUDINOVA, 1959, p. 53] [=Debrennecyathidae VOLOGDIN in VOLOGDIN & YAZMIR, 1966, p. 948, invalid family-group name based on unavailable genus name; =Debrennecyathidae VOLOGDIN, 1977, p. 100]

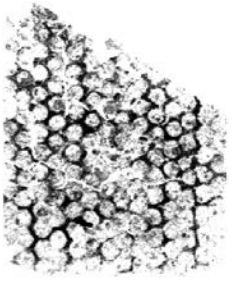
Wall with attached microporous sheath. *lower Cambrian (Atd.4–Bot.3).*

Palaeoconularia CHUDINOVA, 1959, p. 53 [**P. prima*; OD; holotype, CHUDINOVA, 1959, fig. 1–2, PIN 1577/1, Moscow] [=*Laminaecyathus* YAZMIR in VOLOGDIN & YAZMIR, 1966, p. 948 (type, *L. triangulatus*, OD); =*Debrennecyathus* VOLOGDIN in VOLOGDIN & YAZMIR, 1966, p. 948, *nom. nud.*, unavailable genus-group name without associated nominal species; =*Debrennecyathus* VOLOGDIN, 1977, p. 101 (type, *D. pulcher*, OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 122; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 154]. Wall with reticulate carcass pores and attached microporous sheath. *lower Cambrian (Bot.1–Bot.3):* Altay Sayan, Tuva, Mongolia, Transbaikalia.——FIG. 525,*1a–c. *P. prima*, Verkhnemonok Formation, Botoman, Karakol River, West Sayan, Altay Sayan, Russia, holotype, PIN 1577/1; *a,* external longitudinal view of cup, ×2; *b,* tangential section of microporous sheath, ×6; *c,* tangential section of carcass pores, ×11 (Chudinova, 1959).

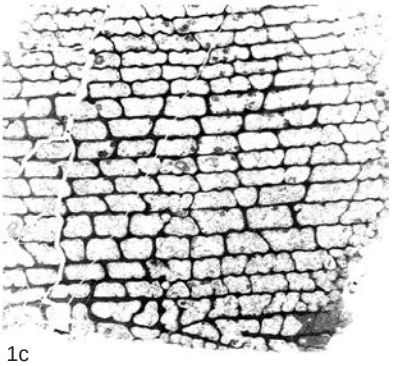
?Butakovicyathus ZHURAVLEVA, 1980, p. 175 [**B. butakovi;* OD; holotype, ZHURAVLEVA, 1980, pl. 30,*1–2*, TsSGM 569, Novosibirsk]. Wall carcass pores of two distinct sizes with attached



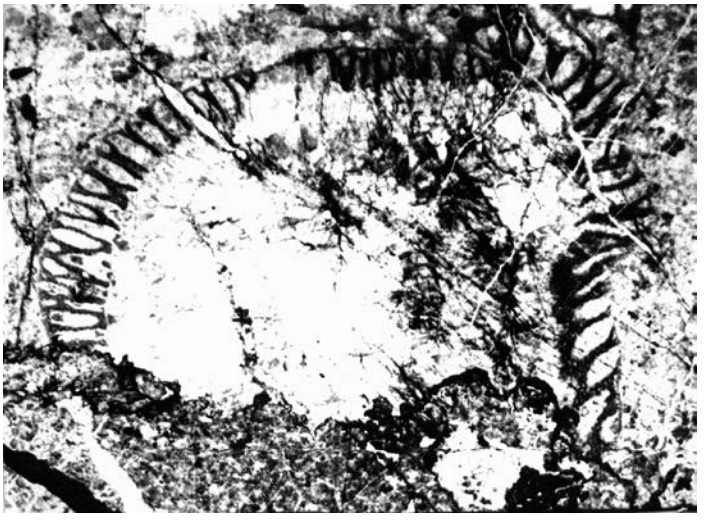
1a Palaeoconularia



1b



1c



2 Butakovicyathus

FIG. 525. Palaeoconulariidae (p. 924–926).

microporous sheath. [The single available section does not provide certainty as to wall structure.] *lower Cambrian (Atd.4–Bot.1):* Altay Sayan.——FIG. 525,*2. *B. butakovi*, Krol Formation, Atdabanian, Mana River, East Sayan, Altay Sayan, Russia, holotype, TsSGM 569, transverse section, ×12 (Zhuravleva, 1980).

Family TUMULIOLYNTHIDAE Rozanov, 1966

[Tumuliolynthidae ROZANOV in ROZANOV & MISSARZHEVSKIY, 1966, p. 77] [=Papulicyathidae VOLOGDIN, 1977, p. 62; =Verrucicyathidae VOLOGDIN, 1977, p. 63; =Orthocyathidae VOLOGDIN, 1977, p. 96]

Wall with simple tumuli. *lower Cambrian (Tom.2–Bot.3).*

Tumuliolynthus ZHURAVLEVA, 1963b, p. 101 [**Rhabdocyathus tubexternus* VOLOGDIN, 1932, p. 64; OD; holotype, VOLOGDIN, 1932, pl. 5,*1a*, TsNIGRm 209a/2957, St. Petersburg] [=*Papulicyathus* VOLOGDIN, 1977, p. 62 (type, *P. longus,* OD); =*Verrucicyathus* VOLOGDIN, 1977, p. 64 (type, *V. tumefactus,* OD), for discussion, see KRUSE, 1982, p. 144; =*Isthmocyathus* VOLOGDIN, 1977, p. 70 (type, *I. articulatus,* OD); =*Mammaticyathus* VOLOGDIN, 1977, p. 71 (type, *M. kyzasicus*, OD); =*Orthocyathus* VOLOGDIN, 1977, p. 97 (type, *O. bateniensis*, OD), *non Cyathophyllum (Orthocyathus)* MERRIAM, 1974, p. 34 (type, *Prismatophyllum flexum* STUMM, 1938, p. 483, OD), cnidarian; for discussion, see DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 165]. Wall with simple tumuli. *lower Cambrian (Tom.2–Bot.3):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East, Urals, Australia, Antarctica, Falkland Islands (allochthonous), Morocco, Iberia.——FIG. 526,*1. *T. tubexternus* (VOLOGDIN), Verkhneynyrga Formation, Botoman, Lebed' River, Altay Mountains, Altay Sayan, Russia, holotype, TsNIGRm 209a/2957, transverse section, ×3 (Vologdin, 1932).

Family SAJANOLYNTHIDAE Rozanov, 1989

[Sajanolynthidae ROZANOV in DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 79] [=Sajanolynthidae KASHINA in ROZANOV, 1973, p. 85, *nom. nud.*]

Wall with multiperforate tumuli. *lower Cambrian (Bot.1).*

Sajanolynthus VOLOGDIN & KASHINA, 1972, p. 152 [**S. desideratus;* OD; holotype, VOLOGDIN & KASHINA, 1972, pl. 20,*1*, KGU 19/1, Krasnoyarsk] [=*Pustulicyathus* VOLOGDIN, 1977, p. 94 (type, *P. tectus*, OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 129; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 159]. Wall with multiperforate tumuli. *lower Cambrian (Bot.1):* Altay Sayan, Far East.——FIG. 526,*2. *S. desideratus*, Torgashino Formation, Botoman, Uyar River, East Sayan, Altay Sayan, Russia, holotype, KGU 19/1, transverse section, ×15 (Vologdin & Kashina, 1972).

Family GLOBOSOCYATHIDAE Okuneva, 1969

[Globosocyathidae OKUNEVA, 1969, p. 75] [=Propriolynthidae ROZANOV, 1973, p. 85, *nom. nud.;* =Tumuloglobosidae ROZANOV, 1973, p. 85, *nom. nud.;* ?=Tecticyathidae VOLOGDIN, 1977, p. 93]

Wall with bracts or scales. *lower Cambrian (Atd.2–Bot.1).*

Propriolynthus OKUNEVA, 1967, p. 133 [**Archaeolynthus vologdini* YAKOVLEV, 1956, p. 855; OD; lectotype, YAKOVLEV, 1956, pl. 1,*1,* SD OKUNEVA, 1967, p. 133, not located] [=*Globosocyathus* OKUNEVA, 1969, p. 75 (type, *G. bellus,* OD); =*Tumuloglobosus* OKUNEVA in OKUNEVA & REPINA, 1973, p. 93 (type, *T. crassus,* OD); =*Subiculicyathus* VOLOGDIN, 1977, p. 49 (type, *Archaeolynthus vologdini* YAKOVLEV, 1956, p. 855, OD); ?=*Tecticyathus* VOLOGDIN, 1977, p. 93 (type, *Archaeolynthus peltathus* MASLOV, 1961, p. 121, OD); =*Propricyathus* OKUNEVA in VOLOGDIN, 1977, p. 100 (type, *P. maritimus*, OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 125; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 156]. Wall with pores bearing downwardly projecting, cupped bracts. *lower Cambrian (Atd.2–Bot.1):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Far East.——FIG. 526,*3a–b. *P. vologdini* (YAKOVLEV), Dmitrievka Formation, Botoman, Spassk-Chernigovka area, Far East, Russia, specimen PGU 30-x_2; *a,* oblique longitudinal section, ×3; *b,* tangential section, ×15 (Okuneva, 1967).

Melkanicyathus BELYAEVA, 1969, p. 88 [**M. limitatus;* OD; holotype, BELYAEVA, 1969, pl. 38,*2–3,* DVGU 212/5, Khabarovsk] [=*Phymatocyathus* VOLOGDIN, 1977, p. 72 (type, *P. orillatus,* OD); =*Scyphocyathus* VOLOGDIN, 1977, p. 96 (type, *Rhabdocnema operculatum* MASLOV, 1960, p. 1117, OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 118; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 151]. Wall with pores bearing upwardly projecting, cupped bracts. *lower Cambrian (Bot.1):* Altay Sayan, Far East.——FIG. 526,*4a–b. *M. limitatus*, Ust'toka unit, Botoman, Bol'shoy Mel'kan River, Dzhagdy Range, Far East, Russia, holotype, DVGU 212/5; *a,* oblique transverse section, ×6; *b,* longitudinal section, ×6 (Belyaeva, 1969).

Family FAVILYNTHIDAE Debrenne, 1989

[Favilynthidae DEBRENNE in DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 79] [=Favilynthidae DEBRENNE, 1974b, p. 98, *nom. nud.*]

Wall with canals. *lower Cambrian (Atd.1–Bot.3).*

Favilynthus DEBRENNE in ZHURAVLEVA, 1974a, p. 138 [**Monocyathus mellifer* R. BEDFORD & W. R.

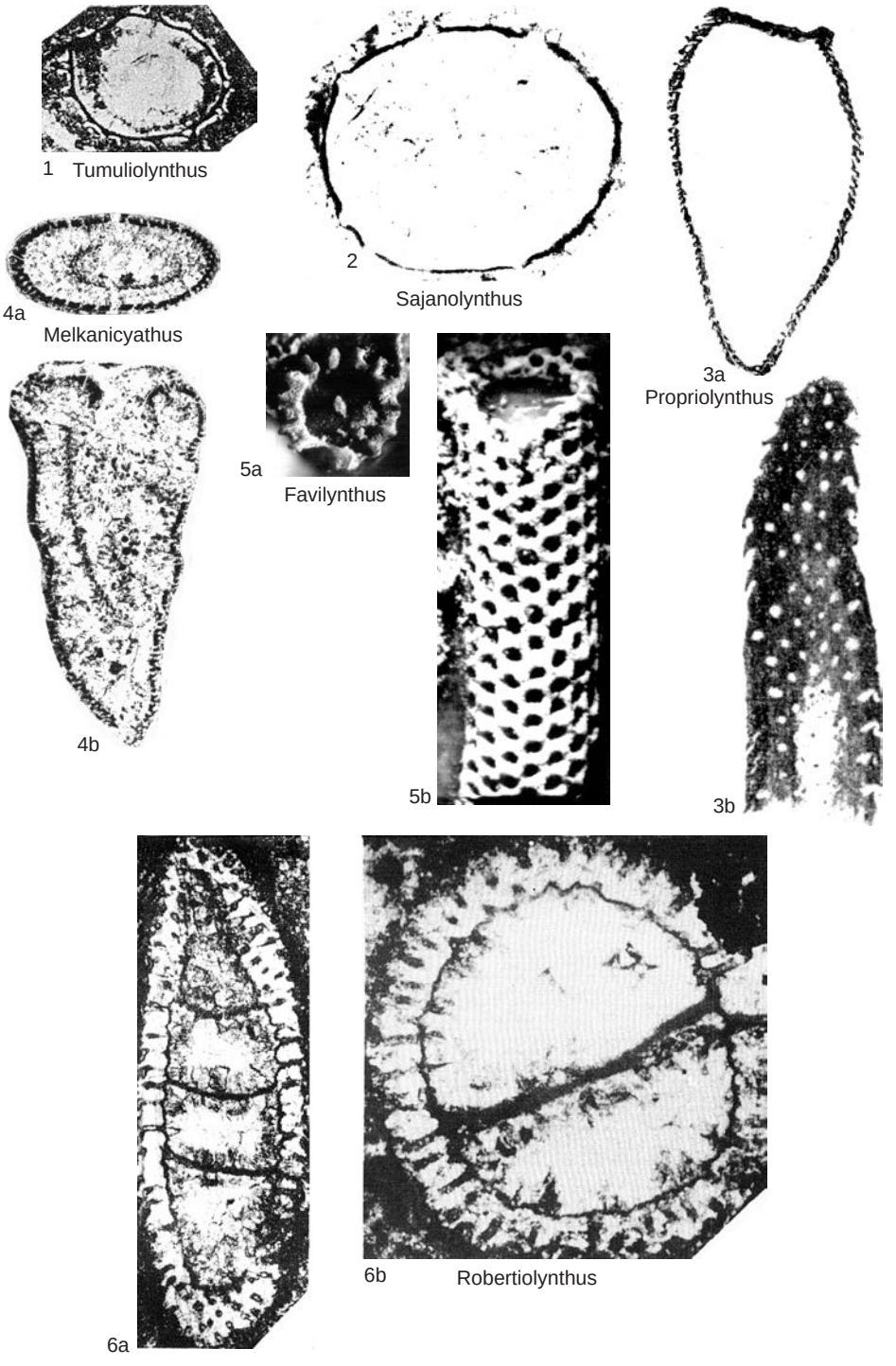


FIG. 526. Tumuliolynthidae, Sajanolynthidae, Globosocyathidae, and Favilynthidae (p. 926–928).

BEDFORD, 1936, p. 12; OD; holotype, R. BEDFORD & W. R. BEDFORD, 1936, fig. 49; ZHURAVLEVA, 1963b, fig. 42; DEBRENNE, 1974b, pl. 19,*5–6*, SAM P932-47, Adelaide]. Wall with horizontal to upwardly projecting, straight canals. *lower Cambrian (Atd.1–Bot.3):* Altay Sayan, Tuva, Mongolia, Far East, Australia, Antarctica, Falkland Islands (allochthonous).——FIG. 526,*5a–b*. **F. mellifer* (R. BEDFORD & W. R. BEDFORD), Ajax Limestone, Botoman, Ajax Mine, South Australia, Australia; *a,* external transverse view, holotype, SAM P932-47, ×6; *b,* external longitudinal view, topotype, USNM PU9, ×6 (Debrenne, 1974b).

Robertiolynthus ZHURAVLEV in VORONOVA & others, 1987, p. 19 [**R. handfieldi*; OD; holotype, VORONOVA & others, 1987, pl. 1,*1*, GSC 90116, Ottawa] [=*Veolynthus* BOYARINOV & KONYAEVA in ZHURAVLEVA & others, 1997a, p. 26 (type, *V. jucundus*, OD)]. Wall with horizontal to upwardly projecting, straight canals bearing supplementary bracts externally. *lower Cambrian (Bot.1–Bot.2):* Altay Sayan, Canada.——FIG. 526,*6a–b*. **R. handfieldi*, Sekwi Formation, Botoman, Mackenzie Mountains, Northwest Territories, Canada; *a,* holotype, GSC 90116, longitudinal section, ×19; *b,* paratype, GSC 90117, transverse section, ×19 (Voronova & others, 1987).

Order AJACICYATHIDA R. Bedford & J. Bedford, 1939

[*nom. correct.* OKULITCH, 1955a, p. 10, *pro* order Ajacicyathina R. BEDFORD & J. BEDFORD, 1939, p. 70] [?=order Somphocyathina OKULITCH, 1943, p. 47, *nom. nud.;* =Somphocyathida OKULITCH, 1955a, p. 19; =Nochoroicyathida ZHURAVLEVA in VOLOGDIN, 1956, p. 879; =Dokidocyathida VOLOGDIN, 1957a, p. 178; =Bronchocyathida ZHURAVLEVA in VOLOGDIN, 1957a, p. 180; =Bosceculida KRASNOPEEVA, 1960, p. 41; =Ethmophyllida VOLOGDIN, 1961, p. 178; =Cyclocyathellida VOLOGDIN, 1961, p. 179]

Cup two walled, solitary or low modular; inner wall of centripetal type of development; intervallum with septa, with or without plate tabulae. *lower Cambrian (Tom.1–Toy.3).*

Suborder DOKIDOCYATHINA Vologdin, 1957

[*nom. transl.* ZHURAVLEVA, 1960b, p. 95, *ex* order Dokidocyathida VOLOGDIN, 1957a, p. 178]

Intervallum with septa bearing single longitudinal pore row. *lower Cambrian (Tom.2–Bot.3).*

Superfamily DOKIDOCYATHOIDEA R. Bedford & W. R. Bedford, 1936

[*nom. correct.* DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 80, *pro* Dokidocyathacea DEBRENNE, 1970a, p. 24, *nom. transl. ex* Dokidocyathidae R. BEDFORD & W. R. BEDFORD, 1936, p. 12]

Outer wall with simple pores. *lower Cambrian (Tom.2–Bot.3).*

Family DOKIDOCYATHIDAE R. Bedford & W. R. Bedford, 1936

[Dokidocyathidae R. BEDFORD & W. R. BEDFORD, 1936, p. 12]

Inner wall with simple pores. *lower Cambrian (Tom.2–Bot.3).*

Dokidocyathus TAYLOR, 1910, p. 146 [**D. simplicissimus*; M; lectotype, TAYLOR, 1910, pl. 16, photos 91–92; ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, pl. 4,*2–3;* ROZANOV, 1973, pl. 14,*1;* DEBRENNE, 1974b, pl. 20,*3;* SD DEBRENNE, 1970a, p. 33, SAM T1589A-B, cups F-G, Adelaide] [?=*Velicyathus* DEBRENNE, 1964, p. 125 (type, *V. levillaini*, OD); =*Dokidolynthus* DEBRENNE, 1974b, p. 101 (type, *Dokidocyathus lenaicus* ROZANOV in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 83, OD); ?=*Kamyshovaecyathus* YAZMIR in ZHURAVLEVA, 1974a, p. 183, *nom. nud.,* based on type species not then available; ?=*Kamyshovaecyathus* YAZMIR in YAZMIR, DALMATOV, & YAZMIR, 1975, p. 38 (type, *K. immanis,* OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 104; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 141]. Outer and inner walls with simple pores. *lower Cambrian (Tom.2–Bot.3):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East, Urals, Australia, Antarctica, Morocco, Iberia.——FIG. 527,*1*. **D. simplicissimus*, Ajax Limestone, Botoman, Ajax Mine, South Australia, Australia, lectotype, SAM T1589A-B, cups F-G, oblique transverse view, ×2.5 (Taylor, 1910).

Family DOKIDOCYATHELLIDAE Debrenne, 1964

[Dokidocyathellidae DEBRENNE, 1964, p. 112]

Inner wall with bracts or scales. *lower Cambrian (Atd.2–Bot.1).*

Dokidocyathella ZHURAVLEVA, 1960b, p. 100 [**D. incognita*; OD; holotype, ZHURAVLEVA, 1960b, fig. 73, pl. 5,*3,* TsSGM 205/8, Novosibirsk]. Inner wall with pores bearing upwardly projecting, S-shaped scales. *lower Cambrian (Atd.2–Bot.1):* Siberian Platform, Altay Sayan, Tuva, Far East.——FIG. 527,*2*. **D. incognita*, Pestrotsvet Formation, Atdabanian, Oy-Muran, Lena River, Sakha (Yakutia), Russia, holotype, TsSGM 205/8, transverse section, ×10 (Zhuravleva, 1960b).

Incurvocyathus ROZANOV in ROZANOV & MISSARZHEVSKIY, 1966, p. 50 [**I. voronovae;* OD; holotype, ROZANOV & MISSARZHEVSKIY, 1966, pl. 1,*4–5*, PIN 4597/57, Moscow]. Cup with regular transverse folds affecting both walls; inner wall with pores bearing possibly upwardly projecting, S-shaped scales. *lower Cambrian (Atd.2–Bot.1):* Altay Sayan, Tuva.——FIG. 527,*3a–b*. **I. voronovae*, Shangan Formation, Botoman, East Tannu-Ola Range, Tuva, Russia, holotype, PIN 4597/57; *a,* longitudinal section (outer wall to left), ×8; *b,* detail of longitudinal section (outer wall to left), ×8 (Rozanov & Missarzhevskiy, 1966).

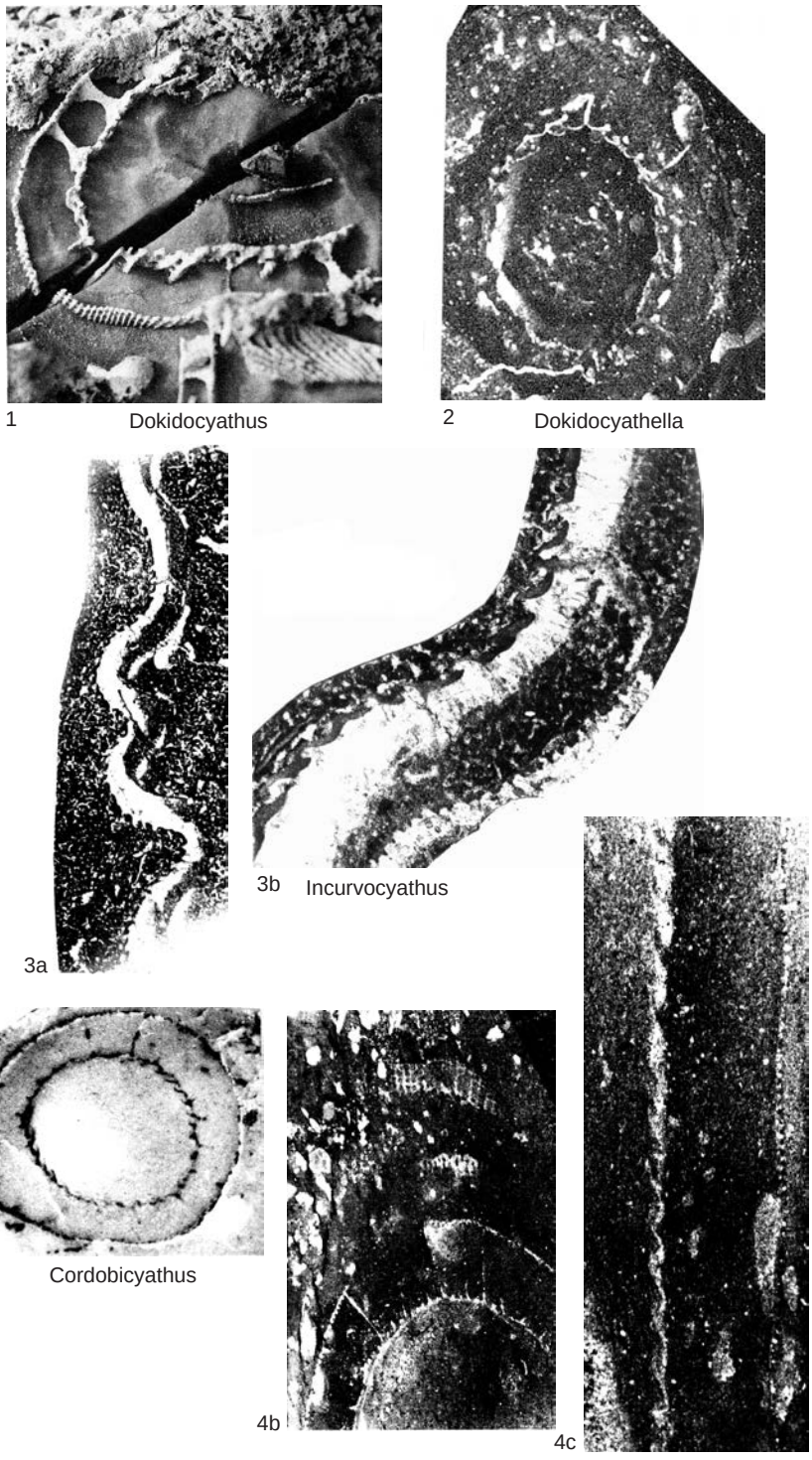


FIG. 527. Dokidocyathidae, Dokidocyathellidae, and Cordobicyathidae (p. 928–930).

Family CORDOBICYATHIDAE Perejón, 1975

[Cordobicyathidae Perejón, 1975a, p. 136]

Inner wall with annuli. *lower Cambrian (Atd.2).*

Cordobicyathus Perejón, 1975a, p. 136 [**C. deserti*; OD; holotype, Perejón, 1975a, pl. 3,*1–3*, CE 3-74-2, Madrid]. Inner wall with upwardly projecting, S-shaped annuli. *lower Cambrian (Atd.2):* Iberia, Germany, Poland.——Fig. 527,*4a–c*. **C. deserti*, Pedroche Formation, Atdabanian, Las Ermitas, Cordoba, Andalusia, Spain, holotype, CE 3-74-2; *a,* transverse section, ×6.5 (Perejón, 1975a); *b,* oblique section, ×6.5; *c,* detail of longitudinal section (outer wall to right), ×15 (Debrenne, Zhuravlev, & Kruse, 2002).

Superfamily KIDRJASOCYATHOIDEA Rozanov, 1964

[*nom. transl.* Debrenne, Zhuravlev, & Rozanov, 1989, p. 80, *ex* Kidrjasocyathidae Rozanov in Zhuravleva, Konyushkov, & Rozanov, 1964, p. 95] [=Kidrjasocyathacea Rozanov, 1973, p. 85, *nom. nud.*]

Outer wall with independent microporous sheath. *lower Cambrian (Atd.2–Bot.1).*

Family KIDRJASOCYATHIDAE Rozanov, 1964

[Kidrjasocyathidae Rozanov in Zhuravleva, Konyushkov, & Rozanov, 1964, p. 95]

Inner wall with simple pores. *lower Cambrian (Atd.2–Bot.1).*

Kidrjasocyathus Rozanov, 1960b, p. 43 [**K. uralensis*; OD; holotype, Rozanov, 1960b, fig. 1, pl. 1,*1a–b;* Zhuravleva, Konyushkov, & Rozanov, 1964, pl. 10,*3*, PIN 4297/9, Moscow]. Inner wall with simple pores. *lower Cambrian (Atd.2–Bot.1):* Altay Sayan, Urals.——Fig. *528a–c*. **K. uralensis*, Terekla Formation, Botoman, Kidryassovo, western flank of southern Urals, Russia, holotype, PIN 4297/9; *a,* transverse section, ×9; *b,* detail of transverse section (outer wall to right), ×20 (Debrenne, Zhuravlev, & Kruse, 2002); *c,* sketch of transverse section, ×20 (Rozanov, 1960b).

Superfamily KALTATOCYATHOIDEA Rozanov, 1964

[*nom. transl.* Debrenne, Zhuravlev, & Rozanov, 1989, p. 80, *ex* Kaltatocyathidae Rozanov in Zhuravleva, Konyushkov, & Rozanov, 1964, p. 92] [=Kaltatocyathacea Rozanov, 1973, p. 85, *nom. nud.*]

Outer wall with simple tumuli. *lower Cambrian (Atd.1–Bot.1).*

Family KALTATOCYATHIDAE Rozanov, 1964

[Kaltatocyathidae Rozanov in Zhuravleva, Konyushkov, & Rozanov, 1964, p. 92]

Inner wall with simple pores. *lower Cambrian (Atd.1–Bot.1).*

Kaltatocyathus Rozanov in Zhuravleva, Konyushkov, & Rozanov, 1964, p. 92 [**K. kaschinae*; OD; holotype, Zhuravleva, Konyushkov, & Rozanov, 1964, pl. 9,*7*, PIN 4297/47, Moscow] [=*Aroonacyathus* Gravestock, 1984, p. 46 (type, *A. gregarius*; OD), for discussion, see Debrenne, Zhuravlev, & Rozanov, 1989, p. 114; Debrenne, Rozanov, & Zhuravlev, 1990, p. 147]. Inner wall with simple pores. *lower Cambrian (Atd.1–Bot.1):* Altay Sayan, Transbaikalia, Far East, Australia.——Fig. 529. **K. kaschinae*, Bazaikha Formation, Atdabanian, Bazaikha River, East Sayan, Altay Sayan, Russia, holotype, PIN 4297/47, transverse section, ×19 (Zhuravleva, Konyushkov, & Rozanov, 1964).

Superfamily PAPILLOCYATHOIDEA Rozanov, 1989

[Papillocyathoidea Rozanov in Debrenne, Zhuravlev, & Rozanov, 1989, p. 80] [=Papillocyathacea Rozanov, 1973, p. 85, *nom. nud.*].

Outer wall with multiperforate tumuli. *lower Cambrian (Atd.4–Bot.1).*

Family PAPILLOCYATHIDAE Rozanov, 1989

[Papillocyathidae Rozanov in Debrenne, Zhuravlev, & Rozanov, 1989, p. 80] [=Papillocyathidae Rozanov, 1973, p. 85, *nom. nud.*]

Inner wall with simple pores. *lower Cambrian (Atd.4–Bot.1).*

Papillocyathus Rozanov in Zhuravleva, Konyushkov, & Rozanov, 1964, p. 94 [**P. vacuus*; OD; holotype, Zhuravleva, Konyushkov, & Rozanov, 1964, pl. 10,*1–2*, PIN 4297/48-2, Moscow]. Inner wall with simple pores. *lower Cambrian (Atd.4–Bot.1):* Altay Sayan.——Fig. *530a–b*. **P. vacuus*, Balakhtinson Formation, Botoman, Kazyr River, East Sayan, Altay Sayan, Russia, holotype, PIN 4297/48-2; *a,* transverse section, ×20; *b,* longitudinal section (outer wall to right), ×20 (Zhuravleva, Konyushkov, & Rozanov, 1964).

Superfamily SOANICYATHOIDEA Rozanov, 1964

[*nom. transl.* Debrenne, Zhuravlev, & Rozanov, 1989, p. 80, *ex* Soanicyathidae Rozanov in Zhuravleva, Konyushkov, & Rozanov, 1964, p. 97] [=Soanicyathacea Rozanov, 1973, p. 85, *nom. nud.*]

Outer wall with bracts or scales. *lower Cambrian (Atd.2–Bot.1).*

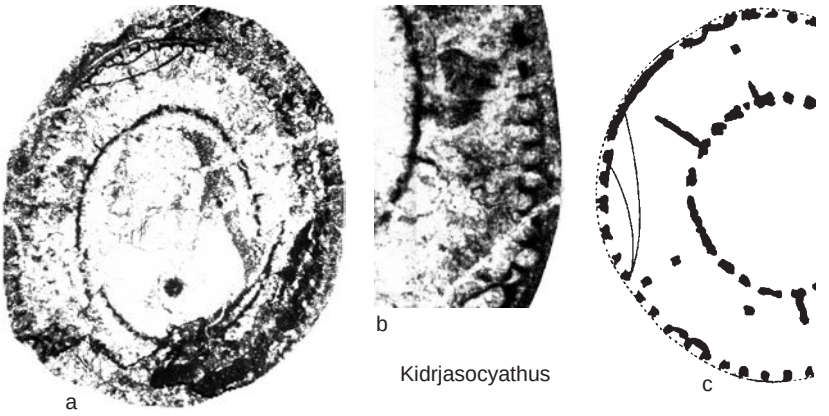


FIG. 528. Kidrjasocyathidae (p. 930).

Family SOANICYATHIDAE Rozanov, 1964

[Soanicyathidae ROZANOV in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 97]

Inner wall with bracts or scales. *lower Cambrian (Atd.2–Bot.1).*

Subtilocyathus VOLOGDIN, 1960, p. 422 [**Archaeocyathus subtilis* VOLOGDIN, 1932, p. 41; OD; lectotype, VOLOGDIN, 1932, fig. 32a–b, pl. 7,*7,* pl. 8,*5b,* SD DEBRENNE, ZHURAVLEV, & KRUSE, 2002, p. 1557, TsNIGRm 50a/2957, St. Petersburg] [=*Soanicyathus* ROZANOV in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 98 (type, *S. admirandus,* OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 133; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 162]. Outer and inner walls with pores bearing upwardly projecting, cupped bracts. *lower Cambrian (Atd.2–Bot.1):* Altay Sayan, Tuva, Mongolia.——FIG. 531,*1a–b*. **S. subtilis* (VOLOGDIN), Verkhneynyrga Formation, Botoman, Lebed' River, Altay Mountains, Altay Sayan, Russia, lectotype, TsNIGRm 50a/2957; *a,* transverse section, ×4; *b,* detail of transverse section, ×20 (Vologdin, 1932).

Batschykicyathus ZHURAVLEV in ZHURAVLEV, ZHURAVLEVA, & FONIN, 1983, p. 23 [**B. angulosus*; OD; holotype, ZHURAVLEV, ZHURAVLEVA, & FONIN, 1983, pl. 3,*4*, PIN 3848/501, Moscow]. Outer wall regularly bulging in transverse files; outer and inner walls with pores bearing upwardly projecting, cupped bracts. *lower Cambrian (Atd.4):* Siberian Platform.——FIG. 531,*2. *B. angulosus*, Pestrotsvet Formation, Atdabanian, Bachyk Creek, Lena River, Sakha (Yakutia), Russia, holotype, PIN 3848/501, oblique longitudinal section, ×10 (Zhuravlev, Zhuravleva, & Fonin, 1983).

Family ZHURAVLEVAECYATHIDAE Rozanov, 1989

[Zhuravlevaecyathidae ROZANOV in DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 81] [=Zhuravlevaecyathidae ROZANOV, 1973, p. 85, *nom. nud.*]

Inner wall with annuli. *lower Cambrian (Bot.1).*

Zhuravlevaecyathus ROZANOV in ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, p. 98 [**Z. pulchellus*; OD; holotype, ZHURAVLEVA, KONYUSHKOV, & ROZANOV, 1964, pl. 11,*5–6*, PIN 4297/54, Moscow]. Outer wall with pores bearing upwardly projecting, cupped bracts; inner wall with possibly upwardly projecting, S-shaped annuli. *lower Cambrian (Bot.1):* Altay Sayan.——FIG. 531,*3a–b*. **Z. pulchellus*, Verkhnemonok Formation, Botoman, Abakan River, West Sayan, Altay Sayan, Russia; *a,* holotype, PIN 4297/54, transverse section, ×4; *b,* paratype, PIN 4297/55, detail of transverse section, ×3.5 (Zhuravleva, Konyushkov, & Rozanov, 1964).

Superfamily KYMBECYATHOIDEA Debrenne, Rozanov, & Zhuravlev, 1989

[Kymbecyathoidea DEBRENNE, ROZANOV, & ZHURAVLEV in DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 81]

Outer wall with canals. *lower Cambrian (Atd.4–Bot.3).*

Family KYMBECYATHIDAE Debrenne, Rozanov, & Zhuravlev, 1989

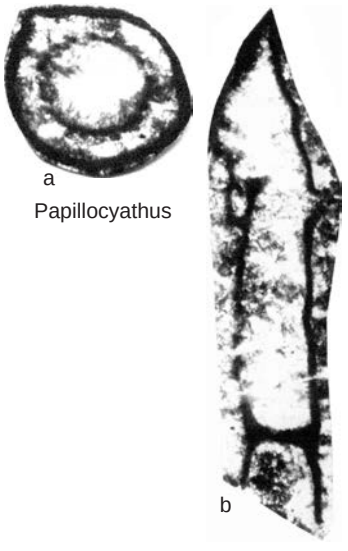
[Kymbecyathidae DEBRENNE, ROZANOV, & ZHURAVLEV in DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 81]

Inner wall with simple pores. *lower Cambrian (Atd.4–Bot.3).*

Kaltatocyathus

FIG. 529. Kaltatocyathidae (p. 930).

Kymbecyathus DEBRENNE & KRUSE, 1986, p. 241 [**K. avius*; OD; holotype, DEBRENNE & KRUSE, 1986, fig. 6A–B, VU VC9, Wellington]. Outer wall with horizontal to upwardly projecting, straight canals; inner wall with simple pores. *lower Cambrian (Atd.4–Bot.3):* Australia, Antarctica.——FIG. 532*a–b*. **K. avius*, Shackleton Limestone, Botoman, Crackling Cwm, Byrd Glacier, Antarctica, holotype, VU VC9; *a,* transverse section, ×3 (Debrenne & Kruse, 1986); *b,* oblique longitudinal section, ×3 (Debrenne, Zhuravlev, & Kruse, 2002).



Papillocyathus

FIG. 530. Papillocyathidae (p. 930).

Suborder AJACICYATHINA R. Bedford & J. Bedford, 1939

[*nom. transl.* ZHURAVLEVA, 1960b, p. 106, *ex* order Ajacicyathina R. BEDFORD & J. BEDFORD, 1939, p. 70] [=Nochoroicyathina ZHURAVLEVA in VOLOGDIN, 1956, p. 879, *nom. transl.* ZHURAVLEVA, 1960b, p. 198, *ex* Nochoroicyathida ZHURAVLEVA in VOLOGDIN, 1956, p. 879; =Schidertycyathina KRASNOPEEVA, 1969, p. 63; =Boscekulcyathina KRASNOPEEVA, 1969, p. 63]

Intervallum with septa; pectinate tabulae or synapticulae may be present. *lower Cambrian (Tom.1–Toy.3).*

Superfamily BRONCHOCYATHOIDEA R. Bedford & J. Bedford, 1936

[*nom. transl.* ZHURAVLEV in VORONOVA & others, 1987, p. 20, *ex* Bronchocyathidae R. BEDFORD & J. BEDFORD, 1936, p. 25] [=Ajacicyathoidea R. BEDFORD & J. BEDFORD, 1939, p. 73, *nom. correct.* DEBRENNE & KRUSE, 1986, p. 242, *pro* Ajacicyathacea ZHURAVLEVA, 1960b, p. 106, *nom. transl. ex* Ajacicyathidae R. BEDFORD & J. BEDFORD, 1939, p. 73; =Nochoroicyathacea ZHURAVLEVA in VOLOGDIN, 1956, p. 879, *nom. transl.* ZHURAVLEVA, 1960b, p. 198, *ex* Nochoroicyathidae ZHURAVLEVA in VOLOGDIN, 1956, p. 879; =Irinacyathacea ZHURAVLEVA in DEBRENNE, 1972, p. 174, *nom. neg.*; =Aldanocyathacea ZADOROZHNAYA, OSADCHAYA, & REPINA, 1973, p. 129, *nom. transl.* KORSHUNOV, 1983a, p. 96, *ex* Aldanocyathinae ZADOROZHNAYA, OSADCHAYA, & REPINA, 1973, p. 129; =Irinaecyathacea ZHURAVLEVA in ZHURAVLEVA & ELKINA, 1974, p. 44; =Inessocyathacea ZHURAVLEVA in ZHURAVLEVA & ELKINA, 1974, p. 45]

Outer wall with simple pores. *lower Cambrian (Tom.1–Toy.2).*

Family AJACICYATHIDAE R. Bedford & J. Bedford, 1939

[Ajacicyathidae R. BEDFORD & J. BEDFORD, 1939, p. 73] [=Nochoroicyathidae ZHURAVLEVA in VOLOGDIN, 1956, p. 879; =Kisasacyathidae KONYUSHKOV, 1972, p. 137; =Aldanocyathidae ZADOROZHNAYA, OSADCHAYA, & REPINA, 1973, p. 129]

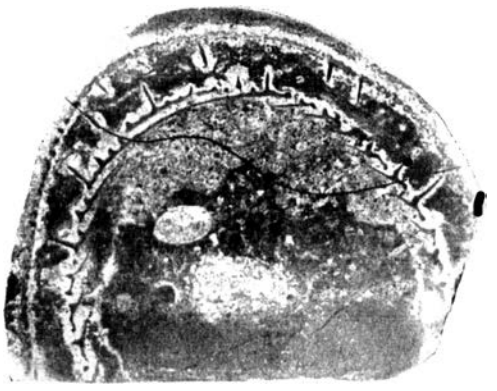
Inner wall with simple pores. *lower Cambrian (Tom.1–Toy.2).*

Ajacicyathus R. BEDFORD & J. BEDFORD, 1939, p. 73 [**Archaeocyathus ajax* TAYLOR, 1910, p. 118; OD; lectotype, TAYLOR, 1910, pl. 1, photo 1a, pl. 7, photo 39 (lower part); HILL, 1965, pl. 1,*6;* DEBRENNE, 1974b, pl. 21,*2–4;* SD DEBRENNE, 1970a, p. 27, SAM T1550A, Adelaide] [=*Loculicyathellus* DEBRENNE, 1969a, p. 310 (type, *Archaeocyathus floreus* R. BEDFORD & W. R. BEDFORD, 1934, p. 2, OD), *nom. transl.* DEBRENNE, 1974b, p. 115, *ex Loculicyathus (Loculicyathellus)* DEBRENNE, 1969a, p. 310; =*Ajacicyathus (Juricyathus)* DEBRENNE, 1974b, p. 110 (type, *Archaeocyathus aequitriens* R. BEDFORD & J. BEDFORD, 1937, p. 35, OD); =*Ambistapis* KRUSE, 1982, p. 161 (type, *A. integer*, OD)]. Inner wall with several rows of simple pores per intersept; stirrup pores may be present; septa aporose to sparsely porous. *lower Cambrian (Atd.1–Toy.2):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Far East, Australia, Antarctica, Sardinia, France, Canada.——FIG. 533,*1a–b*. **A. ajax* (TAYLOR), Ajax Limestone, Botoman,

1a

1b Subtilocyathus

2 Batschykicyathus



3a Zhuravlevaecyathus

3b

FIG. 531. Soanicyathidae and Zhuravlevaecyathidae (p. 931).

Ajax Mine, South Australia, Australia, lectotype, SAM T1550A; *a,* oblique longitudinal view, ×1 (Taylor, 1910); *b,* detail of septum and inner wall in longitudinal view (outer wall to right), ×10 (Debrenne, 1974b).

Davidicyathus DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 139 [**?Loculicyathus racemiferus* GRAVESTOCK, 1984, p. 48; OD; holotype, GRAVESTOCK, 1984, fig. 32H, 32L, SAM P21452, Adelaide]. Outer wall with two sizes of pores, the smaller either isolated or clustered over the larger; inner wall with several rows of simple pores per intersept; septa completely porous. *lower Cambrian (Atd.4):* Australia.——FIG. 533,*2a–c*. **D. racemiferus* (GRAVESTOCK); *a–b,* Wilkawillina Limestone, Atdabanian, Wilkawillina Gorge, South Australia, Australia, holotype, SAM P21452, *a,* transverse section, ×4; *b,* longitudinal section, ×9.5 (Gravestock, 1984); *c,* Ajax Limestone, Atdabanian, Mount Scott Range, South Australia, Australia, SAM P21455-1, tangential section of outer wall, ×15 (Debrenne, Zhuravlev, & Kruse, 2012b).

Dentatocyathus OKUNEVA, 1972, p. 57 [**D. maritimus*; OD; holotype, OKUNEVA, 1972, pl. 10,*7*, PGU 202, Khabarovsk]. Outer wall longitudinally plicate; inner wall with several rows of simple pores per intersept; septa completely porous. *lower Cambrian (Bot.1):* Altay Sayan, Tuva, Mongolia,

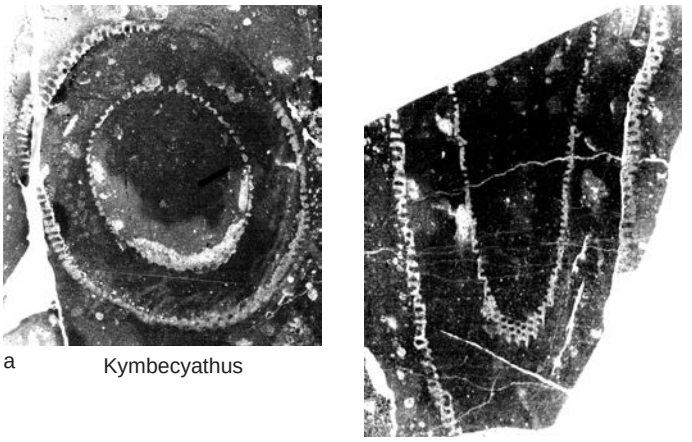


FIG. 532. Kymbecyathidae (p. 932).

Far East.——FIG. 534,*1a–b*. **D. maritimus*, Dmitrievka Formation, Botoman, Knorring Hill, Spassk-Chernigovka area, Far East, Russia, holotype, PGU 202; *a,* transverse section, ×5; *b,* detail of transverse section (outer wall to right), ×10 (Okuneva, 1972).

Iljinicyathus ZHURAVLEVA, 1972b, p. 155 [**I. ulanbatoriensis*; OD; holotype, ZHURAVLEVA, 1972b, pl. 21,*1–3*, TsSGM 755/1, Novosibirsk]. Cup in which inner wall shows periodic transverse folds; inner wall with several rows of simple pores per intersept; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.2–Atd.4):* Mongolia.——FIG. 534,*2a–b*. **I. ulanbatoriensis*, formation not known, Atdabanian, northern Mongolia, holotype, TsSGM 755/1; *a,* transverse section, ×4; *b,* longitudinal section (outer wall to right), ×5 (Zhuravleva, 1972b).

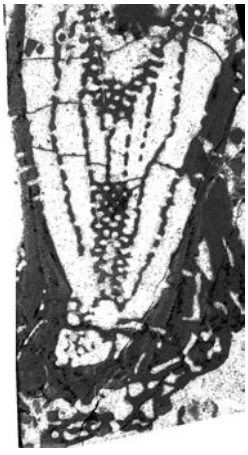
Kisasacyathus KONYUSHKOV, 1972, p. 137 [**K. microtumulatus*; OD; holotype, KONYUSHKOV, 1972, pl. 16,*1*, PIN 4755/7, Moscow] [=*Prethmophyllum* DEBRENNE, 1974c, p. 174 (type, *Archaeocyathus subacutus* R. BEDFORD & W. R. BEDFORD, 1934, p. 2, OD)]. Inner wall with one row of simple pores per intersept, formed by fluting of inner edges of septa; septa aporose to sparsely porous. *lower Cambrian (Atd.4–Bot.3):* Altay Sayan, Tuva, Mongolia, Far East, Australia, Antarctica.——FIG. 534,*3a–b*. **K. microtumulatus*, Verkhnemonok Formation, Botoman, Kizas River, West Sayan, Altay Sayan, Russia; *a,* holotype, PIN 4755/7, oblique longitudinal section, ×6; *b,* paratype, PIN 4755/8, transverse section, ×6 (Konyushkov, 1972).

Nochoroicyathus ZHURAVLEVA, 1951, p. 78 [**N. mirabilis*; OD; holotype, ZHURAVLEVA, 1951, fig. 1a–b, PIN 1168, Moscow, not located] [=*Ajacicyathellus* DEBRENNE, 1958, p. 64 (type, *A. hollardi*, M); =*Ascocyathus* VOLOGDIN, 1960, p. 422 (type, *Archaeocyathus arteintervallum* VOLOGDIN, 1931, p. 84, OD); =*Howellicyathus* VOLOGDIN, 1961, p. 180, *nom. nud.*; =*Howellicyathus* VOLOGDIN, 1962a, p. 126 (type, *Coscinocyathus howelli* VOLOGDIN, 1940b, p. 88, OD); =*Pachecocyathus* PEREJÓN, 1971, p. 81 (type, *P. cabanasi*, OD); =*Aldanocyathus* VORONIN in DEBRENNE & VORONIN, 1971, p. 30 (type, *Ajacicyathus sunnaginicus* ZHURAVLEVA, 1960b, p. 115, OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 120; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 153]. Inner wall with several rows of simple pores per intersept; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Tom.1–Bot.3):* Siberian Platform, Kolyma, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East, Urals, Kazakhstan, Australia, South China, Morocco, Iberia, France, Sardinia, Germany, Serbia.——FIG. 534,*4a–c*. **N. mirabilis*; *a,* Pestrotsvet Formation, Tommotian, Nokhoroy Creek, Lena River, Sakha (Yakutia), Russia, holotype, PIN 1168, transverse section, ×6 (Zhuravleva, 1951); *b–c,* Medvezh'ya Formation, Tommotian, Kotuy River, Krasnoyarsk region, Russia; *b,* TsSGM 205/87, detail of septum in longitudinal section (outer wall to left), ×6; *c,* specimen TsSGM 205/88, detail of transverse section at inner wall, ×20 (Debrenne, Zhuravlev, & Kruse, 2002).

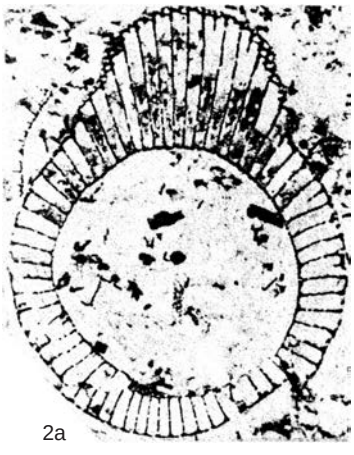
Orbiasterocyathus ZHURAVLEVA in REPINA & others, 1964, p. 183 [**O. geri*; OD; holotype, REPINA & others, 1964, pl. 11,*6*, TsSGM 4272/5, Novosibirsk]. Cup in which both walls are longitudinally folded, resulting in stellate transverse section; inner wall with several rows of simple pores per intersept; septa completely porous. *lower Cambrian (Atd.3–Atd.4):* Altay Sayan.——FIG. 534,*5*. **O. geri*, Adiak Formation, Atdabanian, Terensu River, Gornaya Shoria, Altay Sayan, Russia, holotype,

1a

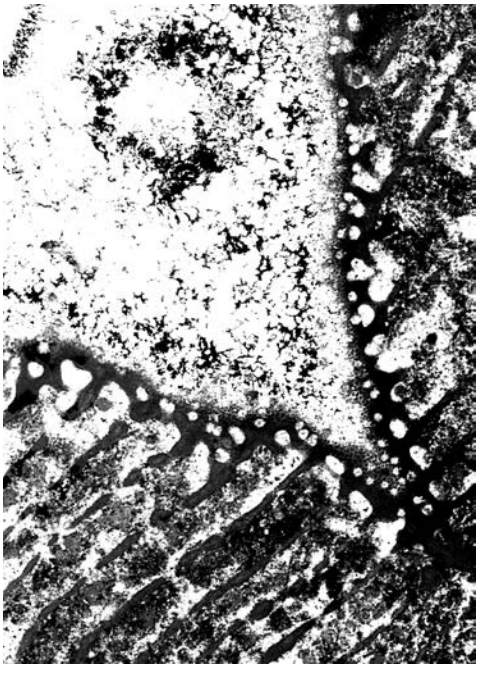
1b Ajacicyathus



2b Davidicyathus



2a

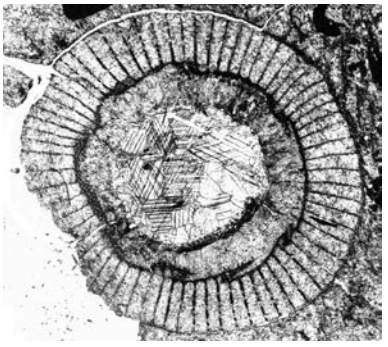


2c

FIG. 533. Ajacicyathidae (p. 932–933).

TsSGM 4272/5, transverse section, ×4 (Repina & others, 1964).

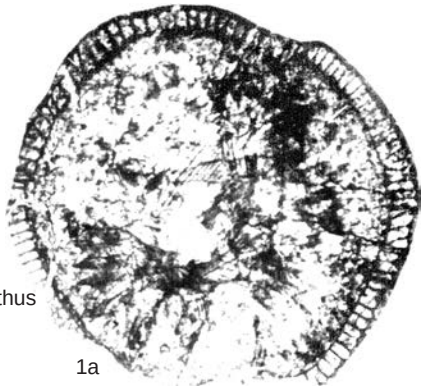
Orbicyathellus OSADCHAYA in ZADOROZHNAYA, OSADCHAYA, & REPINA, 1973, p. 133 [**O. bogradi*; OD; holotype, ZADOROZHNAYA, OSADCHAYA, & REPINA, 1973, pl. 19,*1–2*, TsSGM 424/1, Novosibirsk]. Cup in which both walls show periodic, synchronous transverse folds; inner wall with stirrup pores only; septa aporose to sparsely porous. *lower Cambrian (Atd.1–Atd.4):* Siberian Platform, Altay Sayan, Mongolia.——FIG. 535,*1a–b. *O. bogradi*, Usa Formation, Atdabanian, Bograd, Batenev Range, Kuznetsk Alatau, Russia, holotype, TsSGM 424/1; *a,* oblique longitudinal section, ×4.5; *b,* tangential section of inner wall, ×12 (Zadorozhnaya, Osadchaya, & Repina, 1973).



2a Iljinicyathus

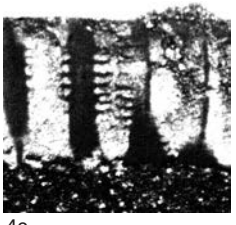
1b

Dentatocyathus



1a

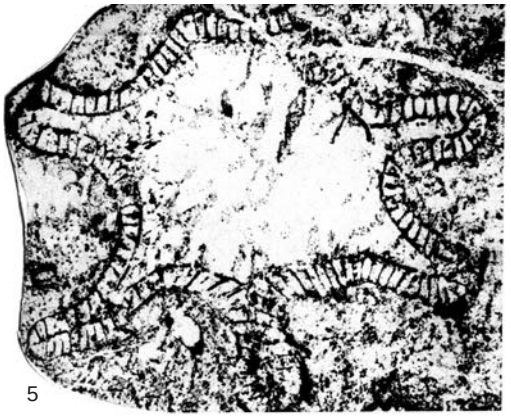
2b



4c

Nochoroicyathus

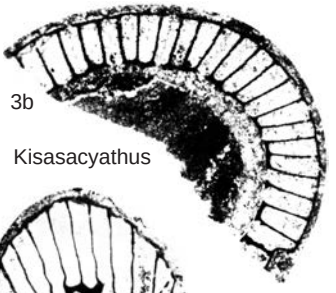
4b



5

Orbiasterocyathus

4a



3b

Kisasacyathus

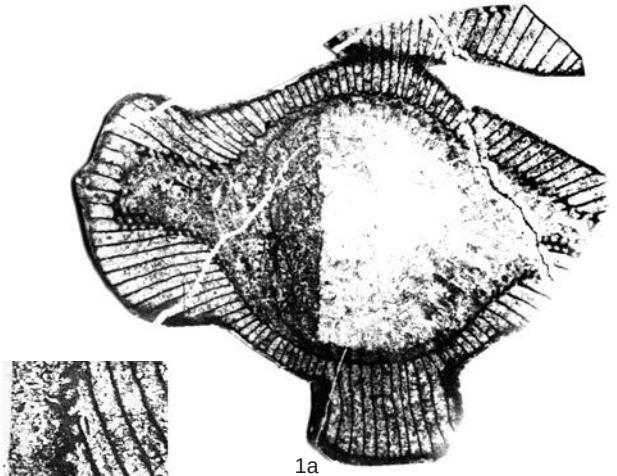
6b

Orbicyathus

3a

6a

FIG. 534. Ajacicyathidae (p. 933–938).

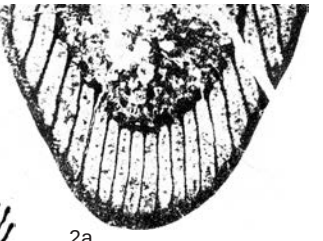


1a

Orbicyathellus

2b

1b



2a

Robustocyathellus

4a

Sibirecyathus

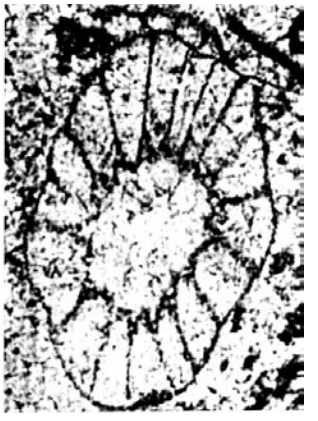
4b

3

Rotundocyathus

5

Stapicyathus



6

Urcyathus

Fig. 535. Ajacicyathidae (p. 935–938).

Orbicyathus VOLOGDIN, 1937b, p. 468 [**O. mongolicus*; M; holotype, VOLOGDIN, 1937b, pl. 2,*4*, not located]. Cup in which both walls show periodic, synchronous transverse folds; inner wall with several rows of simple pores per intersept; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Tom.4–Bot.1):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Morocco.——FIG. 534,*6a–b*. **O. mongolicus*, Burgasutay Formation, Atdabanian, Seer' Mountains, Ikh nuuruundyn hotgor, western Mongolia, holotype; *a,* longitudinal section, ×3; *b,* schematic reconstruction of cup, ×2 (Vologdin, 1937b).

Robustocyathellus KONYUSHKOV, 1972, p. 133 [**R. spinosus*; OD; holotype, KONYUSHKOV, 1972, pl. 13,*1*, not located]. Inner wall with one row of simple pores per intersept; septa aporose to sparsely porous. *lower Cambrian (Atd.1–Bot.3):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East, Tajikistan, South China, Canada.——FIG. 535,*2a–b*. **R. spinosus*, Verkhnemonok Formation, Botoman, Kizas River, West Sayan, Altay Sayan, Russia, holotype; *a,* oblique longitudinal section, ×6; *b,* longitudinal section, ×3 (Konyushkov, 1972).

Rotundocyathus VOLOGDIN, 1960, p. 422 [**R. rotaceus*; OD; holotype, VOLOGDIN, 1960, fig. 1zh, not located]. Inner wall with one row of simple pores per intersept; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.2–Bot.1):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East, South China, Morocco, Iberia, France, Sardinia.——FIG. 535,*3*. **R. rotaceus*, Verkhneynyrga Formation, Botoman, Lebed' River, Altay Mountains, Altay Sayan, Russia, holotype, transverse section, ×1 (Vologdin, 1960).

Sibirecyathus VOLOGDIN, 1937b, p. 468 [**S. naletovi*; M; holotype not designated, collection not located]. Inner wall with one row of simple pores per intersept; septa completely porous, linked by synapticulae. *lower Cambrian (Tom.3–Bot.3):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East, South China, Morocco, Iberia, France, Sardinia, Germany.——FIG. 535,*4a–b*. **S. naletovi*, Burgasutay Formation, Botoman, Seer' Mountains, Ikh nuuruundyn hotgor, western Mongolia, *a,* unlocated syntype, transverse section, ×4; *b,* unlocated syntype, oblique longitudinal section, ×4 (Vologdin, 1937b).

Stapicyathus DEBRENNE, 1964, p. 127, *nom. transl.* DEBRENNE, 1970a, p. 43, *ex Archaeocyathellus (Stapicyathus)* DEBRENNE, 1964, p. 127 [**Archaeocyathus stapipora* TAYLOR, 1910, p. 118; OD; lectotype, TAYLOR, 1910, pl. 7, photos 37a, 38D, 38G; DEBRENNE, 1974b, pl. 24,*1;* SD DEBRENNE, 1970a, p. 43, SAM T1591, Adelaide] [=*Sivovicyathus* KONYUSHKOV, 1972, p. 134 (type, *S. abakanensis,* OD); =*Nochoroicyathellus* OSADCHAYA in OSADCHAYA & others, 1979, p. 154 (type, *N. activus*, OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 132; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 161]. Inner wall with stirrup pores only; septa aporose to sparsely porous; pectinate tabulae may be present. *lower Cambrian (Atd.2–Bot.3):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East, Australia, Antarctica, South Africa (allochthonous).——FIG. 535,*5*. **S. stapipora* (TAYLOR), Ajax Limestone, Botoman, Ajax Mine, South Australia, Australia, lectotype, SAM T1591, oblique longitudinal section, ×4 (Taylor, 1910).

Urcyathus VOLOGDIN, 1940b, p. 64 [**U. asteroides*; OD; holotype, VOLOGDIN, 1940b, pl. 14,*5,* not located] [=*Pectenocyathus* KASHINA in REPINA & others, 1964, p. 211 (type, *P. torgaschinicus*, OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 139; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 166]. Inner wall longitudinally plicate, with several rows of simple pores per intersept; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.1–Atd.2):* Altay Sayan, Tuva, Mongolia, Iberia, Germany.——FIG. 535,*6*. **U. asteroides*, Gavrilovskoe Formation, Atdabanian, Gorskino, Salair, Russia, holotype, oblique transverse section, ×9 (Vologdin, 1940b).

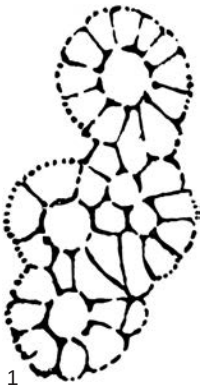
Family DENSOCYATHIDAE Vologdin, 1937

[Densocyathidae VOLOGDIN, 1937b, p. 471] [=Leptosocyathidae VOLOGDIN, 1961, p. 178; =Tennericyathidae ROZANOV in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 34]

Inner wall with bracts or scales. *lower Cambrian (Atd.1–Bot.3).*

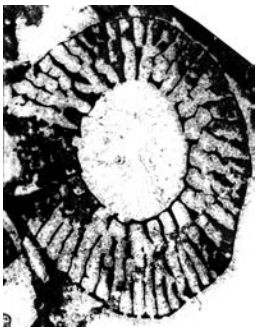
Densocyathus VOLOGDIN, 1937b, p. 471 [**D. sanaschticolensis;* M; holotype not designated, collection not located]. Inner wall with several rows of pores per intersept, bearing upwardly projecting, S-shaped scales; septa aporose to sparsely porous. *lower Cambrian (Bot.1–Bot.3):* Altay Sayan.——FIG. 536,*1*. **D. sanaschticolensis*, Verkhnemonok Formation, Botoman, Sanashtykgol Spring, West Sayan, Altay Sayan, Russia; unlocated syntype, transverse section of modular skeleton, ×5 (Vologdin, 1937b).

Cadniacyathus R. BEDFORD & J. BEDFORD, 1937, p. 36 [**C. asperatus;* OD; lectotype, R. BEDFORD & J. BEDFORD, 1937, fig. 152; DEBRENNE, 1974b, pl. 27,*2;* SD DEBRENNE, 1970a, p. 30, USNM PU86616(1), Washington, D.C.]. Inner wall with several rows of pores per intersept, bearing upwardly projecting, planar fused bracts; septa aporose to sparsely porous. *lower Cambrian (Bot.3):* Australia, ?Antarctica.——FIG. 536,*2*. **C. asperatus*, Ajax Limestone, Botoman, Ajax Mine, South Australia, Australia, lectotype, USNM PU86616(1), oblique transverse view, ×3 (Debrenne, Zhuravlev, & Kruse, 2002).



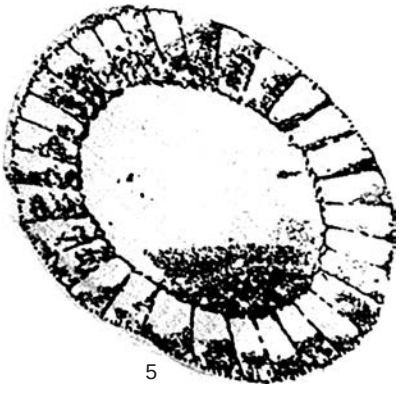
1 Densocyathus

2 Cadniacyathus



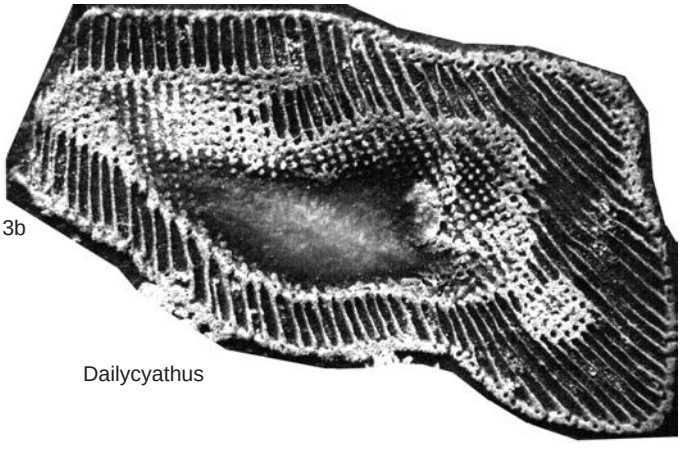
4a Deceptioncyathus

4b



5 Khirgisocyathus

3a



3b Dailycyathus

FIG. 536. Densocyathidae (p. 938–940).

Dailycyathus Debrenne, 1970a, p. 32 [**Paranacyathus margarita* R. Bedford & J. Bedford, 1937, p. 34; OD; lectotype, R. Bedford & J. Bedford, 1937, fig. 138b–c; Debrenne, 1970a, pl. 1,*5;* SD Debrenne, 1970a, p. 32, USNM PU87214, specimen 304, Washington, D.C.] [=*Joanaecyathus* Gravestock, 1984, p. 53 (type, *J. cupulosus*, OD; =*Paranacyathus margarita* R. Bedford & J. Bedford, 1937, p. 34), for discussion, see Debrenne, Rozanov, & Zhuravlev, 1990, p. 139]. Inner wall with one row of pores per intersept, bearing upwardly projecting, cupped bracts; septa aporose to sparsely porous. *lower Cambrian (Atd.4–Bot.3):* Altay Sayan, Mongolia, Tarim, South China, Australia.——Fig. 536,*3a–b*. **D. margarita* (R. Bedford & J. Bedford), Ajax Limestone, Atdabanian, Paint Mine, South Australia, Australia; *a,* lectotype, USNM PU87214, specimen 304, transverse view near cup base, ×5; *b,* paralectotype, USNM PU87215, tangential view of inner wall, ×5 (Debrenne, 1970a).

Deceptioncyathus Gravestock, 1984, p. 53 [**D. synapticulosus*; OD; holotype, Gravestock, 1984, fig. 34H–J, SAM P21504-1, Adelaide]. Inner wall with one row of pores per intersept, bearing upwardly projecting cupped bracts; septa completely porous, linked by synapticulae. *lower Cambrian (Atd.4):* Australia.——Fig. 536,*4a–b*. **D. synapticulosus*, Ajax Limestone, Atdabanian, Mount Scott Range, South Australia, Australia, holotype, SAM P21504-1; *a,* transverse section, ×2; *b,* longitudinal section, ×2 (Gravestock, 1984).

Khirgisocyathus Voronin, 1988, p. 5 [**K. primus*; OD; holotype, Voronin, 1988, pl. 2,*1*, PIN 3301/511, Moscow]. Inner wall with several rows of pores per intersept, bearing upwardly projecting cupped bracts; septa completely porous. *lower Cambrian (Atd.2):* Mongolia.——Fig. 536,5. **K. primus*, Ichituin Formation, Atdabanian, Boro-Khairkhan-Obo Mountain, Khan-Khukhiy Range, Mongolia, holotype, PIN 3301/511, oblique transverse section, ×9 (Voronin, 1988).

Leptosocyathellus Osadchaya in Osadchaya & others, 1979, p. 119 [**L. mirandus*; OD; holotype, Osadchaya & others, 1979, pl. 5,*3*, VSEGEI 11594, St. Petersburg]. Inner wall with stirrup pores only, bearing upwardly projecting, S-shaped scales; septa completely porous. *lower Cambrian (Atd.2–Atd.4):* Altay Sayan, Iberia.——Fig. 537,*1a–b*. **L. mirandus*; *a,* Usa Formation, Atdabanian, Krutoy Log, Batenev Range, Kuznetsk Alatau, Russia, holotype, VSEGEI 11594, transverse section, ×8.5; *b,* Usa Formation, Atdabanian, Srednyaya Mountain, Batenev Range, Kuznetsk Alatau, Russia, VSEGEI C-69, oblique longitudinal section, ×8 (Osadchaya & others, 1979).

Leptosocyathus Vologdin, 1937b, p. 470 [**L. curviseptum*; OD; holotype, Vologdin, 1937b, fig. 14, not located; =*Leptocyathus curviseptatus* Vologdin, 1940a, p. 146] [=*Leptocyathus* Vologdin, 1937b, p. 468, *nom. null.*, *non Leptocyathus* Milne-Edwards & Haime, 1850, a scleractinian; =*Halysicyathus* Debrenne, 1965, p. 144 (type, *H. multifurcus,* OD)]. Inner wall with one row of pores per intersept, bearing upwardly projecting, S-shaped scales; septa aporose to sparsely porous. *lower Cambrian (Atd.1–Bot.3):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East, Tajikistan, Australia, Antarctica, Morocco, Iberia.——Fig. 537,*2a–c*. **L. curviseptus*, Burgasutay Formation, Botoman, Seer' Mountains, Ikh nuuruundyn hotgor, western Mongolia; *a,* holotype, transverse section, ×1; *b,* holotype, oblique transverse section of inner wall, ×1 (Vologdin, 1937b); *c,* topotype, PIN 3156/3000, transverse section, ×9 (Debrenne, Zhuravlev, & Kruse, 2002).

Natalijaecyathus Kotel'nikov, 1995, p. 23 [**N. vadibalaensis*; OD; holotype, Kotel'nikov, 1995, fig. 1d, pl. 2,*7*, TsNIGRm 12890/4, St. Petersburg]. Inner wall with stirrup pores only, bearing upwardly projecting, S-shaped scales; longitudinal bars may be present, bisecting stirrup pores; septa completely porous. *lower Cambrian (Atd.2):* Tuva.——Fig. 537,*3a–b*. **N. vadibalaensis*, Il'chir Formation, Atdabanian, Vadi-Bala Creek, Tapsa River, Tuva, Russia, holotype, TsNIGRm 12890/4; *a,* oblique transverse section, ×5.5; *b,* detail of oblique transverse section, ×9 (Kotel'nikov, 1995).

Rectannulus Debrenne, 1977a, p. 106 [**R. willefertae*; OD; holotype, Debrenne, 1977a, pl. 6,*2–3*, MNHN M80026, specimen IRH4-2b, Paris]. Inner wall with stirrup pores only, bearing horizontal to upwardly projecting, S-shaped scales; scales may be fused into pseudoannuli; septa sparsely to completely porous. *lower Cambrian (Atd.4–Bot.1):* Morocco.——Fig. 538,*1a–b*. **R. willefertae*, Issafen Formation, Botoman, Jbel Irhoud, Morocco, holotype, MNHN M80026, specimen IRH4-2b; *a,* detail of transverse section, ×5 (Debrenne, 1977a); *b,* oblique longitudinal section, ×5 (Debrenne, Zhuravlev, & Kruse, 2012b).

Tennericyathus Rozanov in Zhuravleva, Korshunov, & Rozanov, 1969, p. 35 (Rozanov in Rozanov & others, 1969, p. 182, *nom. nud.*) [**T. malycanicus*; OD; holotype, Zhuravleva, Korshunov, & Rozanov, 1969, pl. 4,*5;* Rozanov, 1973, pl. 9,*4*, PIN 4297/79, Moscow, not located] [=*Memoriacyathus* Yazmir in Zhuravleva, 1974a, p. 215, *nom. nud.*; =*Memoriacyathus* Yazmir in Yazmir, Dalmatov, & Yazmir, 1975, p. 47 (type, *M. burjaticus*, OD); =*Raropectinus* Debrenne & Rozanov, 1983, p. 735, *nom. nov. pro Rarocyathus* Osadchaya in Osadchaya & others, 1979, p. 155, *non* Vologdin & Jankauskas, 1968, p. 203, cribricyath (type, *R. rarus,* OD), for discussion, see Debrenne, Zhuravlev, & Rozanov, 1989, p. 135; Debrenne, Rozanov, & Zhuravlev, 1990, p. 163]. Inner wall with several rows of pores per intersept, bearing upwardly projecting, S-shaped scales; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.1–Bot.1):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East.——Fig. 538,*2. **T. maly-*

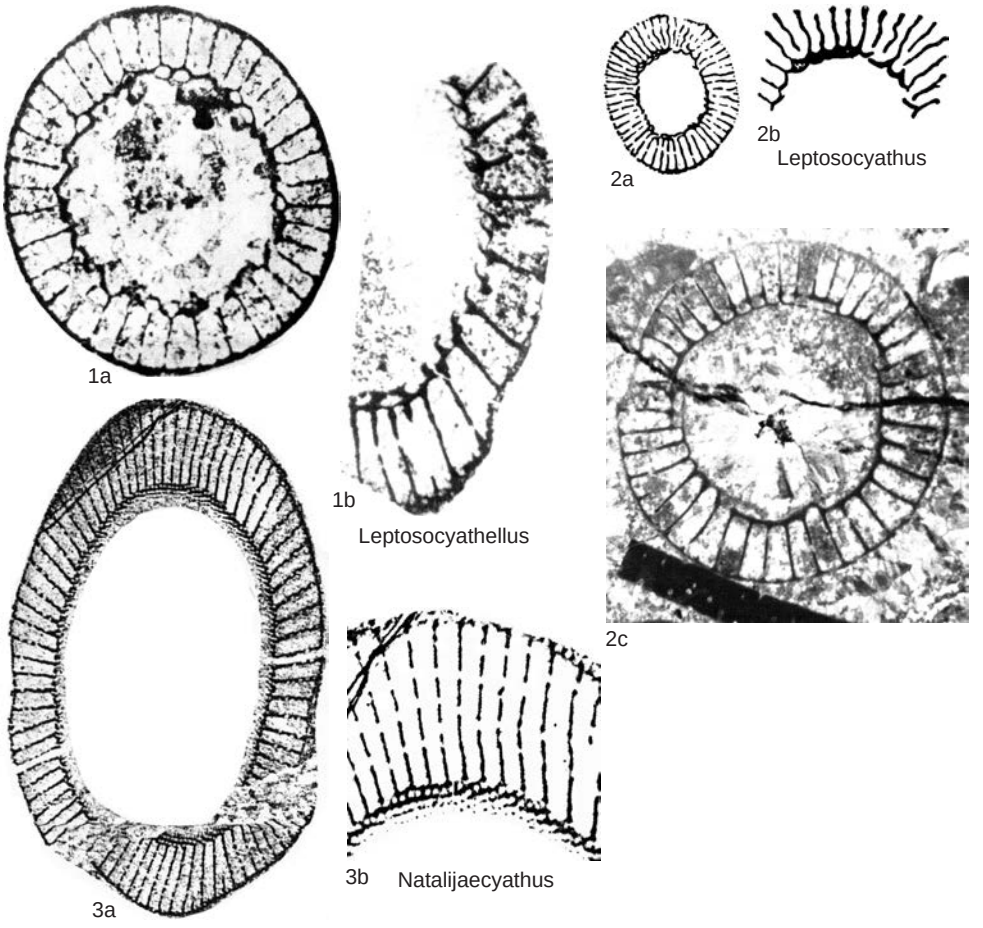


FIG. 537. Densocyathidae (p. 940).

canicus, Pestrotsvet Formation, Atdabanian, Malykan, Lena River, Sakha (Yakutia), Russia, holotype, PIN 4297/79, detail of oblique transverse section, ×15 (Zhuravleva, Korshunov, & Rozanov, 1969).

Family BRONCHOCYATHIDAE R. Bedford & J. Bedford, 1936

[Bronchocyathidae R. BEDFORD & J. BEDFORD, 1936, p. 25] [=Stillicidocyathidae TING, 1937, p. 367; =Thalamocyathidae ZHURAVLEVA, 1954, p. 28; =Cyclocyathellidae ZHURAVLEVA, 1960c, p. 74; =Triniaecyathidae DEBRENNE, 1964, p. 114; =Compositocyathidae ZHURAVLEVA in ZHURAVLEVA & others, 1967, p. 52; =Glaessnericyathidae DEBRENNE, 1970a, p. 35]

Inner wall with annuli. *lower Cambrian (Atd.1–Bot.3).*

Thalamocyathus GORDON, 1920, p. 687 [**Archaeocyathus trachealis* TAYLOR, 1910, p. 125; SD TING, 1937, p. 368, by elimination; lectotype, TAYLOR, 1910, pl. 8, photo 47(8); HILL, 1965, pl. 7,*1*; DEBRENNE, 1973, pl. 1,*6;* SD DEBRENNE, 1969b, p. 262; SAM T1555A, Adelaide] [=*Bronchocyathus* R. BEDFORD & J. BEDFORD, 1936, p. 25 (type, *Archaeocyathus trachealis* TAYLOR, 1910, p. 125, OD); =*Thalamopectinus* DEBRENNE, 1973, p. 8 (type, *T. arterialis*, OD; =*Archaeocyathus trachealis* TAYLOR, 1910, p. 125), for discussion, see DEBRENNE & KRUSE, 1989, p. 27; =*Gordonicyathella* YAZMIR in ZHURAVLEVA, 1974a, p. 160, *nom. nud.*; =*Gordonicyathellus* YAZMIR in YAZMIR, DALMATOV, & YAZMIR, 1975, p. 48 (type, *G. solidus*, OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 136; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 164]. Inner wall with one pore row per intersept and upright, V-shaped annuli; septa aporose to sparsely porous; pectinate tabulae may be present. *lower Cambrian (Atd.2–Bot.3):* Altay Sayan, Tuva, Mongolia, Transbaikalia, South China, Australia, Antarctica, South Africa (allochthonous), Falkland

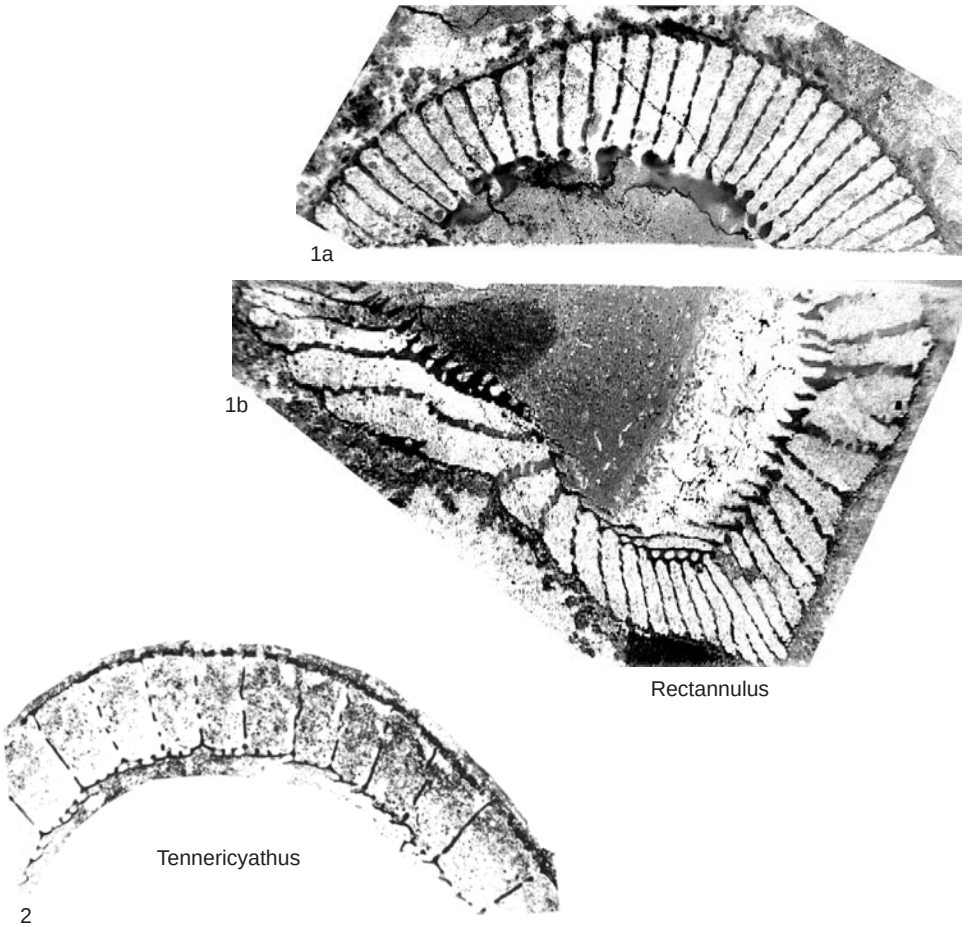


FIG. 538. Densocyathidae (p. 940–941).

Islands (allochthonous).——FIG. 539,*1a–b*. **T. trachealis* (TAYLOR), Ajax Limestone, Botoman, Ajax Mine, South Australia, Australia, lectotype, SAM T1555A; *a,* transverse view, ×3.5 (Debrenne, 1973); *b,* external longitudinal view of cup, ×8 (Taylor, 1910).

Compositocyathus ZHURAVLEVA, 1960b, p. 159 [**Thalamocyathus muchattensis* ZHURAVLEVA in ZHURAVLEVA & ZELENOV, 1955, p. 71; OD; holotype, ZHURAVLEVA & ZELENOV, 1955, pl. 2,*1–2;* ZHURAVLEVA, 1960b, pl. 10,*3–5,* TsSGM 205/47a-b, Novosibirsk]. Inner wall with one pore row per intersept and planar annuli bearing short beams that support supplementary microporous sheath; septa aporose to sparsely porous; pectinate tabulae may be present. *lower Cambrian (Atd.1–Bot.1):* Siberian Platform, Altay Sayan, Tuva, Transbaikalia.——FIG. 539,*2a–b*. **C. muchattensis* (ZHURAVLEVA), Pestrotsvet Formation, Atdabanian, Mukhatta River, Lena River, Sakha (Yakutia), Russia; *a,* holotype, TsSGM 205/47b, longitudinal section (outer wall to left), ×7 (Zhuravleva & Zelenov, 1955); *b,* topotype TsSGM 323, oblique transverse section, ×7 (Debrenne, Zhuravlev, & Kruse, 2002).

Conannulofungia YUAN in YUAN & ZHANG, 1980, p. 383 [**C. jinshaensis*; OD; holotype, YUAN & ZHANG, 1980, pl. 2,*1a–f,* NIGP 51288, Nanjing]. Inner wall with one pore row per intersept and upwardly projecting, S-shaped annuli linked to septa by ribs; septa completely porous, linked by synapticulae. *lower Cambrian (Bot.1–Bot.2):* South China.——FIG. 540,*1a–c*. **C. jinshaensis*, Minxinsi (Minghsingssu) Formation, Botoman, Yankong, Guizhou, China; *a–b,* holotype, NIGP 51288; *a,* transverse section, ×4; *b,* longitudinal section near inner wall, ×4 (Yuan & Zhang, 1980); *c,* specimen MNHN M85006, longitudinal section near inner wall, ×8 (Debrenne, Zhuravlev, & Kruse, 2002).

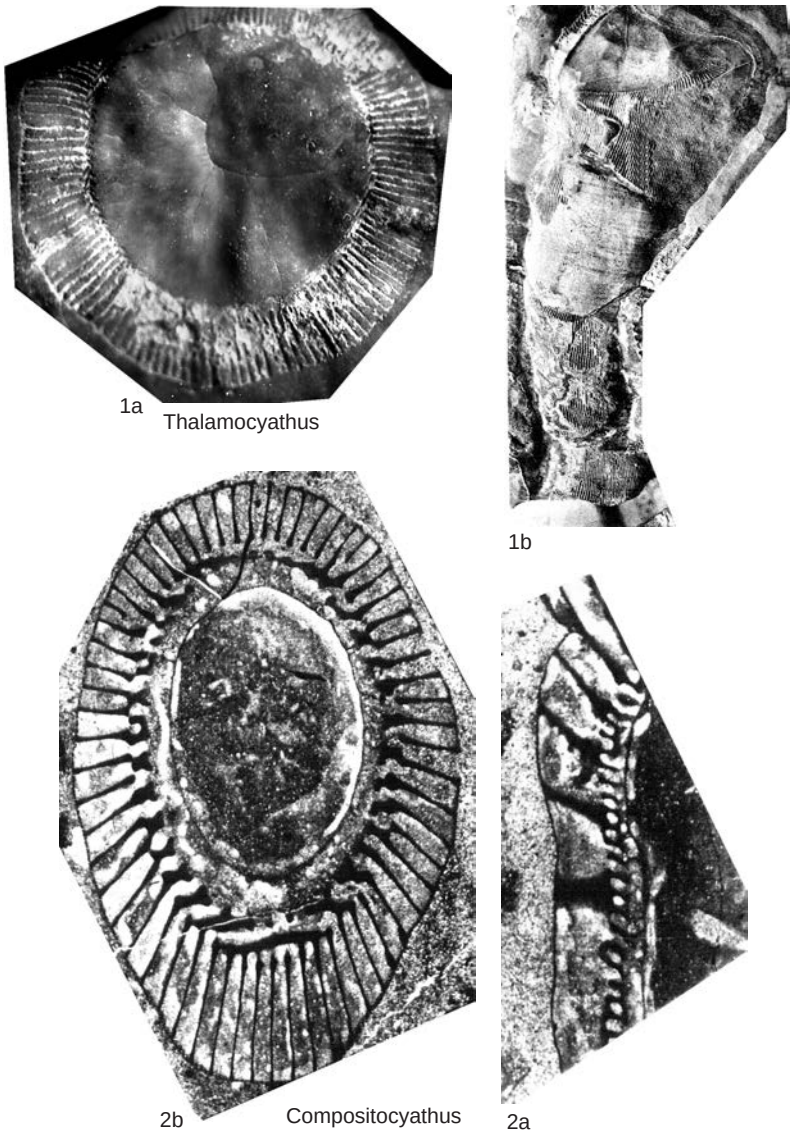
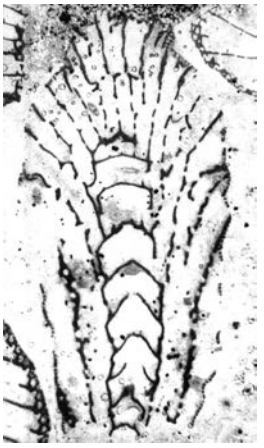
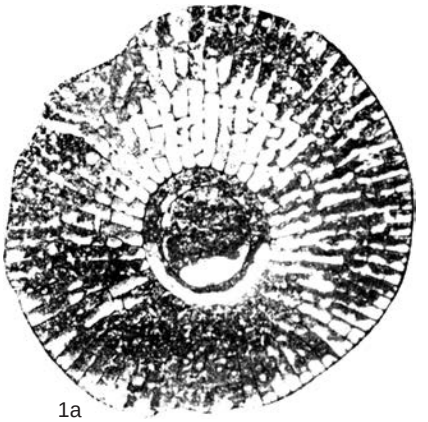


FIG. 539. Bronchocyathidae (p. 941–942).

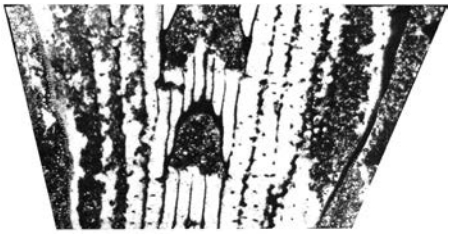
Cyathocricus DEBRENNE, 1969a, p. 318 [**Archaeocyathus tracheodentatus* R. BEDFORD & W. R. BEDFORD, 1934, p. 2; OD; lectotype, R. BEDFORD & W. R. BEDFORD, 1934, fig. 5; DEBRENNE, 1969a, pl. 5,*4–5;* SD DEBRENNE, 1969a, p. 319, NHM S4148, London; =*Ethmophyllum dentatum* TAYLOR, 1910, p. 129; lectotype, TAYLOR, 1910, pl. 16, photo 89; DEBRENNE, 1970a, pl. 1,*1;* SD DEBRENNE, 1974b, p. 132, SAM T1606C-D, Adelaide] [=*Cricopectinus* DEBRENNE, 1970a, p. 32 (type, *C. dentulus*, OD)]. Inner wall with one pore row per intersept and commonly horizontally projecting waved annuli that may mutually coalesce; denticles may be present on annular rims; septa aporose to sparsely porous; pectinate tabulae may be present. *lower Cambrian (?Atd.4–Bot.3):* Altay Sayan, Tuva, Far East, Australia, Antarctica, ?Morocco.——FIG. 540,*2a–c*. **C. dentatus* (TAYLOR), Ajax Limestone, Botoman, Ajax Mine, South Australia, Australia, lectotype, SAM T1606C-D; *a,* transverse view, ×6; *b,* oblique longitudinal view, ×5 (Debrenne, Zhuravlev, & Kruse, 2002); *c,* oblique longitudinal view, ×4 (Taylor, 1910).



1c



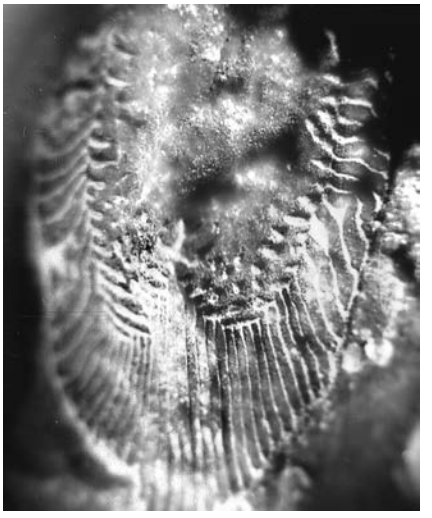
1a



1b Conannulofungia

2a Cyathocricus

2c



2b

FIG. 540. Bronchocyathidae (p. 942–943).

Cyclocyathella Vologdin in Zhuravleva, Krasnopeeva, & Chernysheva, 1960, p. 105 [**Cyclocyathus yakovlevi* Vologdin, 1931, p. 49; OD; lectotype, Vologdin, 1931, pl. 4,*7–8;* SD Debrenne, Zhuravlev, & Kruse, 2002, p. 1569, TsNIGRm 44a/2956, St. Petersburg] [=*Cyclocyathus* Vologdin, 1928, p. 30, *nom. nud.*, *non* Milne-Edwards & Haime, 1850, p. liv, scleractinian, *nec* Duncan & Thompson, 1867, p. 1, rugose coral; =*Cyclocyathus* Simon, 1939, p. 27 (type, *C. yakovlevi* Vologdin, 1931, p. 49)]. Inner wall with one pore row per intersept and inverted V-shaped annuli; septa completely porous. *lower Cambrian (Atd.2):* Altay Sayan, Tuva, Far East.——Fig. 541,*1a–c*. **C. yakovlevi* (Vologdin), Torgashino Formation, Atdabanian, Kameshki, East Sayan, Altay Sayan, Russia; *a,* paralectotype, TsNIGRm 45/2956, transverse section, ×6; *b,* paralectotype, TsNIGRm 47a/2956, longitudinal section, ×6; *c,* schematic sketch of septum in longitudinal section (outer wall to left), ×8 (Vologdin, 1931).

Denaecyathus Zhuravleva in Zhuravleva & others, 1967, p. 57 [**D. biporosus*; OD; holotype, Zhuravleva & others, 1967, pl. 17,*5–6*, TsSGM 325/17, Novosibirsk]. Inner wall with several pore rows per intersept and upright, V-shaped annuli; septa aporose to sparsely porous. *lower Cambrian (Bot.1)*: Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East.——Fig. 541,*2a–c*. **D. biporosus*, Shangan Formation, Botoman, Shivelig-Khem River, East Tannu-Ola Range, Tuva, Russia; *a,* holotype, TsSGM 325/17, oblique transverse section, ×5; *b,* paratype, TsSGM 325/16, oblique longitudinal section (outer wall at bottom), ×5; *c,* holotype, TsSGM 325/17, oblique transverse section (outer wall to left), ×5 (Zhuravleva & others, 1967).

Gordonicyathus Zhuravleva, 1959, p. 426 [**Thalamocyathus gerassimovensis* Krasnopeeva, 1955, p. 95; OD; holotype not designated, collection not located] [=*Sichotecyathus* Okuneva in Okuneva & Repina, 1973, p. 138 (type, *S. orientalis*, OD), for discussion, see Debrenne, Zhuravlev, & Rozanov, 1989, p. 109; Debrenne, Rozanov, & Zhuravlev, 1990, p. 144]. Inner wall with one pore row per intersept and upright, V-shaped annuli; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.1–Bot.3):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East, Australia.——Fig. 541,*3*. **G. gerassimovensis* (Krasnopeeva), Verkhnemonok Formation, Botoman, Gerasimov Spring, Monok River, West Sayan, Altay Sayan, Russia, unlocated syntype, oblique transverse section, ×7 (Krasnopeeva, 1955).

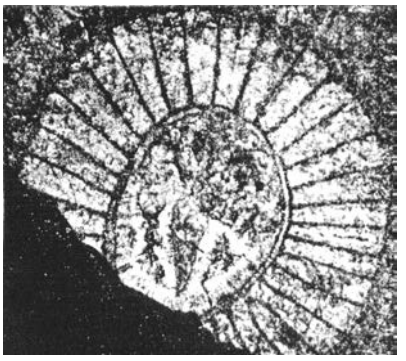
Gordonifungia Rozanov in Repina & others, 1964, p. 193 [**G. batinensis*; OD; holotype, Repina & others, 1964, pl. 11,*1*, PIN 4297/24, Moscow]. Inner wall with one pore row per intersept and upright, V-shaped annuli; septa completely porous, linked by synapticulae. *lower Cambrian (Atd.3–Bot.1):* Altay Sayan, ?Morocco.——Fig. 542,*1*. **G. batinensis*, Usa Formation, Atdabanian, Verkhnyaya Erba, Batenev Range, Kuznetsk Alatau, Russia, holotype, PIN 4297/24, oblique transverse section, ×4 (Repina & others, 1964).

Morenicyathus Perejón, 1975b, p. 169 [**M. arruzafai*; OD; holotype, Perejón, 1975b, pl. 6,*5–6;* Perejón, 1975c, pl. 6,*8–9*, CE 62-14, Madrid; =*Archaeocyathellus (Protocyathus) cordobae* Simon, 1939, p. 74; holotype, Simon, 1939, pl. 2,*11*, SM 26-179e, Frankfurt am Main] [=*Kellericyathus* Rozanov, 1973, p. 61, *nom. nud.*; =*Denaecyathellus* Osadchaya in Osadchaya & others, 1979, p. 122 (type, *D. makarichus*, OD); =*Kellericyathus* Rozanov in Debrenne, Zhuravlev, & Rozanov, 1989, p. 114 (type, *K. altaicus*, OD)]. Inner wall with several pore rows per intersept and upright, V-shaped annuli; septa completely porous. *lower Cambrian (Atd.2–Atd.3):* Kolyma, Altay Sayan, Iberia.——Fig. 542,*2a–b*. **M. cordobae* (Simon) [=*M. arruzafai* Perejón], Pedroche Formation, Atdabanian, Las Ermitas, Cordoba, Andalusia, Spain, holotype, CE 62-14; *a,* oblique transverse section, ×4; *b,* detail of longitudinal section (outer wall to left), ×8 (Perejón, 1975c).

Pseudotennericyathellus Osadchaya in Osadchaya & others, 1979, p. 120 [**Tennericyathus latus* Osadchaya in Zadorozhnaya, Osadchaya, & Repina, 1973, p. 134; OD; holotype, Zadorozhnaya, Osadchaya, & Repina, 1973, pl. 19,*3;* Osadchaya & others, 1979, pl. 5,*1–2*, TsSGM IGiG424, Novosibirsk]. Inner wall with several pore rows per intersept and upwardly projecting, S-shaped annuli; septa completely porous. *lower Cambrian (Atd.2–Atd.4):* Altay Sayan, Mongolia.——Fig. 542,*3a–b*. **P. latus* (Osadchaya), Usa Formation, Atdabanian, Bograd, Batenev Range, Kuznetsk Alatau, Russia, holotype, TsSGM IGiG424; *a,* transverse section, ×9; *b,* longitudinal section (outer wall to left), ×9 (Osadchaya & others, 1979).

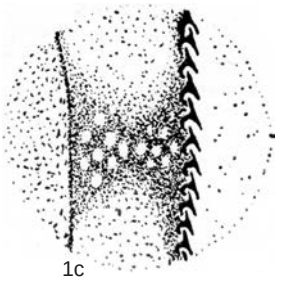
Sagacyathus Kruse, 1982, p. 178 [**S. stonyx*; OD; holotype, Kruse, 1982, fig. 15D–H, AM F.83576, Sydney]. Inner wall with one pore row per intersept and upright, V-shaped annuli bearing denticulate rims; septa aporose to sparsely porous; pectinate tabulae may be present. *lower Cambrian (Atd.4–Bot.3):* Altay Sayan, Mongolia, Far East, Australia.——Fig. 542,*4a–c*. **S. stonyx*, Cymbric Vale Formation, Botoman, Mt. Wright, New South Wales, Australia, holotype, AM F.83576; *a,* transverse section AM FT.8487, ×6; *b,* oblique longitudinal section AM FT.8486, ×4; *c,* longitudinal section AM FT.8490, ×4 (Kruse, 1982).

Stillicidocyathus Ting, 1937, p. 367 [**Coscinocyathus aulax* Taylor, 1910, p. 139; OD; lectotype, Taylor, 1910, pl. 10, photo 57; SD Debrenne, 1969b, p. 263, SAM T1605A-B, Adelaide] [=*Glaessnericyathus* Debrenne, 1970a, p. 35 (type, *Bronchocyathus sigmoideus* R. Bedford & J. Bedford, 1936, p. 25, OD), for discussion, see Gravestock, 1984, p.



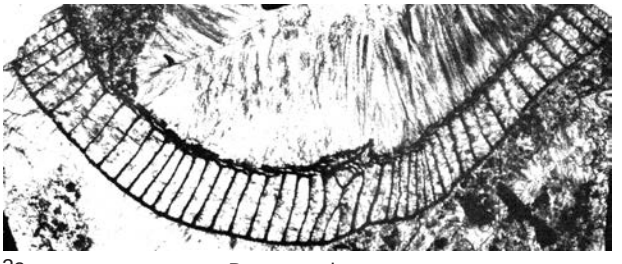
1a

1b Cyclocyathella

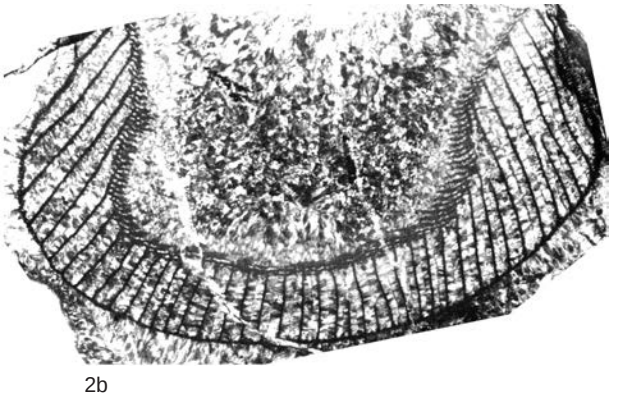


1c

2c



2a Denaecyathus



2b

3 Gordonicyathus

FIG. 541. Bronchocyathidae (p. 945).

69; Debrenne, Zhuravlev, & Rozanov, 1989, p. 133; Debrenne, Rozanov, & Zhuravlev, 1990, p. 162]. Inner wall with one pore row per intersept and upwardly projecting, S-shaped annuli; septa aporose to sparsely porous; pectinate tabulae may be present. *lower Cambrian (Bot.1–Bot.3):* Altay Sayan, Tuva, Mongolia, Australia, Antarctica, South China, Iberia, Sardinia.——Fig. 543,*1.* **C. aulax* (Taylor), Ajax Limestone, Botoman, Ajax Mine, South Australia, Australia, lectotype, SAM T1605A-B, longitudinal view, ×7 (Taylor, 1910).

Svetlanocyathus Missarzhevskiy & Rozanov, 1962, p. 43 [**S. primus*; OD; holotype, Missarzhevskiy & Rozanov, 1962, pl. 3,*2a–v;* Rozanov, 1973, pl. 1,*5*, PIN 4297/19-20, Moscow]. Outer wall with slitlike, simple pores; inner wall with one pore row per intersept and inverted V-shaped annuli; septa aporose to sparsely porous. *lower Cambrian (Bot.1):* Altay Sayan, Tuva.——Fig. 543,*2.* **S. primus*, Shangan Formation, Botoman, Shivelig-Khem River, East Tannu-Ola Range, Tuva, Russia, holotype, PIN 4297/19-20, oblique transverse view, ×5 (Debrenne, Zhuravlev, & Rozanov, 1989).

Taylorcyathus Vologdin, 1955, p. 143 [**Cyclocyathus subtersiensis* Vologdin, 1940b, p. 63; OD; holotype not designated, collection not located] [=*Tersicyathus* Vologdin, 1955, p. 143 (type, *Cyclocyathus tersiensis* Vologdin, 1931, p. 87, OD); =*Thalamocyathellus* Osadchaya in Osadchaya & others, 1979, p. 155 (type, *T. inclinatus*, OD), for discussion, see Debrenne, Zhuravlev, & Rozanov, 1989, p. 134; Debrenne, Rozanov, & Zhuravlev, 1990, p. 163; =*Pospelovicyathus* Konyaeva in Zhuravleva & others, 1997a, p. 49 (type, *P. gravis*, OD)]. Inner wall with one pore row per intersept and upwardly projecting, S-shaped annuli; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.1–Bot.3):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East, Australia, Iberia, France, Sardinia.——Fig. 543,*3.* **T. subtersiensis* (Vologdin), Gavrilovskoe Formation, Atdabanian, Belaya Gorka, Salair, Russia, topotype, PIN 4754/50, oblique transverse section, ×6 (Debrenne, Zhuravlev, & Kruse, 2002).

Taylorfungia Perejón, 1989, p. 180 [**Thalamocyathus synapticulosus* Zhuravleva, 1955a, p. 41; OD; holotype, Zhuravleva, 1955a, pl. 5,*1*, PIN 495, Moscow, not located]. Inner wall with one pore row per intersept and upwardly projecting, planar to S-shaped annuli; septa completely porous, linked by synapticulae. *lower Cambrian (Atd.2–Atd.3):* Altay Sayan.——Fig. 543,*4.* **T. synapticulosa* (Zhuravleva), Usa Formation, Atdabanian, Bol'shaya Erba (Potekhino), Batenev Range, Kuznetsk Alatau, Russia, holotype, PIN 495, oblique transverse section, ×8 (Zhuravleva, 1955a).

Trininaecyathus Zhuravleva, 1960b, p. 218 [**T. macroporus*; OD; holotype not located; paratypes, Zhuravleva, 1960b, pl. 18,*6–8,* fig. 122, TsSGM 205/100, 205/101, Novosibirsk]. Inner wall with one pore row per intersept and upwardly projecting, S-shaped annuli bearing denticulate rims; septa aporose to sparsely porous; pectinate tabulae may be present. *lower Cambrian (Bot.1):* Siberian Platform.——Fig. 543,*5.* **T. macroporus*, Perekhod Formation, Botoman, Botoma River, Sakha (Yakutia), Russia, paratype, TsSGM 205/100, oblique transverse section, ×8 (Zhuravleva, 1960b).

Family ETHMOCYATHIDAE Debrenne, 1969

[Ethmocyathidae Debrenne, 1969a, p. 322] [=Ethmopectinidae Debrenne, 1970a, p. 25; =Zonacyathellidae Zhuravleva in Zhuravleva & Elkina, 1974, p. 65; =Baikalocyathinae Zhuravleva in Zhuravleva & Elkina, 1974, p. 68; =Inessocyathidae Zhuravleva in Zhuravleva & Elkina, 1974, p. 106; =Hyptocyathidae Kruse, 1978, p. 29; =Gnaltacyathidae Kruse, 1982, p. 166; =Baikalopectinidae Gravestock, 1984, p. 66]

Inner wall with noncommunicating canals. *lower Cambrian (Atd.1–Bot.3).*

Ethmocyathus R. Bedford & W. R. Bedford, 1934, p. 2 [**E. lineatus;* M; holotype, R. Bedford & W. R. Bedford, 1934, fig. 8; Hill, 1965, pl. 4,*2;* Debrenne, 1969a, pl. 5,*1–3;* Debrenne, 1974b, pl. 27,*1;* NHM S4149, M, London] [=*Ethmopectinus* Debrenne, 1970a, p. 34 (type, *E. walteri,* OD), for discussion, see Debrenne, Zhuravlev, & Rozanov, 1989, p. 106; Debrenne, Rozanov, & Zhuravlev, 1990, p. 142]. Inner wall with one row of horizontal to upwardly projecting, straight canals per intersept, formed by flexure of inner edges of septa; supplementary screen of planar rings on central cavity side; septa aporose to sparsely porous; pectinate tabulae may be present. *lower Cambrian (Bot.3):* Australia, Antarctica, Falkland Islands (allochthonous).——Fig. 544,*1a–b.* **E. lineatus*, Ajax Limestone, Botoman, Ajax Mine, South Australia, Australia, holotype, NHM S4149; *a,* longitudinal view of inner wall, ×7; *b,* oblique longitudinal view of inner wall (to left) and septa (to right), ×15 (Debrenne, 1969a).

Afiacyathus Voronin, 1962, p. 26 [**A. lativallum*; OD; holotype, Voronin, 1962, pl. 4,*4–5*, PIN 1914/74-80a, Moscow, not located] [=*Axiculifungia* F. Debrenne & M. Debrenne in F. Debrenne, M. Debrenne, & Rozanov, 1976, p. 102 (type, *Ajacicyathus compositus* Debrenne, 1961, p. 9, OD)]. Inner wall with one row of horizontal to upwardly projecting, straight canals per intersept; septa completely porous, linked by synapticulae. *lower Cambrian (Atd.2–Bot.1):* Tuva, Morocco, South China, Iberia, Sardinia, ?Poland.——Fig. 544,*2a–b.* **A. lativallum*, Shangan Formation, Botoman, Shivelig-Khem River, East Tannu-Ola Range, Tuva, Russia, holotype, PIN 1914/74-80a; *a,* oblique transverse view, ×2; *b,* oblique longitudinal view, ×2 (Voronin, 1962).

Baikalocyathus Yazmir in Zhuravleva, 1974a, p. 55 [**Ethmophyllum rossicum* Zhuravleva, 1960b, p. 164; OD; holotype, Zhuravleva, 1960b, pl. 11,*2*, TsSGM 205/51, Novosibirsk] [=*Nochoroicyathella* Korshunov, 1983b, p. 110 (type, *N. fragilis*, OD); =*Baikalopectinus* Gravestock, 1984, p. 66 (type,

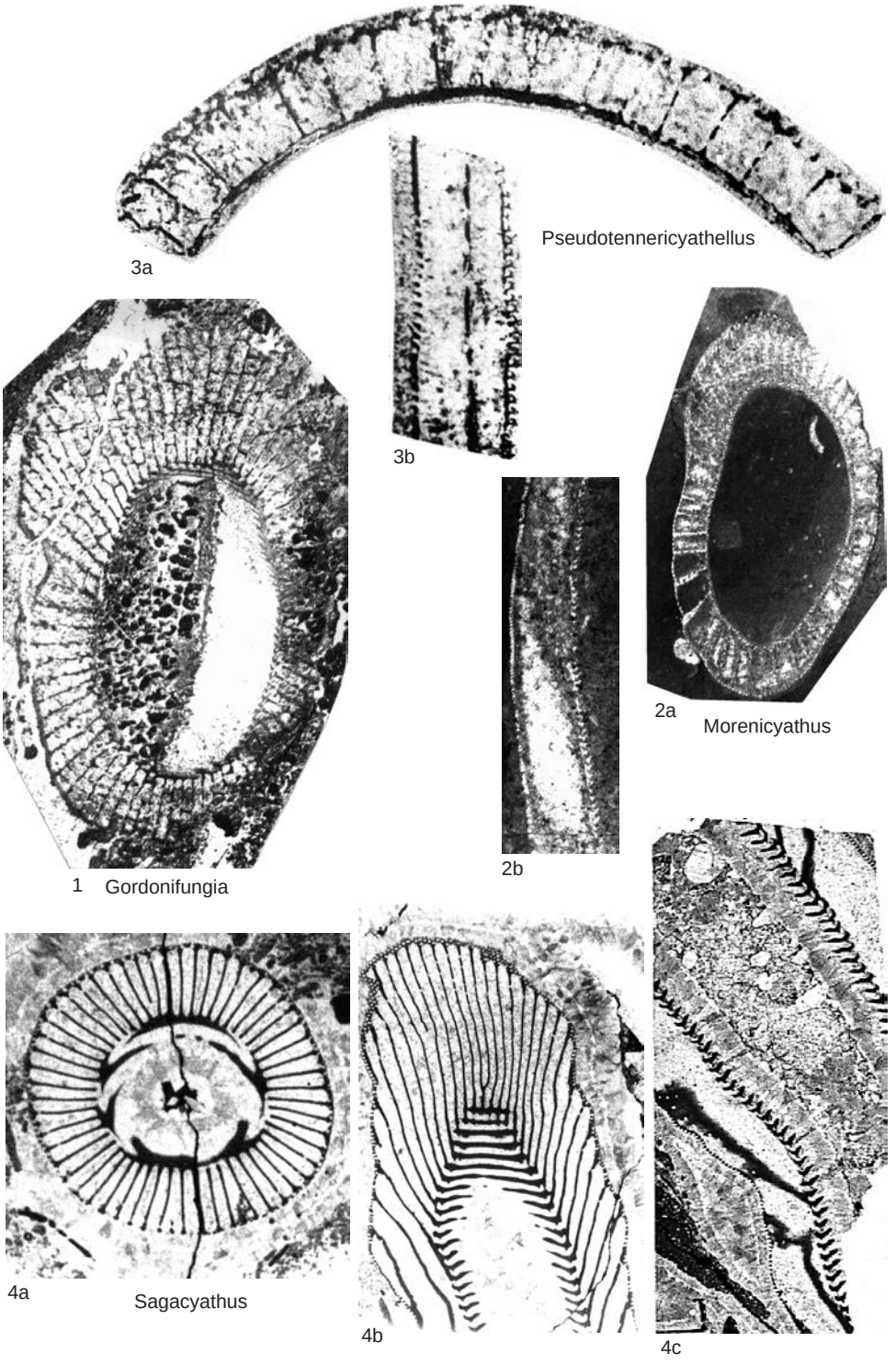
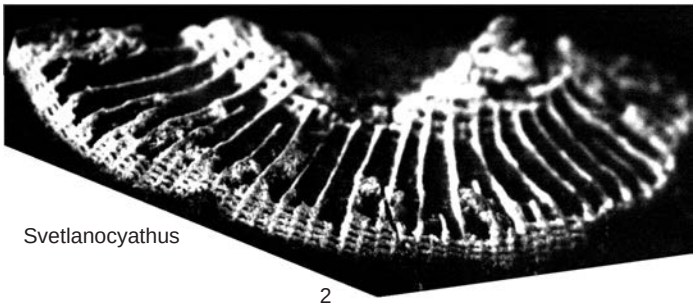
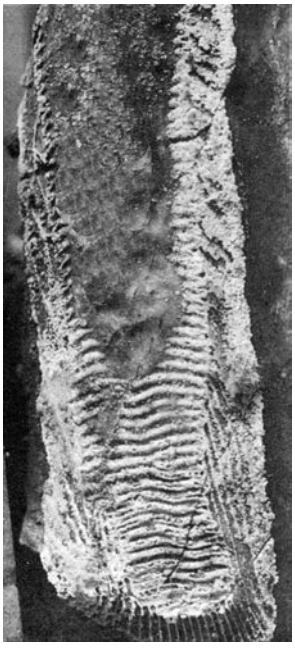


Fig. 542. Bronchocyathidae (p. 945).



Svetlanocyathus

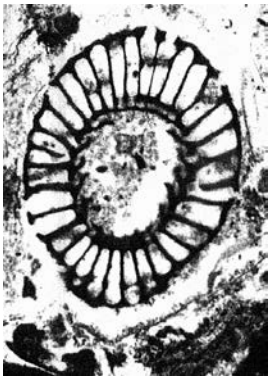
2



1 Stillicidocyathus

4 Taylorfungia

3 Taylorcyathus



5 Trininaecyathus

FIG. 543. Bronchocyathidae (p. 945–947).

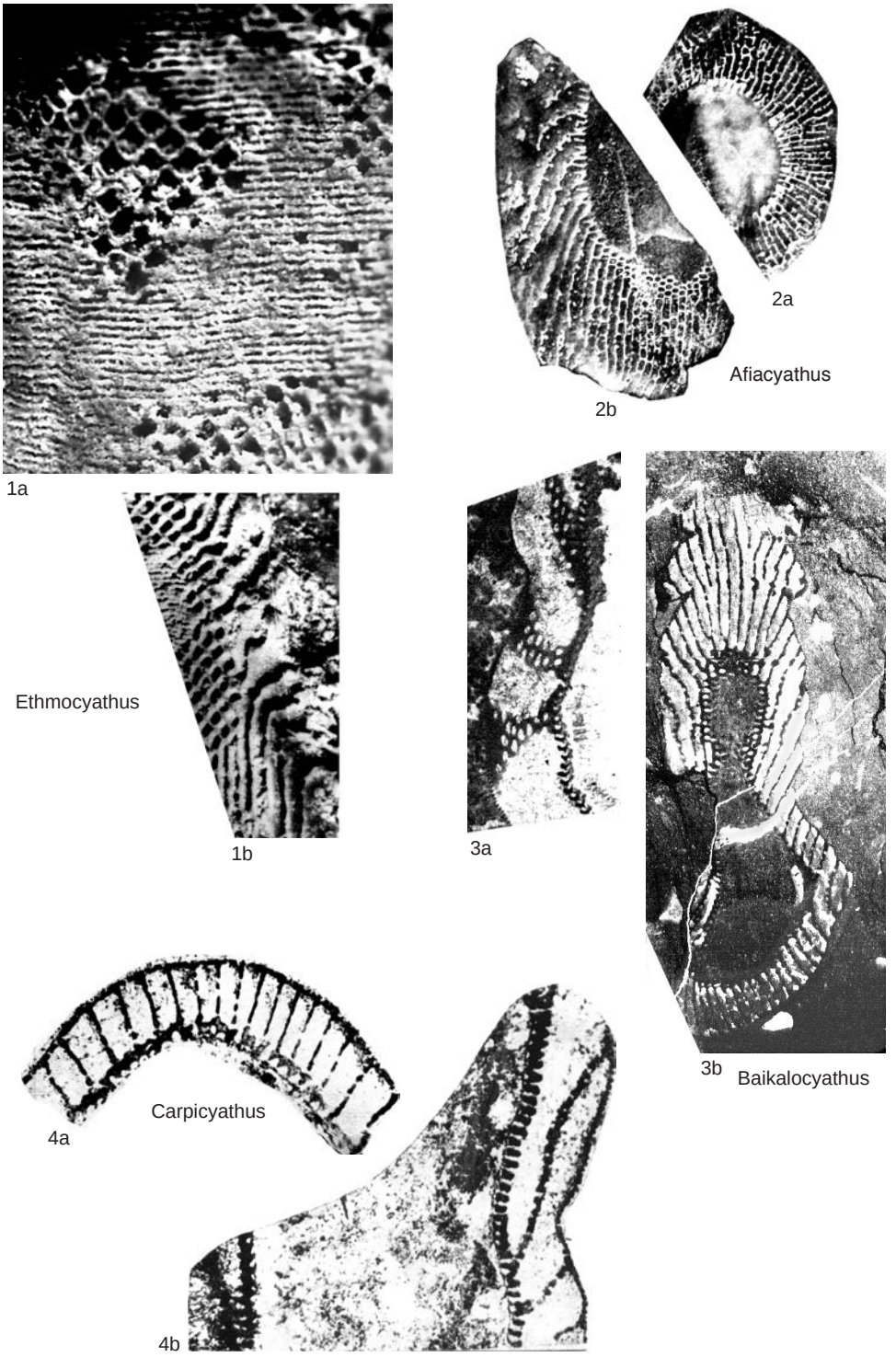


FIG. 544. Ethmocyathidae (p. 947–951).

B. capulus, OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 95; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 134]. Inner wall with one row of downwardly projecting, straight canals per intersept, bearing supplementary bracts on central cavity side; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.1–Bot.1):* Siberian Platform, Kolyma, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East, Australia, ?Morocco.——FIG. 544,*3a–b*. **B. rossicus* (ZHURAVLEVA); *a,* Pestrotsvet Formation, Atdabanian, Oy-Muran, Lena River, Sakha (Yakutia), Russia, holotype, TsSGM 205/51, detail of longitudinal section of septum (outer wall to left), ×10 (Zhuravleva, 1960b); *b,* Pestrotsvet Formation, Atdabanian, Mukhatta River, Lena River, Sakha (Yakutia), Russia, paratype, TsSGM 205/52, oblique longitudinal section, ×6 (Debrenne, Zhuravlev, & Kruse, 2002).

Carpicyathus OSADCHAYA in ZHURAVLEVA & others, 1967, p. 51 [**C. mysticus*; OD; holotype, ZHURAVLEVA & others, 1967, pl. 14,*3–6*, VSEGEI 9594, St. Petersburg]. Inner wall with several rows of horizontal to upwardly projecting, straight canals per intersept, bearing supplementary bracts on central cavity side; septa completely porous. *lower Cambrian (Atd.2–Bot.2):* Altay Sayan, Tuva, Transbaikalia, Morocco.——FIG. 544,*4a–b*. **C. mysticus*, Shangan Formation, Shivelig-Khem River, East Tannu-Ola Range, Tuva, Russia, holotype, VSEGEI 9594; *a,* transverse section, ×1.5; *b,* longitudinal section, ×3.5 (Zhuravleva & others, 1967).

Degeletticyathus ZHURAVLEVA in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 36 [**Ethmophyllum? galuschkoi* ZHURAVLEVA, 1960b, p. 169; OD; holotype, ZHURAVLEVA, 1960b, pl. 11,*7*, TsSGM 205/56, Novosibirsk] [=*Degeletticyathellus* ZHURAVLEVA in ZHURAVLEVA & ELKINA, 1974, p. 66 (type, *D. lebedevae,* OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 103]. Inner wall with horizontal to upwardly projecting, straight stirrup canals only; septa aporose to sparsely porous. *lower Cambrian (Atd.2–Bot.3):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Tajikistan, Australia, Morocco.——FIG. 545,*1a–b*. **D. galuschkoi* (ZHURAVLEVA), Oy-Muran reef massif, Botoman, Lena River, Sakha (Yakutia), Russia; *a,* specimen TsSGM 323/40, transverse section, Oy-Muran, ×5 (Zhuravleva, Korshunov, & Rozanov, 1969); *b*, holotype, TsSGM 205/56, longitudinal section of septum (outer wall to left), Mukhatta River, ×5 (Zhuravleva, 1960b).

Frinalicyathus DEBRENNE, ROZANOV, & ZHURAVLEVA in ZHURAVLEVA & ELKINA, 1974, p. 73 [**Leptosocyathus altaicus* ROZANOV in REPINA & others, 1964, p. 190; OD; holotype, REPINA & others, 1964, pl. 4,*2*, PIN 4297/21, Moscow] [=*Pseudodegeletticyathellus* OSADCHAYA in OSADCHAYA & others, 1979, p. 123 (type, *P. ladae*, OD), for discussion, see DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 143]. Inner wall with downwardly projecting, straight stirrup canals only, bearing supplementary scales on central cavity side; septa completely porous. *lower Cambrian (Atd.1–Atd.4):* Altay Sayan, Mongolia.——FIG. 545,*2. *F. altaicus* (ROZANOV), Verkhneynyrga Formation, Atdabanian, Tyrga River, Altay Mountains, Altay Sayan, Russia, holotype, PIN 4297/21, transverse section, ×3 (Repina & others, 1964).

Gnaltacyathus KRUSE, 1982, p. 166 [**G. nodus*; OD; holotype, KRUSE, 1982, pl. 3,*2–4*, AM FT.8453, 8454, 8495b, Sydney]. Inner wall with horizontal to upwardly projecting, straight canals, each canal spanning several intersepts; septa completely porous. *lower Cambrian (Bot.1–Bot.3):* Tuva, ?Mongolia, Australia.——FIG. 545,*3a–b*. **G. nodus*, Cymbric Vale Formation, Botoman, Mt. Wright, New South Wales, Australia, holotype, AM FT.8453, 8454, 8495b; *a,* transverse section, AM FT.8495b, ×8; *b,* longitudinal section, AM FT.8454, ×8 (Kruse, 1982).

Hyptocyathus KRUSE, 1978, p. 30 [**H. licinus*; OD; holotype, KRUSE, 1978, fig. 2–3, AM F.83402, Sydney]. Inner wall with downwardly projecting, straight stirrup canals only, bearing upwardly projecting, branching canals on central cavity side; septa aporose to sparsely porous. *lower Cambrian (Bot.3):* Australia.——FIG. 546,*1a–c*. **H. licinus*, Cymbric Vale Formation, Botoman, Mt. Wright, New South Wales, Australia, holotype, AM F.83402; *a,* oblique transverse section, AM FT.14171, ×4; *b,* longitudinal section, AM FT.14173, ×4; *c,* tangential section of inner wall, AM FT.14174, ×15 (Kruse, 1978).

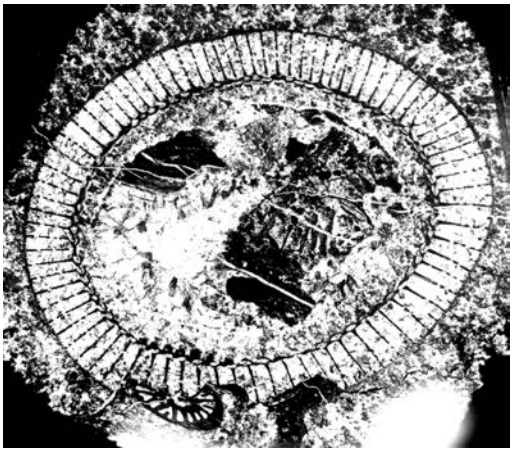
Inessocyathellus BELYAEVA in ZHURAVLEVA & ELKINA, 1974, p. 78 [**I. synapticulosus*; OD; holotype, ZHURAVLEVA & ELKINA, 1974, pl. 7,*3*, DVGU, Khabarovsk]. Inner wall with one row of horizontal to upwardly projecting, straight canals per intersept; septa aporose to sparsely porous, linked by synapticulae. *lower Cambrian (Bot.3):* Far East.——FIG. 546,*2a–b*. **I. synapticulosus*, Ust'toka unit, Botoman, Verkhneurminsk Spring, Dzhagdy Range, Far East, Russia, holotype, DVGU, Khabarovsk; *a,* transverse section, ×10; *b,* oblique longitudinal section, ×10 (Zhuravleva & Elkina, 1974).

Inessocyathus DEBRENNE, 1964, p. 143 [**Archaeocyathus spatiosus* BORNEMANN, 1886, p. 59; OD; lectotype, BORNEMANN, 1886, pl. 15,*1a;* SD DEBRENNE, 1964, p. 143, not located; topotype, DEBRENNE, 1964, pl. 9,*1–2*, MNHN M84074, specimen SPi-13, Paris] [=*Voroninicyathus* ZHURAVLEVA in ZHURAVLEVA & ELKINA, 1974, p. 79 (type, *Inessocyathus karakolicus* VORONIN, 1969, p. 103, OD); =*Rowanpectinus* GRAVESTOCK, 1984, p. 67 (type, *R. clarus*, OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 112; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 146]. Inner wall with one row of horizontal to upwardly projecting, straight canals per intersept; septa completely porous. *lower Cambrian (Atd.1–Bot.3):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Far East, Australia, South China, Morocco, Iberia, France, Sardinia, Germany.——FIG. 546,*3a–b*. **I. spatiosus* (BORNEMANN), Matoppa Formation, Botoman, San Pietro, Sardinia, Italy; *a,* lectotype, transverse section, ×2.5 (Bornemann, 1886); *b,* topotype,

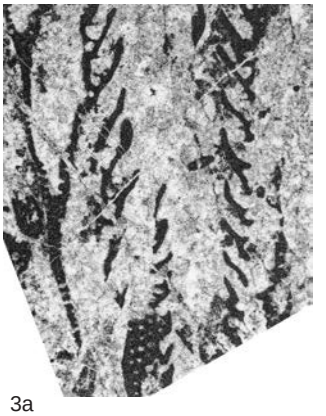
1a

Degeletticyathus

1b

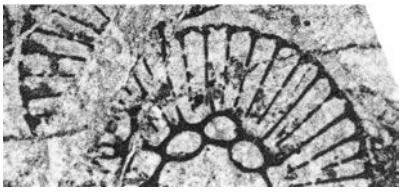


2 Frinalicyathus



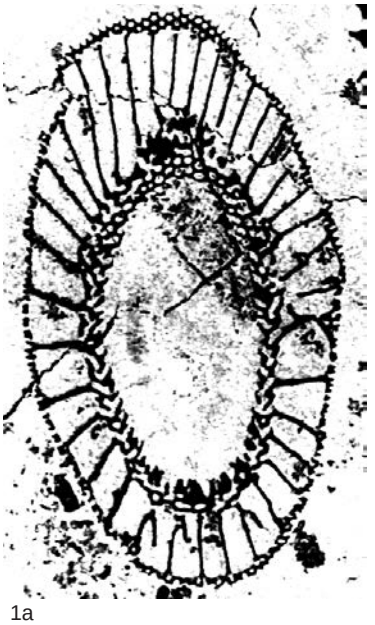
3a

Gnaltacyathus

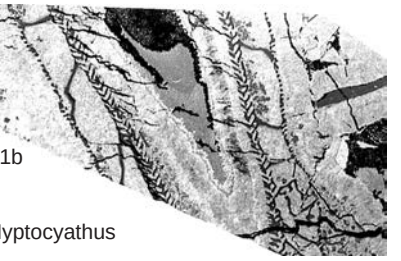


3b

Fig. 545. Ethmocyathidae (p. 951).

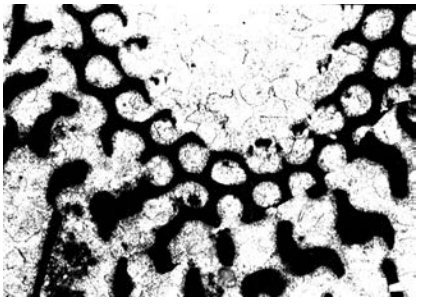


1a



1b

Hyptocyathus



1c

3a

Inessocyathus

3b

2a

2b

Inessocyathellus

FIG. 546. Ethmocyathidae (p. 951–954).

MNHN M84074, specimen SPi-13, longitudinal section, ×2.5 (Debrenne, Zhuravlev, & Kruse, 2002).

Mackenziecyathus Handfield, 1971, p. 43 [**M. bukryi*; OD; holotype, Handfield, 1971, pl. 5,*1a–d*, GSC 25334, Ottawa] [=*Ussuricyathus* Okuneva in Okuneva & Repina, 1973, p. 113 (type, *U. kropotkini*, OD)]. Inner wall with horizontal to upwardly projecting straight stirrup canals only, bearing supplementary scales on central cavity side; septa aporose to sparsely porous; pectinate tabulae may be present. *lower Cambrian (Bot.1):* Altay Sayan, Tuva, Mongolia, Far East, Canada, United States.——Fig. 547,*1a–c*. **M. bukryi*, unnamed Sekwi Formation equivalent (map unit 5 of Handfield, 1971), Botoman, Coal River, Yukon Territory, Canada, holotype, GSC 25334; *a,* transverse section, ×4; *b,* longitudinal section (outer wall to right), ×4; *c,* tangential section of inner wall, ×4 (Handfield, 1971).

Rasetticyathus Debrenne, 1971, p. 193 [**R. iglesiensis*; OD; holotype, Debrenne, 1971, fig. 1–2, not located; =*Archaeocyathus acutus* Bornemann, 1886, p. 50; holotype not designated; for discussion, see Debrenne, Rozanov, & Zhuravlev, 1990, p. 157]. Inner wall with one row of horizontal to upwardly projecting, S-shaped canals per intersept; septa aporose to sparsely porous; synapticulae may be present. *lower Cambrian (Bot.1–Bot.2):* South China, Morocco, Iberia, Sardinia.——Fig. 547,*2*. **R. acutus* (Bornemann) [=*R. iglesiensis*], Matoppa Formation, Botoman, Monte Cuccurinu, Sardinia, Italy, holotype, transverse section, ×16 (Debrenne, 1972).

Terraecyathus Zhuravleva in Zhuravleva & Elkina, 1974, p. 104 [**T. lathentis*; OD; holotype, Zhuravleva & Elkina, 1974, pl. 23,*2,* TsSGM 442/37, Novosibirsk] [=*Sericyathus* Voronin, 1988, p. 7 (type, *S. tartsinicus*, OD)]. Inner wall with several rows of horizontal to upwardly projecting, straight canals per intersept; septa completely porous. *lower Cambrian (Atd.1–Bot.1):* Altay Sayan, Tuva, Mongolia, Morocco.——Fig. 547,*3a–b*. **T. lathentis*; *a,* Adiak Formation, Atdabanian, Tom' River, Gornaya Shoria, Altay Sayan, Russia, holotype, TsSGM 442/37, transverse section, ×5 (Debrenne, Zhuravlev, & Kruse, 2002); *b,* Usa Formation, Botoman, Bograd, Batenev Range, Kuznetsk Alatau, Russia, paratype, TsSGM 442/38, longitudinal section of septum (outer wall to left), ×5 (Zhuravleva & Elkina, 1974).

Ussuricyathellus Voronin, 1988, p. 6 [**U. bellus*; OD; holotype, Voronin, 1988, pl. 1,*4*, PIN 3175-920/a-2, Moscow]. Inner wall with several rows of horizontal to upwardly projecting, straight canals per intersept; septa aporose to sparsely porous. *lower Cambrian (Bot.1–Bot.3):* Mongolia, Australia.——Fig. 547,*4*. **U. bellus*, Burgasutay Formation, Botoman, Seer' Mountains, Ikh nuuruundyn hotgor, western Mongolia, holotype, PIN 3175-920/a-2, transverse section, ×5 (Voronin, 1988).

Zonacyathellus Zhuravleva in Zhuravleva & Elkina, 1974, p. 66 [**?Zonacyathus monoporosus* Zhuravleva in Zhuravleva & others, 1967, p. 66; OD; holotype, Zhuravleva & others, 1967, pl. 23,*2;* Zhuravleva & Elkina, 1974, pl. 3,*2*, TsSGM 325/35, Novosibirsk]. Inner wall with one row of horizontal to upwardly projecting, straight canals per intersept; septa aporose to sparsely porous. *lower Cambrian (Bot.1):* Tuva.——Fig. 547,*5*. **Z. monoporosus* (Zhuravleva), Shangan Formation, Botoman, Shivelig-Khem River, East Tannu-Ola Range, Tuva, Russia, holotype, TsSGM 325/35, longitudinal section, ×5 (Zhuravleva & others, 1967).

Family SAJANOCYATHIDAE Vologdin, 1956

[Sajanocyathidae Vologdin, 1956, p. 879] [=Formosocyathidae Zhuravleva, 1957, p. 175; =Irinacyathidae Zhuravleva in Debrenne, 1972, p. 173, *nom. neg.*; =Irinaecyathidae Zhuravleva in Zhuravleva & Elkina, 1974, p. 67; =Diplocyathidae Debrenne, 1974b, p. 123]

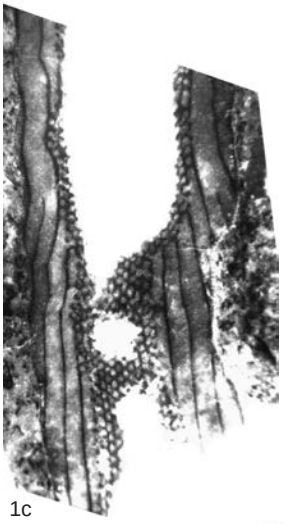
Inner wall with communicating canals. *lower Cambrian (Atd.1–Toy.2).*

Sajanocyathus Vologdin, 1940b, p. 81 (Vologdin, 1937b, p. 471, *nom. nud.*) [**S. ussovi*; OD; lectotype, Vologdin, 1940b, pl. 22,*8;* SD Zhuravlev, 2001a, p. 92, PIN 4754/2, Moscow] [=*Sayanocyathus* Vologdin, 1937b, p. 479, *nom. nud.* (type, *Sayanocyathus ussovi* Vologdin, 1937b, p. 479, M)]. Inner wall with several rows of anastomosing, horizontal to upwardly and laterally projecting, waved canals per intersept; septa aporose to sparsely porous. *lower Cambrian (Bot.1–Toy.2):* Siberian Platform, Altay Sayan, ?Antarctica, ?northeastern China (Hinggan), ?Sardinia, Canada, United States.——Fig. 548,*1*. **S. ussovi*, Verkhnemonok Formation, Botoman, Sanashtykgol River, West Sayan, Altay Sayan, Russia, lectotype, PIN 4754/2, transverse section of modular skeleton, ×8 (Debrenne, Zhuravlev, & Kruse, 2002).

Chakassicyathus Zhuravleva & Osadchaya in Zhuravleva & Elkina, 1974, p. 93 [**Ethmophyllum pseudoratum* Zhuravleva in Zhuravleva & others, 1967, p. 62; OD; holotype, Zhuravleva & others, 1967, pl. 21,*2,* TsSGM 325/28b, Novosibirsk]. Inner wall with one row of downwardly projecting, straight porous canals per intersept, bearing supplementary bracts or annuli on central cavity side; septa aporose to sparsely porous. *lower Cambrian (Bot.1):* Altay Sayan, Tuva.——Fig. 548,*2*. **C. pseudoratus* (Zhuravleva), Shangan Formation, Botoman, Shivelig-Khem River, East Tannu-Ola Range, Tuva, Russia, holotype, TsSGM 325/28b, oblique longitudinal section, ×5.5 (Zhuravleva & others, 1967).

Emucyathus Kruse & Moreno-Eiris, 2013, p. 23 [**E. elinorae*; OD; holotype, Kruse & Moreno-Eiris, 2013, fig. 15a–c, SAM P48475, Adelaide]. Inner wall with horizontal to upwardly projecting, straight stirrup canals only; septa completely porous. *lower Cambrian (Bot.3):* Australia.——Fig. 548,*3a–c*. **E. elinorae,* White Point Conglomerate, Botoman,

1a Mackenziecyathus

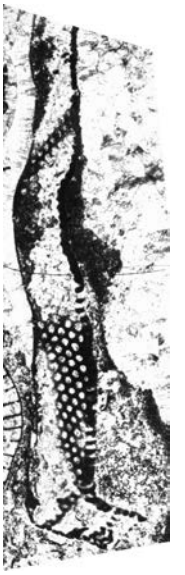


1c

1b

2 Rasetticyathus

3a

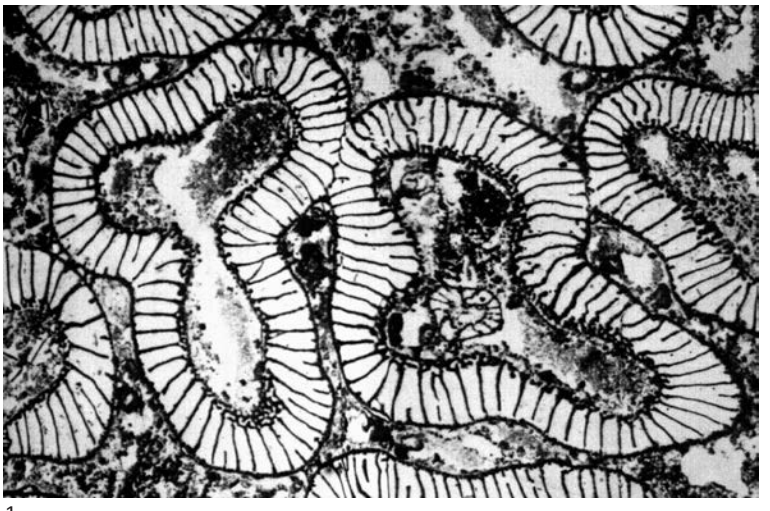


3b Terraecyathus

5 Zonacyathellus

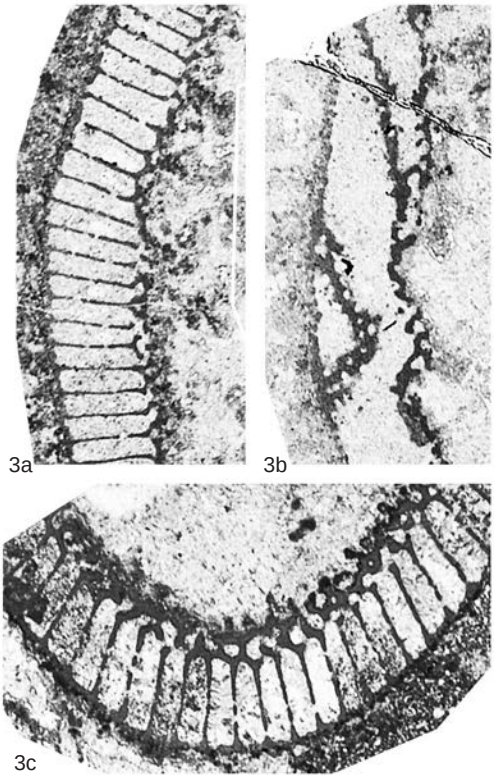
4 Ussuricyathellus

FIG. 547. Ethmocyathidae (p. 954).



1 Sajanocyathus

2 Chakassicyathus



3a 3b 3c Emucyathus

FIG. 548. Sajanocyathidae (p. 954–956).

Cape d'Estaing, South Australia, Australia; *a–b,* holotype, SAM P48475; *a,* transverse section (outer wall to left), ×8; *b,* longitudinal section (outer wall to left), ×8; *c,* paratype, SAM P48476, oblique transverse section (outer wall at bottom), ×8 (Kruse & Moreno-Eiris, 2013).

Formosocyathus VOLOGDIN, 1940b, p. 90 (VOLOGDIN, 1937b, p. 471, *nom. nud.*) [**F. bulynnikovi*; OD;

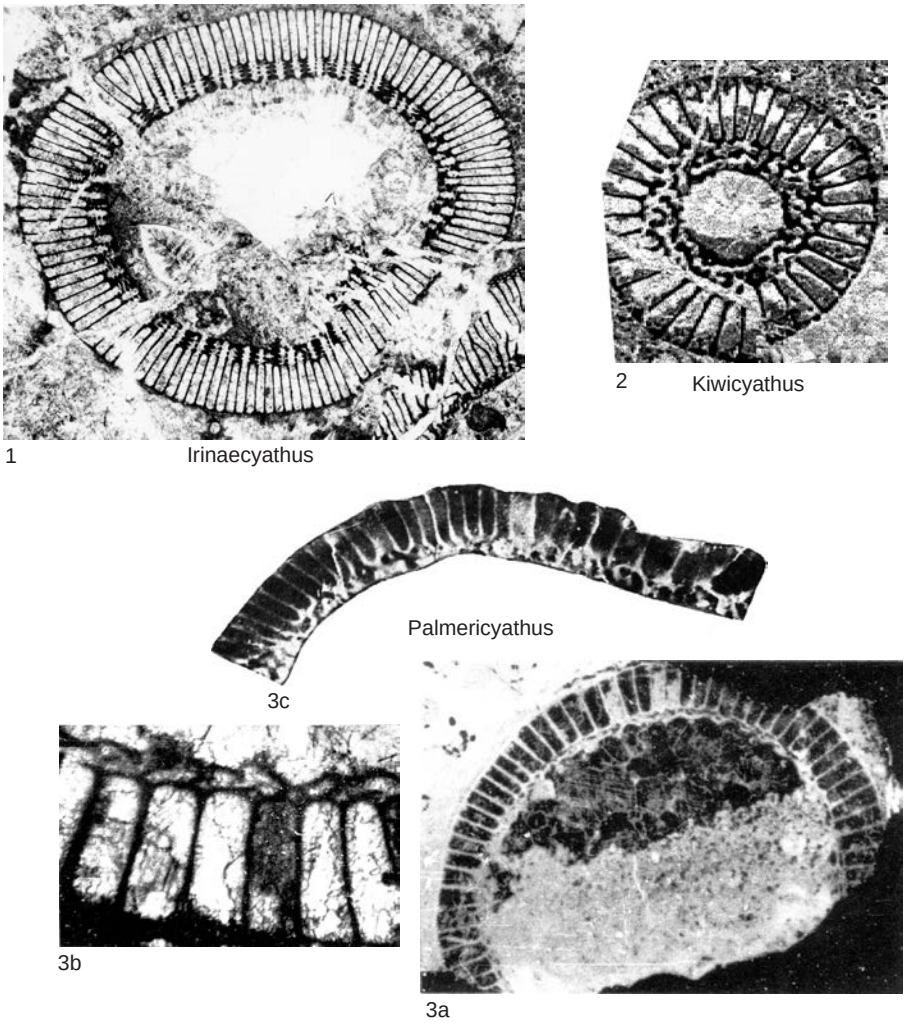


FIG. 549. Sajanocyathidae (p. 957–959).

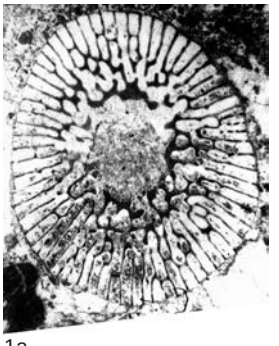
holotype not designated, collection not located]. Inner wall with one row of anastomosing, horizontal to upwardly and laterally projecting, waved canals per intersept; supplementary spines, annular structures, and/or microporous sheath may be present on central cavity side; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.1–Bot.2):* Altay Sayan, Tuva, Mongolia, Transbaikalia.——FIG. 550,*3a–b*. **F. bulynnikovi*, Verkhnemonok Formation, Botoman, Sanashtykgol River, West Sayan, Altay Sayan, Russia, unlocated syntype; *a,* transverse section (outer wall at top), ×6; *b,* longitudinal section (outer wall to left), ×6 (Vologdin, 1940b).

Irinaecyathus ZHURAVLEVA in ZHURAVLEVA & ELKINA, 1974, p. 87 [**Ethmophyllum grandiperforatum* VOLOGDIN, 1940a, p. 160; OD; lectotype, VOLOGDIN, 1940a, fig. 75, pl. 46,*1,* SD ZHURAVLEVA & ELKINA, 1974, p. 88, collection not located] [=*Kandatocyathus* KASHINA in OSADCHAYA & others, 1979, p. 156 (type, *K. kalleganovi,* OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 112; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 146]. Inner wall with one row of downwardly projecting, straight porous canals per intersept, bearing supplementary bracts or annuli on central cavity side; septa sparsely to completely porous; pectinate tabulae may be present. *lower Cambrian (Bot.1–Toy.2):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East.——FIG. 549,*1*. **I. grandiperforatus* (VOLOGDIN), Burgasutay Formation, Botoman, Seer' Mountains, Ikh nuuruundyn hotgor, western Mongolia, topotype, PIN 4327/24-2042/5, transverse section, ×5 (Debrenne, Zhuravlev, & Kruse, 2002).

2a

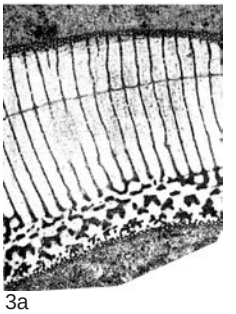
2b Zonacyathus

2c



1a Siderocyathus

1b



3a

3b Formosocyathus

FIG. 550. Sajanocyathidae (p. 956–959).

Kiwicyathus Debrenne & Kruse, 1986, p. 250 [**K. nix*; OD; holotype, Debrenne & Kruse, 1986, fig. 15A–B, VU VC19, Wellington]. Inner wall with horizontal to upwardly projecting, straight porous stirrup canals only; septa aporose to sparsely porous. *lower Cambrian (Bot.3):* Antarctica.——Fig. 549,*2.* **K. nix*, Shackleton Limestone, Botoman, Mt. Egerton, Byrd Glacier, Antarctica, holotype, VU VC19, transverse section, ×6 (Debrenne & Kruse, 1986).

Palmericyathus Handfield, 1971, p. 44 [**Ethmophyllum lineatum* Greggs, 1959, p. 66; OD; holotype, Greggs, 1959, pl. 14,*2,* GSC 14315, Ottawa; =*Ethmophyllum americanum* Okulitch in Cooper & others, 1952, p. 30; holotype, Cooper & others, 1952, pl. 7,*3–4,* USNM 111816, Washington, D.C. (for discussion, see Debrenne, 1987, p. 270)]. Inner wall with anastomosing, horizontal to upwardly and laterally projecting, waved stirrup canals only; septa aporose to sparsely porous. *lower Cambrian (Bot.1):* Canada, United States, Mexico.——Fig. 549,*3a–c*. **P. americanus* (Okulitch); *a–b,* Puerto Blanco Formation, Botoman, Caborca, Sonora, Mexico, holotype, USNM 111816; *a,* transverse section, ×8; *b,* detail of transverse section (outer wall at bottom), ×25 (Cooper & others, 1952); *c,* [=*P. lineatus* (Greggs)], Laib Formation, Botoman, Salmo, British Columbia, Canada, holotype, GSC 14315, transverse section (outer wall at top), ×6 (Greggs, 1959).

Siderocyathus Debrenne & Gangloff in Debrenne, Gandin, & Gangloff, 1990, p. 87 [**S. duncanae*; OD; holotype, Debrenne, Gandin, & Gangloff, 1990, pl. 1,*7,* USNM 443555, specimen IR1-3, Washington, D.C.]. Inner wall with one row of short, noncommunicating, horizontal to upwardly projecting canals per intersept, continuing into central cavity as communicating waved canals bearing supplementary bracts on central cavity side; septa aporose to sparsely porous, linked by synapticulae. *lower Cambrian (Bot.1):* United States.——Fig. 550,*1a–b*. **S. duncanae*, Valmy Formation, Botoman, Iron Canyon, Nevada, United States, holotype, USNM 443555, specimen IR1-3; *a,* transverse section, ×5; *b,* longitudinal section, ×5 (Debrenne, Gandin, & Gangloff, 1990).

Zonacyathus R. Bedford & J. Bedford, 1937, p. 36 [**Archaeocyathus retevallum* R. Bedford & W. R. Bedford, 1934, p. 2; OD; holotype, R. Bedford & W. R. Bedford, 1934, fig. 6; Hill, 1965, pl. 4,*3;* Debrenne, 1969a, pl. 4,*4;* NHM S4147, M, London; =*Archaeocyathus retezona* Taylor, 1910, p. 121; OD; lectotype, Taylor, 1910, pl. 6,*31;* Debrenne, 1974b, pl. 26,*4–5;* SD Debrenne, 1974b, p. 124, SAM T1577A, Adelaide] [=*Diplocyathellus* Debrenne, 1977b, p. 1222, *nom. nov. pro Diplocyathus* Debrenne, 1974b, p. 124, *non* Allman, 1888, p. 16, cnidarian (type, *Archaeocyathus retezona* Taylor, 1910, p. 121; OD)]. Inner wall with one row of horizontal to upwardly projecting, straight canals per intersept, canals branching and becoming porous toward central cavity; septa sparsely to completely porous; stirrup canals may be present. *lower Cambrian (?Bot.1, Bot.2–Bot.3):* ?Siberian Platform, Australia.——Fig. 550,*2a–c*. **Z. retezona* (Taylor), Ajax Limestone, Botoman, Ajax Mine, South Australia, Australia; *a–b,* [= *Z. retevallus* (R. Bedford & W. R. Bedford)] holotype, NHM S4147; *a,* oblique longitudinal view, ×5 (Debrenne, Zhuravlev, & Kruse, 2002); *b,* tangential view of inner wall, ×5 (Hill, 1965); *c,* topotype, USNM PU86606, longitudinal view (outer wall to right), ×5 (Debrenne, 1974b).

Family BIPALLICYATHIDAE Debrenne, Rozanov, & Zhuravlev, 1989

[Bipallicyathidae Debrenne, Rozanov, & Zhuravlev in Debrenne, Zhuravlev, & Rozanov, 1989, p. 82]

Inner wall with attached microporous sheath. *lower Cambrian (Atd.2).*

Bipallicyathus Zhuravlev in Voronin & others, 1982, p. 78 [**B. manifestus*; OD; holotype, Voronin & others, 1982, pl. 15,*6a–b*, PIN 3302/3305, Moscow] [=*Kashinaecyathus* Yaroshevich, 1990, p. 25 (type, *K. salairicus,* OD), for discussion, see Debrenne & Zhuravlev, 1992b, p. 173]. Inner wall with one pore row per intersept and attached microporous sheath; septa completely porous. *lower Cambrian (Atd.2):* Altay Sayan, Mongolia.——Fig. 551,*1a–c*. **B. manifestus*, Salaany Gol Formation, Atdabanian, Khasagt-Khayrkhan Range, Tsagaan Oloom province, western Mongolia; *a,* paratype, PIN 3302/3006, oblique transverse section, ×8; *b–c,* holotype, PIN 3302/3305; *b,* longitudinal section, ×7; *c,* detail of inner wall, ×17 (Voronin & others, 1982).

?Heckericyathus Zhuravleva, 1960b, p. 220 [**Ethmophyllum heckeri* Zhuravleva in Zhuravleva & Zelenov, 1955, p. 69; OD; holotype, PIN 1161, Moscow, not located; paratypes, Zhuravleva & Zelenov, 1955, pl. 1,*3–4,* TsSGM 205/102, 205/103, Novosibirsk] [=*Heckerocyathus* Zhuravleva in Vologdin, 1957a, p. 180, *nom. nud.*]. Inner wall with one pore row per intersept and independent microporous sheath, each micropore bearing a supplementary bract; septa completely porous; pectinate tabulae may be present. [Inner wall bears supplementary elements atypical of other members of family.] *lower Cambrian (Atd.1–Atd.4):* Siberian Platform, Transbaikalia, Far East.——Fig. 551,*2a–c*. **H. heckeri* (Zhuravleva), Pestrotsvet Formation, Atdabanian, Oy-Muran, Lena River, Sakha (Yakutia), Russia; *a,* paratype, TsSGM 205/102, transverse section, ×8 (Zhuravleva & Zelenov, 1955); *b–c,* paratype, TsSGM 205/103; *b,* detail of septum in longitudinal section (outer wall to right), ×16; *c,* detail of inner wall in oblique longitudinal section, ×16 (Debrenne, Zhuravlev, & Kruse, 2002).

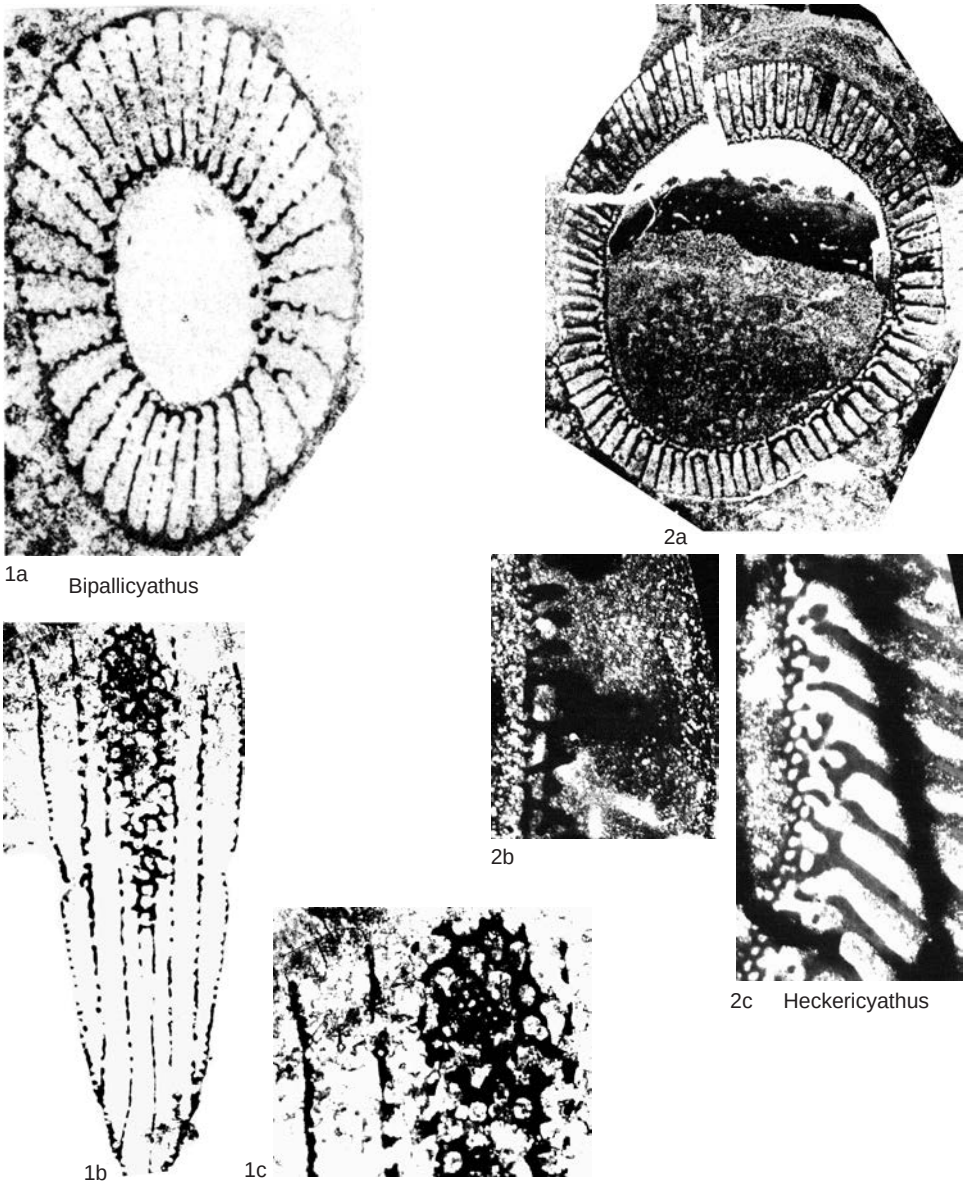


FIG. 551. Bipallicyathidae (p. 959).

Superfamily PRETIOSOCYATHOIDEA Rozanov, 1969

[*nom. correct.* DEBRENNE, ZHURAVLEV, & KRUSE, herein, *pro* Pretiosocyathacea ROZANOV, 1969, p. 112]

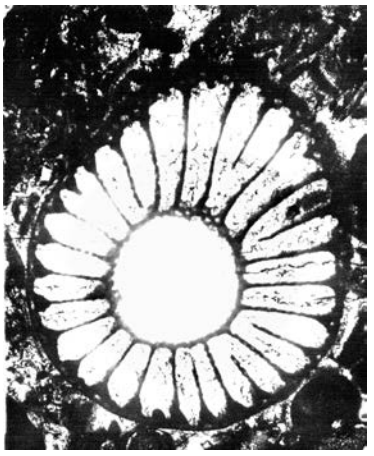
Outer wall with independent microporous sheath. *lower Cambrian (Atd.1–Bot.2).*

Family ROBERTOCYATHIDAE Rozanov, 1969

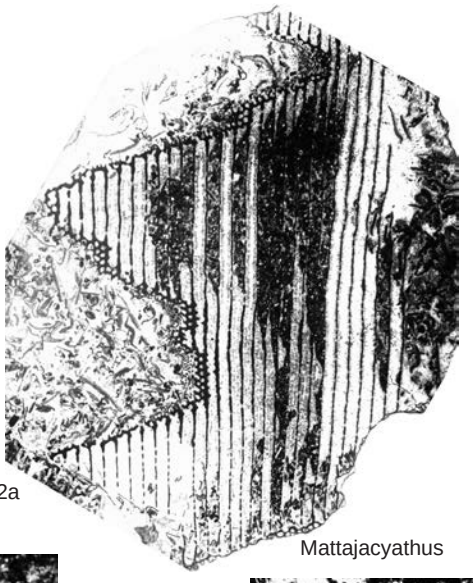
[Robertocyathidae ROZANOV, 1969, p. 112]

Inner wall with simple pores. *lower Cambrian (Atd.2–Bot.1).*

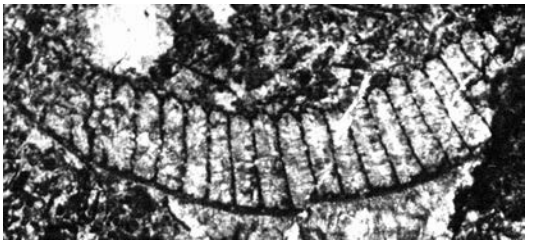
Robertocyathus ROZANOV, 1969, p. 112 [**R. polaris*; OD; holotype, ROZANOV, 1969, pl. 42,*1–2*, PIN



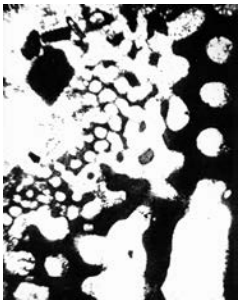
1 Robertocyathus



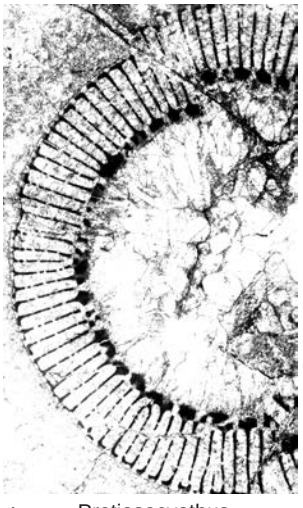
2a Mattajacyathus



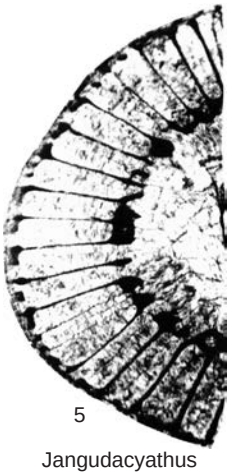
3 Urcyathella



2b



4 Pretiosocyathus



5 Jangudacyathus

6 Loculicyathopsis

FIG. 552. Robertocyathidae and Pretiosocyathidae (p. 960–962).

4297/96, Moscow]. Inner wall with several rows of simple pores per intersept; septa completely porous. *lower Cambrian (Atd.1–Bot.3):* Siberian Platform, Altay Sayan, Australia, Morocco, Iberia.——FIG. 552,*1. *R. polaris*, Erkeket Formation, Botoman, Khorbusuonka River, Olenek Basin, Sakha (Yakutia), Russia, holotype, PIN 4297/96, transverse section, ×7 (Debrenne, Zhuravlev, & Kruse, 2002).

Mattajacyathus ROZANOV in DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 118 (ROZANOV, 1973, p. 61, *nom. nud.;* ROZANOV in DEBRENNE & ROZANOV, 1983, p. 735, *nom. nud.*) [**Robertocyathus arduus* ROZANOV, 1969, p. 113; OD; holotype, ROZANOV, 1969, pl. 42,*3–4;* ROZANOV, 1973, pl. 5,*1*, PIN 4297/97, Moscow]. Cup in which both walls show periodic, synchronous transverse folds; inner wall with several rows of simple pores per intersept; septa completely porous. *lower Cambrian (Bot.1):* Siberian Platform.——FIG. 552,*2a–b. *M. arduus* (ROZANOV), Erkeket Formation, Botoman, Khorbusuonka River, Olenek Basin, Sakha (Yakutia), Russia, holotype, PIN 4297/97; *a,* longitudinal section, ×7; *b,* detail of outer wall in tangential section, ×15 (Debrenne, Zhuravlev, & Kruse, 2002).

Urcyathella ZHURAVLEVA in MUSATOV & others, 1961, p. 25 [**U. tercyathoides*; OD; holotype, MUSATOV & others, 1961, pl. 3,*8–9*, TsSGM 264/26, Novosibirsk]. Inner wall longitudinally plicate, with several rows of simple pores per intersept; septa completely porous. *lower Cambrian (Atd.4–Bot.1):* Altay Sayan.——FIG. 552,*3. *U. tercyathoides*, Balakhtinson Formation, Atdabanian, Kazyr River, East Sayan, Altay Sayan, Russia, holotype, TsSGM 264/26, transverse section, ×7 (Debrenne, Zhuravlev, & Kruse, 2002).

Family PRETIOSOCYATHIDAE Rozanov, 1969

[Pretiosocyathidae ROZANOV, 1969, p. 112]

Inner wall with noncommunicating canals. *lower Cambrian (Atd.1–Bot.1).*

Pretiosocyathus ROZANOV in ROZANOV & MISSARZHEVSKIY, 1966, p. 55 [**P. subtilis*; OD; holotype, ROZANOV & MISSARZHEVSKIY, 1966, pl. 4,*4;* ROZANOV, 1973, pl. 11,*3*, PIN 4297/65, Moscow] [=*Cosmocyathus* YAZMIR in ZHURAVLEVA, 1974a, p. 96, *nom. nud.*; =*Cosmocyathus* YAZMIR in YAZMIR, DALMATOV, & YAZMIR, 1975, p. 63 (type, *C. perforatus*, OD); =*Pretiosocyathellus* OSADCHAYA in OSADCHAYA & others, 1979, p. 133 (type, *P. toltschiensis*, OD); =*Grandicyathus* KORSHUNOV, 1983b, p. 109 (type, *G. lectus*; OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 125; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 156]. Inner wall with horizontal to upwardly projecting, straight stirrup canals only; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.1–Bot.1):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia, Tajikistan.——FIG. 552,*4. *P. subtilis*, Usa Formation, Atdabanian, Bol'shaya Erba, Batenev Range, Kuznetsk Alatau, Russia, holotype, PIN 4297/65, transverse section, ×7 (Debrenne, Zhuravlev, & Kruse, 2002).

Jangudacyathus YAZMIR in YAZMIR, DALMATOV, & YAZMIR, 1975, p. 62 (YAZMIR in ZHURAVLEVA, 1974a, p. 180, *nom. nud.*) [**J. simplex*; OD; holotype, YAZMIR, DALMATOV, & YAZMIR, 1975, pl. 23,*5*, BGU 0138/21, Ulan-Ude]. Inner wall with several rows of horizontal to upwardly projecting, straight canals per intersept; septa aporose to sparsely porous. *lower Cambrian (Bot.1):* Transbaikalia.——FIG. 552,*5. *J. simplex*, Uran Formation, Botoman, Yanguda River, Vitim Highlands, Transbaikalia, Russia, holotype, BGU 0138/21, transverse section, ×7 (Debrenne, Zhuravlev, & Kruse, 2002).

Loculicyathopsis BOYARINOV in ZHURAVLEVA & others, 1997a, p. 61 [**L. septospinosus;* OD; holotype, ZHURAVLEVA & others, 1997a, pl. 11,*9*, ZSGGU 2329/62, Novokuznetsk]. Inner wall with one row of horizontal to upwardly projecting, straight canals per intersept; septa completely porous. *lower Cambrian (Atd.2):* Altay Sayan.——FIG. 552,*6. *L. septospinosus*, Usa Formation, Atdabanian, Malaya Belokamenka River, Kiya River, Kuznetsk Alatau, Russia, holotype, ZSGGU 2329/62, oblique transverse section, ×5 (Zhuravleva & others, 1997a).

Superfamily ERBOCYATHOIDEA Vologdin & Zhuravleva, 1956

[*nom. correct*. DEBRENNE & KRUSE, 1986, p. 251, *pro* Erbocyathacea ZHURAVLEVA, 1960b, p. 187, *nom. transl. ex* Erbocyathidae VOLOGDIN & ZHURAVLEVA in VOLOGDIN, 1956, p. 879] [=Bosceculcyathacea KRASNOPEEVA, 1959, p. 7, *nom. transl.* HILL, 1972, p. 77, *ex* Bosceculcyathidae KRASNOPEEVA, 1959, p. 7; =Kordecyathoidea MISSARZHEVSKIY, 1961, p. 21, *nom. transl.* MISSARZHEVSKIY in REPINA & others, 1964, p. 218, *ex* Kordecyathidae MISSARZHEVSKIY, 1961, p. 21, *nom. correct. pro* Kordecyathacea DEBRENNE, ROZANOV, & ZHURAVLEV in DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 82]

Outer wall with attached microporous sheath. *lower Cambrian (Atd.1–Toy.3).*

Family ERBOCYATHIDAE Vologdin & Zhuravleva, 1956

[Erbocyathidae VOLOGDIN & ZHURAVLEVA in VOLOGDIN, 1956, p. 879, *nom. nov. pro* Polycyathidae VOLOGDIN, 1928, p. 35, invalid name based on junior homonym] [=Ladaecyathidae DEBRENNE, 1964, p. 114]

Inner wall with simple pores. *lower Cambrian (Atd.1–Toy.3).*

Pluralicyathus OKULITCH, 1950c, p. 503, *nom. nov. pro Polycyathus* VOLOGDIN, 1928, p. 32, *non* DUNCAN, 1876, p. 433, cnidarian [**Polycyathus heterovallum* VOLOGDIN, 1928, p. 36; SD SIMON, 1939, p. 34; lectotype, VOLOGDIN, 1928, pl. 2,*1,2,4,5;* SD

DEBRENNE, ZHURAVLEV, & KRUSE, 2002, p. 1586, TsNIGRm 1/a-t/2617, St. Petersburg] [=*Erbocyathus* ZHURAVLEVA, 1950, p. 857, *nom. nud.; =Erbocyathus* ZHURAVLEVA, 1955a, p. 44, *nom. nov. pro Polycyathus* VOLOGDIN, 1928, p. 32 (type, *Polycyathus heterovallum,* SD SIMON, 1939, p. 34), *non* DUNCAN, 1876, p. 433, cnidarian; application by DEBRENNE, ZHURAVLEV, and KRUSE (2003) to suppress *Pluralicyathus* and conserve *Erbocyathus* rejected by ICZN (2005); =*Neocyathus* VOLOGDIN, 1960, p. 422 (type, *Archaeocyathus laevus* VOLOGDIN, 1940b, p. 57, OD)]. Inner wall with several rows of simple pores per intersept; septa aporose to sparsely porous. *lower Cambrian (Bot.1–Toy.3):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Far East, Uzbekistan.——FIG. 553,*1a–b*. **P. heterovallum* (VOLOGDIN); *a,* Torgashino Formation, Toyonian, Uyar River, East Sayan, Altay Sayan, Russia, unlocated specimen, transverse section, ×8.5 (Debrenne, Zhuravlev, & Kruse, 2002); *b,* Khomustakh Formation, Toyonian, Amga River, Sakha (Yakutia), Russia, specimen TsSGM 205/71, section of modular skeleton, ×1 (Zhuravleva, 1960b).

Ladaecyathus ZHURAVLEVA, 1960a, p. 43 [**Tegerocyathus limbatus* ZHURAVLEVA, 1955a, p. 46; OD; holotype, ZHURAVLEVA, 1955a, pl. 5,*3–4*, PIN 494, Moscow, not located]. Inner wall with several rows of simple pores per intersept; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.4–Bot.3):* Siberian Platform, Kolyma, Altay Sayan, Transbaikalia, Far East, Australia, Antarctica, Morocco.——FIG. 553,*2a–b*. **L. limbatus* (ZHURAVLEVA), Usa Formation, Botoman, Mt. Martyukhina, Batenev Range, Kuznetsk Alatau, Russia; *a,* holotype, PIN 494, transverse section, ×6.5 (Zhuravleva, 1955a); *b,* TsSGM 273/4d, longitudinal section of septum (outer wall to left), ×7 (Debrenne, Zhuravlev, & Kruse, 2002).

Milaecyathus DEBRENNE & ZHURAVLEV, 2000, p. 49 [**Ladaecyathus melnikovae* ZHURAVLEV in VORONIN & others, 1982, p. 79; OD; holotype, VORONIN & others, 1982, pl. 16,*2,5*, PIN 3302/300v, Moscow]. Inner wall with stirrup pores only; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.1–Atd.2):* Altay Sayan, Mongolia.——FIG. 553,*3a–b*. **M. melnikovae* (ZHURAVLEV), Salaany Gol Formation, Atdabanian, Salaany-Gol River, Khasagt-Khairkhan Range, Tsagaan Oloom province, western Mongolia, holotype, PIN 3302/300v; *a,* transverse section, ×5 (Voronin & others, 1982); *b,* detail of outer wall in tangential section, ×25 (Debrenne, Zhuravlev, & Kruse, 2002).

Family PEREGRINICYATHIDAE Zhuravleva, 1967

[Peregrinicyathidae ZHURAVLEVA in ZHURAVLEVA & others, 1967, p. 74]

Inner wall with annuli. *lower Cambrian (Bot.1–Bot.2).*

Peregrinicyathus ZHURAVLEVA in ZHURAVLEVA & others, 1967, p. 75 [**P. dorotheae*; OD; holotype, ZHURAVLEVA & others, 1967, pl. 28,*1*, TsSGM 325/54, Novosibirsk]. Inner wall with one pore row per intersept and upright, V-shaped annuli; septa completely porous. *lower Cambrian (Bot.1–Bot.2):* Altay Sayan, Tuva.——FIG. 554,*1a–b*. **P. dorotheae*, Shangan Formation, Botoman, Shivelig-Khem River, East Tannu-Ola Range, Tuva, Russia; *a,* holotype, TsSGM 325/54, transverse section, ×4.5 (Debrenne, Zhuravlev, & Kruse, 2002); *b,* paratype, TsSGM 325, specimen 1, thin section 1, sample 314-7, OR-64, detail of oblique transverse section (outer wall to left), ×8 (Zhuravleva & others, 1967).

Family VOLOGDINOCYATHIDAE Yaroshevich, 1957

[Vologdinocyathidae YAROSHEVICH, 1957, p. 1015] [=Bosceculcyathidae KRASNOPEEVA, 1959, p. 7; =Kordecyathidae MISSARZHEVSKIY, 1961, p. 21; =Schidertycyathidae KRASNOPEEVA, 1969, p. 63; =Gumbycyathidae DEBRENNE & KRUSE, 1986, p. 253]

Inner wall with noncommunicating canals. *lower Cambrian (Bot.1–Toy.2).*

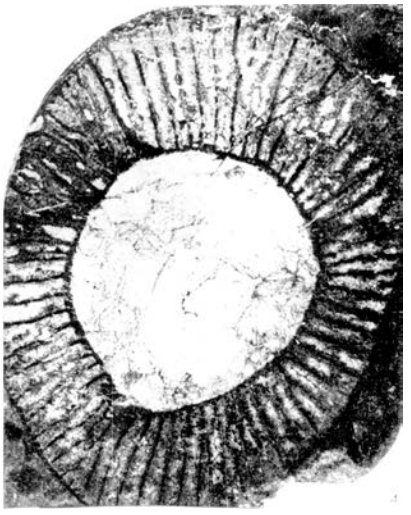
Vologdinocyathus YAROSHEVICH, 1957, p. 1015 [**V. erbiensis*; OD; holotype, YAROSHEVICH, 1957, fig. 1a–v, TsSGM 499/1a-b, Novosibirsk] [=*Tegerocyathella* KONYUSHKOV, 1967, p. 109 (type, *T. borovikovi*, OD); =*Larecyathus* KASHINA, 1979, p. 46, *nom. nud.*; =*Larecyathus* KASHINA in OSADCHAYA & others, 1979, p. 145 (type, *L. infinitus,* OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 139; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 167]. Inner wall with one row of horizontal to upwardly projecting, straight canals per intersept; septa aporose to sparsely porous. *lower Cambrian (Bot.3–Toy.2):* Altay Sayan, Tuva, Mongolia, Kazakhstan, Uzbekistan, Antarctica, Greenland.——FIG. 554,*2a–b*. **V. erbiensis*, Usa Formation, Toyonian, Bol'shaya Erba, Batenev Range, Kuznetsk Alatau, Altay Sayan, Russia, holotype, TsSGM 499/1a-b; *a,* detail of transverse section, ×30; *b,* detail of septum in longitudinal section (outer wall to left), ×50 (Debrenne, Zhuravlev, & Kruse, 2002).

Gumbycyathus KRUSE, 1982, p. 168 [**G. pythoni;* OD; holotype, KRUSE, 1982, pl. 4,*1–5,* AM F.83930, Sydney]. Inner wall with several rows of horizontal to upwardly projecting, straight canals per intersept, bearing supplementary bracts on central cavity side; septa completely porous. *lower Cambrian (Bot.1–Bot.3):* Mongolia, Australia.——FIG. 555,*1a–d*. **G. pythoni,* Cymbric Vale Formation, Botoman, Mt. Wright, New South Wales, Australia, holotype, AM F.83930; *a,* transverse section (outer wall to right), AM FT.8457, ×6; *b,* detail of longitudinal section (outer wall to left), AM FT.8455, ×8; *c,* detail of outer wall in tangential section, AM FT.8458, ×8; *d,* detail of

1a

Pluralicyathus

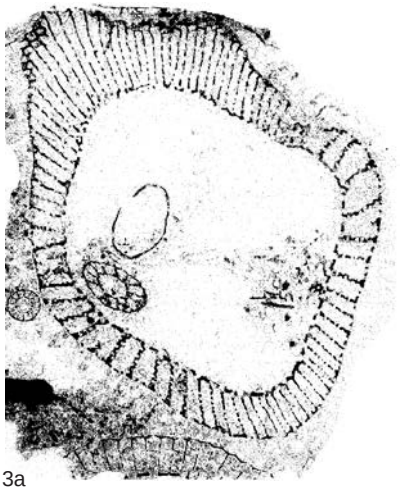
1b



2a

Ladaecyathus

2b



3a

3b

Milaecyathus

Fig. 553. Erbocyathidae (p. 962–963).

inner wall in tangential section, AM FT.8456, ×8 (Kruse, 1982).

Inacyathella Debrenne, 1977a, p. 109 [**I. pulchra*; OD; holotype, Debrenne, 1977a, pl. 8,*3–4*, MNHN M80037, Paris]. Inner wall with one row of horizontal to upwardly projecting, S-shaped canals per intersept; septa completely porous. *lower Cambrian (Bot.1):* Morocco.——Fig. 554,*3a–b*. **I. pulchra*, Issafen Formation, Botoman, Jbel Irhoud, Morocco, holotype, MNHN M80037; *a,* oblique transverse section, ×3.5 (Debrenne, Zhuravlev, & Kruse, 2002); *b,* detail of septum in longitudinal section (outer wall to left), ×10 (Debrenne, 1977a).

Kordecyathus Missarzhevskiy, 1961, p. 21 [**K. shiveligensis;* OD; holotype, Missarzhevskiy, 1961, pl. 1,*3*, PIN 1914/73M/1, Moscow, not located]. Inner wall with one row of horizontal to upwardly projecting, straight canals per intersept, bearing supplementary bracts on central cavity side; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Bot.1–Bot.2):* Tuva, Mongolia.——Fig. 554,*4a–b*. **K. shiveligensis*, Shangan Formation, Botoman, Shivelig-Khem River, East Tannu-Ola Range, Tuva, Russia, holotype, PIN 1914/73M/1; *a,* detail of transverse section (outer wall at top), ×8 (Missarzhevskiy, 1961); *b,* oblique longitudinal section, ×3 (Debrenne, Zhuravlev, & Kruse, 2002).

Sanarkophyllum Debrenne & Kruse, 1986, p. 254 [**Formosocyathus antarcticus* Hill, 1964c, p. 616; OD; holotype, Hill, 1964c, fig. 1(4a), An 62/1B/p, not located]. Inner wall with one row of downwardly projecting, straight canals per intersept, bearing supplementary bracts on central cavity side; septa aporose to sparsely porous. *lower Cambrian (Bot.3):* Antarctica.——Fig. 555,*2a–d*. **S. antarcticum* (Hill), Shackleton Limestone, Botoman; *a,* Plunket Point, Beardmore Glacier, Antarctica, holotype, An 62/1B/p, oblique transverse section, ×2 (Hill, 1964c); *b–d,* Holyoake Range, Nimrod Glacier, Antarctica, specimen GNS MG509; *b,* transverse section, ×4; *c,* oblique longitudinal section, ×3.5; *d,* detail of repeated longitudinal section (outer wall to left), ×6 (Debrenne, Zhuravlev, & Kruse, 2002).

Syringocyathus Vologdin, 1940b, p. 82 (Vologdin, 1937b, p. 471, *nom. nud.*) [**S. aspectabilis;* OD; lectotype, Vologdin, 1940b, pl. 23,*3;* SD Zhuravlev, 2001a, p. 92, PIN 4754/3, Moscow] [=*Schidertycyathus* Krasnopeeva, 1959, p. 3 (type, *S. borucaevi,* M); ?=*Bosceculcyathus* Krasnopeeva, 1959, p. 7 (type, *B. agyrekensis,* OD); ?=*Boscekulcyathus* Krasnopeeva, 1959, p. 7, *nom. null.;* =*Schidertycyathellus* Konyushkov, 1967, p. 108 (type, *S. borukaevi,* OD); =*Syringocyathellus* Kashina in Osadchaya & others, 1979, p. 149 (type, *S. kazachstani,* OD), for discussion, see Debrenne, Rozanov, & Zhuravlev, 1990, p. 162]. Inner wall with several rows of horizontal to upwardly projecting, straight canals per intersept; septa completely porous, linked by interseptal plates. *lower Cambrian (Bot.3–Toy.2):* Altay Sayan, Tuva, Kazakhstan, Uzbekistan.——Fig. 555,*3*. **S. aspectabilis*, Verkhnemonok Formation, Botoman, Abakan River, West Sayan, Altay Sayan, Russia, lectotype, PIN 4754/3, oblique transverse section, ×5 (Vologdin, 1940b).

Family TEGEROCYATHIDAE Krasnopeeva, 1972

[Tegerocyathidae Krasnopeeva, 1972, p. 145]

Inner wall with communicating canals. *lower Cambrian (Bot.1–Toy.3).*

Tegerocyathus Krasnopeeva, 1955, p. 90 (Krasnopeeva, 1953, p. 52, 56, *nom. nud.*) [**Ethmophyllum abakanensis* Vologdin, 1940b, p. 69; holotype not designated, collection not located; Zhuravleva, 1960b, p. 192, invalidly nominated *Ethmophyllum edelsteini* Vologdin, 1931, p. 47, as type species] [=*Tegerocoscinus* Krasnopeeva, 1972, p. 145 (type, *T. tchesnokovensis*, OD); =*Alexandricyathus* Kashina in Osadchaya & others, 1979, p. 142 (type, *A. ultrus*, OD), for discussion, see Debrenne, Zhuravlev, & Rozanov, 1989, p. 134; Debrenne, Rozanov, & Zhuravlev, 1990, p. 163]. Inner wall with one row of horizontal to upwardly projecting, straight porous canals per intersept; septa sparsely to completely porous; pectinate tabulae may be present. *lower Cambrian (Bot.1–Toy.3):* Siberian Platform, Altay Sayan, Mongolia, Uzbekistan, Antarctica, Greenland, United States.——Fig. 556,*1a–b*. **T. abakanensis* (Vologdin), Verkhnemonok Formation, Botoman, Abakan River, West Sayan, Altay Sayan, Russia, unlocated syntype; *a,* transverse section, ×5; *b,* longitudinal section, ×5 (Vologdin, 1940b).

Krasnopeevaecyathus Rozanov in Repina & others, 1964, p. 208 [**K. tyrgaensis*; OD; holotype, Repina & others, 1964, pl. 21,*3–4*), PIN 4297/26-27, Moscow] [=*Krishnanicyathus* Vologdin, 1964b, p. 358 (type, *K. elegans*, OD); =*Ethmosyringocyathus* Konyushkov, 1972, p. 138 (type, *E. primus*, OD)]. Inner wall longitudinally plicate, with several rows of anastomosing, horizontal to upwardly projecting, waved canals per intersept; septa completely porous. *lower Cambrian (Bot.2):* Altay Sayan, United States.——Fig. 556,*2*. **K. tyrgaensis*, Verkhneynyrga Formation, Botoman, Tyrga River, Altay Mountains, Altay Sayan, Russia, holotype, PIN 4297/26-27, oblique transverse section, ×3.5 (Repina & others, 1964).

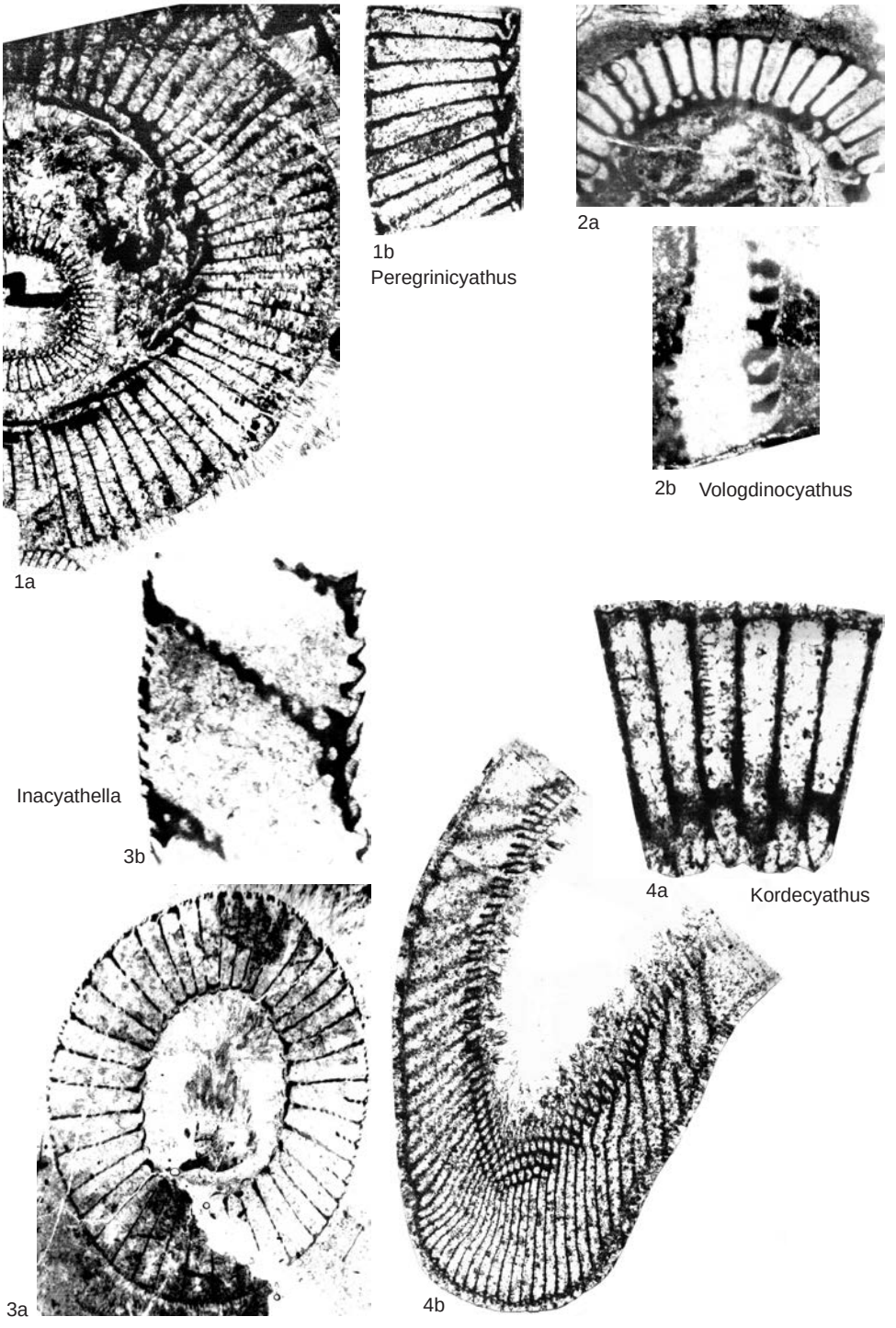
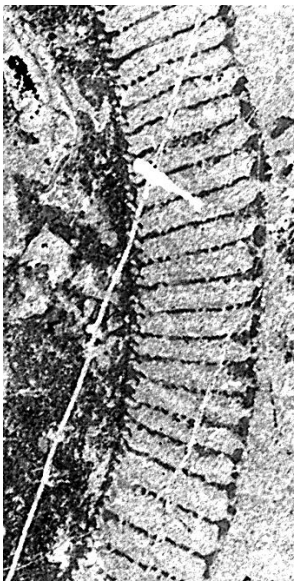
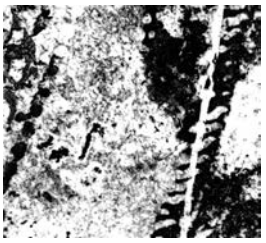


FIG. 554. Peregrinicyathidae and Vologdinocyathidae (p. 963–965).

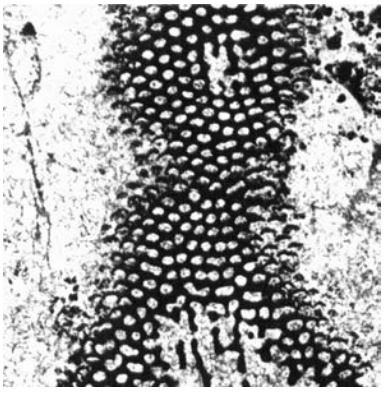


1a Gumbycyathus



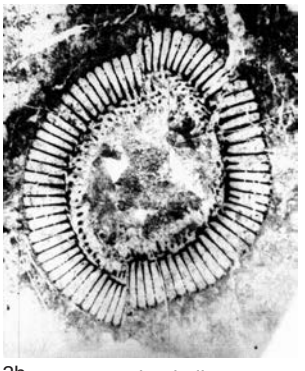
1b

1c



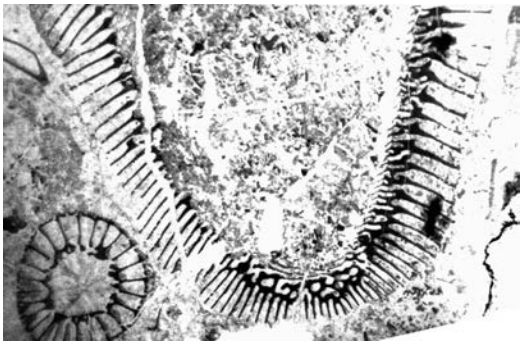
1d

2a

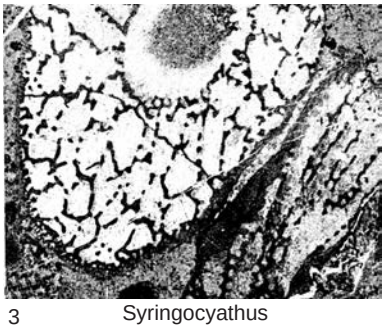


2b Sanarkophyllum

2d



2c



3 Syringocyathus

FIG. 555. Vologdinocyathidae (p. 963–965).

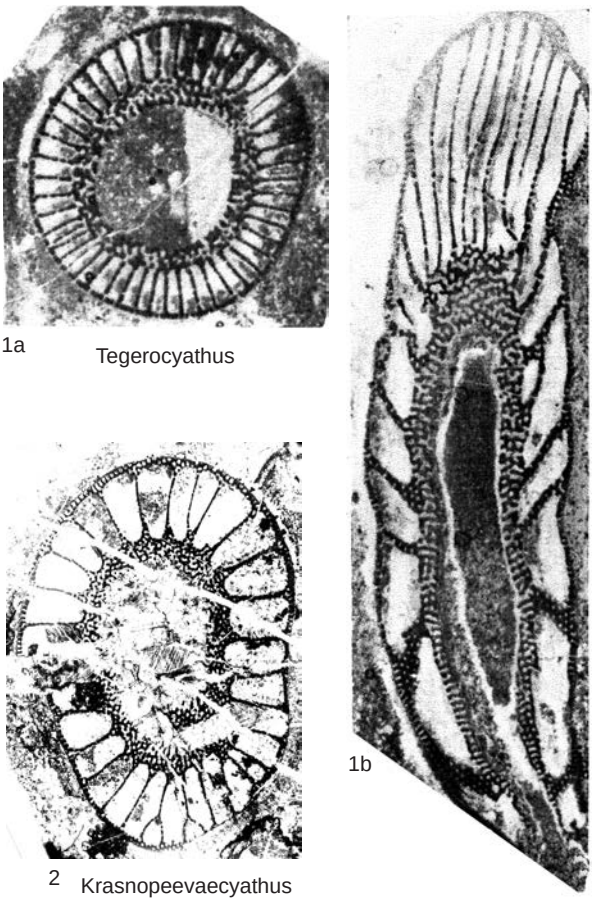


FIG. 556. Tegerocyathidae (p. 965).

Superfamily TUMULOCYATHOIDEA Krasnopeeva, 1953

[*nom. correct*. ZHURAVLEV & ROZANOV in VORONOVA & others, 1987, p. 21, *pro* Tumulocyathacea DEBRENNE, 1964, p. 113, *nom. transl. ex* Tumulocyathidae KRASNOPEEVA, 1953, p. 56] [=Geocyathacea DEBRENNE, 1964, p. 114, *nom. nud.*, *nom. transl*. ROZANOV, 1973, p. 86 *ex* Geocyathidae DEBRENNE, 1964, p. 114]

Outer wall with simple tumuli. *lower Cambrian (Tom.2–Bot.3).*

Family TUMULOCYATHIDAE Krasnopeeva, 1953

[Tumulocyathidae KRASNOPEEVA, 1953, p. 56] [=Kotuyicyathidae ROZANOV in ROZANOV & others, 1969, p. 186, *nom. nud.*]

Inner wall with simple pores. *lower Cambrian (Tom.2–Bot.3).*

Tumulocyathus VOLOGDIN, 1937b, p. 470 [**T. pustulatus*; M; holotype not designated, collection not located] [=*Kotuyicyathus* ZHURAVLEVA, 1960b, p. 226 (type, *K. kotuyikensis*, OD), for discussion, see DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 138; DEBRENNE, ROZANOV, & ZHURAVLEV, 1990, p. 165; =*Tumulocyathoides* BOYARINOV & KONYAEVA in ZHURAVLEVA & others, 1997b, p. 123 (type, *T. kiyaensis*, OD)]. Inner wall with one row of simple pores per intersept; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Tom.2–Bot.1):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Australia.——FIG. 557,*1.* **T. pustulatus*; Salaany Gol Formation, Atdabanian, Salaany Gol, Khasagt-Khayrkhan Range, Tsagaan Oloom province, western Mongolia, specimen PIN 3302/710, oblique transverse section, ×7 (Debrenne, Zhuravlev, & Kruse, 2002).

Isiticyathus KORSHUNOV, 1972, p. 60 [**?Tumulifungia ultra* KORSHUNOV in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 38; OD; holotype, ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, pl. 10,*2;*

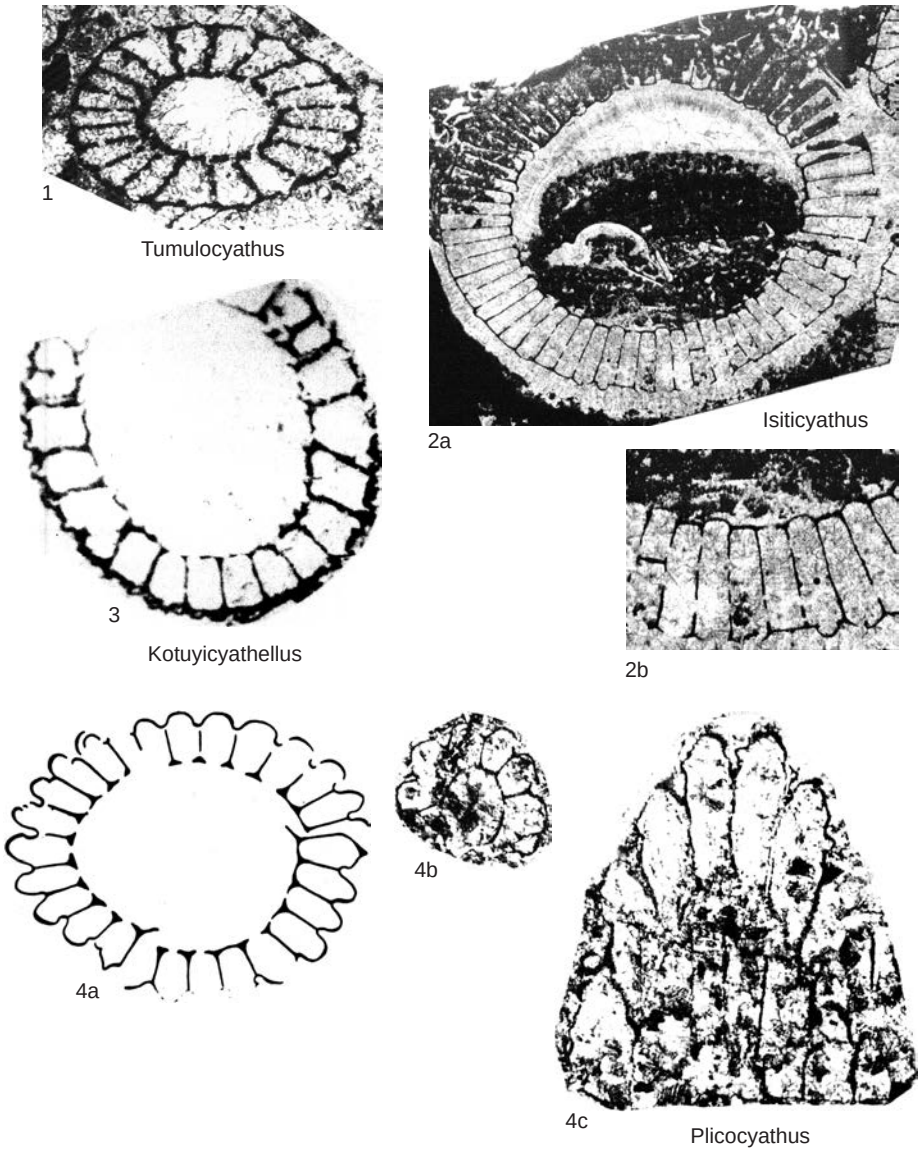


FIG. 557. Tumulocyathidae (p. 968–970).

KORSHUNOV, 1972, pl. 8,*6*, TsSGM 323/45, Novosibirsk]. Inner wall with one row of simple pores per intersept; septa completely porous, linked by synapticulae. *lower Cambrian (Atd.4–Bot.1):* Siberian Platform, Transbaikalia.——FIG. 557,*2a–b*. **I. ultra* (KORSHUNOV), Oy-Muran reef massif, Atdabanian, Oy-Muran, Lena River, Sakha (Yakutia), Russia, holotype, TsSGM 323/45; *a,* transverse section, ×8 (Zhuravleva, Korshunov, & Rozanov, 1969); *b,* detail of transverse section (outer wall at bottom), ×13 (Debrenne, Zhuravlev, & Kruse, 2002).

Kotuyicyathellus OSADCHAYA in OSADCHAYA & others, 1979, p. 157 [**K. minus*; OD; holotype, OSADCHAYA & others, 1979, pl. 25,*5*, VSEGEI 11594, St. Petersburg] [=*Borocyathus* VORONIN, 1988, p. 8 (type, *B. khairkhanicus,* OD)]. Inner wall with several rows of simple pores per intersept; septa aporose to sparsely porous; pectinate tabulae may be present. *lower Cambrian (Atd.2–Bot.1):* Siberian Platform, Altay Sayan, Mongolia, Far East.——FIG. 557,*3*. **K. minus*, Usa Formation, Atdabanian, Krutoy Log, Batenev Range, Kuznetsk

Alatau, Russia, holotype, VSEGEI 11594, transverse section, ×15 (Osadchaya & others, 1979).

Plicocyathus Vologdin, 1960, p. 424 [**P. krassnyi*; OD; holotype, Vologdin, 1960, fig. 1m, PIN 4754/45, Moscow] [=*Tumulocyathellus* Zhuravleva, 1960b, p. 174, *nom. transl.* Repina & others, 1964, p. 194, *ex Tumulocyathus (Tumulocyathellus)* Zhuravleva, 1960b, p. 174 (type, *Tumulocyathus admirabilis* Vologdin, 1940b, p. 72, OD); for discussion, see Debrenne, Zhuravlev, & Rozanov, 1989, p. 123; Debrenne, Rozanov, & Zhuravlev, 1990, p. 155; =*Torosocyathellus* Osadchaya in Osadchaya & others, 1979, p. 128 (type, *T. torosus*, OD)]. Outer wall longitudinally plicate; inner wall with stirrup pores only; septa aporose to sparsely porous; pectinate tabulae may be present. *lower Cambrian (Atd.1–Bot.3):* Siberian Platform, Kolyma, Altay Sayan, Tuva, Mongolia, Transbaikalia, Far East, Morocco, Iberia, Canada, United States, Mexico.——Fig. 557,*4a–c*. **P. krassnyi*; *a,* Ust'toka unit, Botoman, Gerbikan River, Dzhagdy Range, Far East, Russia, holotype, PIN 4754/45, sketch of transverse section, ×5 (Vologdin, 1960); *b–c,* Ust'toka unit, Botoman, Onnetok River, Dzhagdy Range, Far East, Russia, specimen DVGU 6M; *b,* transverse section, ×10; *c,* oblique transverse section, ×10 (Belyaeva & others, 1975).

Family SANARKOCYATHIDAE Hill, 1972

[Sanarkocyathidae Hill, 1972, p. 79] [=Sanaricyathidae Rozanov, 1969, p. 107, name based on invalid generic name *Sanaricyathus* Rozanov, 1969, p. 108, *nom. null. pro Sanarkocyathus* Zhuravleva, 1963a, p. 118]

Inner wall with bracts or scales. *lower Cambrian (Atd.3–Bot.1).*

Sanarkocyathus Zhuravleva, 1963a, p. 118 [**S. mamaevi;* OD; holotype, Zhuravleva, 1963a, fig. 2, TsSGM 99/1, Novosibirsk] [=*Sanaricyathus* Rozanov, 1969, p. 108, *nom. null.*]. Inner wall with one row of pores per intersept, bearing possibly upwardly projecting, S-shaped scales; septa aporose to sparsely porous. *lower Cambrian (Bot.1):* Urals, Altay Sayan.——Fig. 558,*1*. **S. mamaevi,* Sanarka Formation, Botoman, Sanarka River, eastern flank of southern Urals, Russia, holotype, TsSGM 99/1, oblique transverse section, ×6 (Zhuravleva, 1963a).

Neokolbicyathus Konyaeva in Zhuravleva & others, 1997b, p.131 [**N. azhuravlevi;* OD; holotype, Zhuravleva & others, 1997b, pl. 4,*3*, ZSGGU 2329/83, Novokuznetsk]. Inner wall with stirrup pores only, bearing upwardly projecting, S-shaped scales; septa aporose to sparsely porous. *lower Cambrian (Atd.4–Bot.1):* Altay Sayan, Far East, Canada.——Fig. 558,*2*. **N. azhuravlevi*, Usa Formation, Atdabanian, Malaya Belokamenka River, Kiya River, Kuznetsk Alatau, Russia, holotype, ZSGGU 2329/83, oblique transverse section, ×8 (Zhuravleva & others, 1997b).

Ringifungia Korshunov in Zhuravleva, Korshunov, & Rozanov, 1969, p. 38 [**R. vavilovi;* OD; holotype, Zhuravleva, Korshunov, & Rozanov, 1969, pl. 10,*4–5*, TsSGM 323/47, Novosibirsk]. Inner wall with one row of pores per intersept, bearing upwardly projecting, S-shaped scales; septa completely porous, linked by synapticulae. *lower Cambrian (Atd.3):* Siberian Platform.——Fig. 558,*3*. **R. vavilovi*, Perekhod Formation, Atdabanian, Ulakhan-Taryng Creek, Lena River, Sakha (Yakutia), Russia, holotype, TsSGM 323/47, oblique transverse section, ×8 (Zhuravleva, Korshunov, & Rozanov, 1969).

Family GEOCYATHIDAE Debrenne, 1964

[Geocyathidae Debrenne, 1964, p. 114] [=Jakutocyathidae Korshunov, 1972, p. 65; =Eladicyathidae Perejón, 1977, p. 550]

Inner wall with annuli. *lower Cambrian (Atd.1–Bot.1).*

Geocyathus Zhuravleva, 1960b, p. 234 [**Thalamocyathus botomanensis* Zhuravleva in Zhuravleva & Zelenov, 1955, p. 71; OD; holotype, Zhuravleva & Zelenov, 1955, pl. 2,*3–4*, TsSGM 205/115a-b, Novosibirsk; =*T. botomaensis* Zhuravleva, 1960b, p. 234, *nom. null.*] [=*Jakutocyathus (Jakutocyathus)* Zhuravleva, 1960b, p. 230 (type, *J. (J.) latini*, OD); =*Eladicyathus* Perejón, 1977, p. 550 (type, *E. beticus*, OD); for discussion, see Debrenne, Zhuravlev, & Rozanov, 1989, p. 108; Debrenne, Rozanov, & Zhuravlev, 1990, p. 144]. Inner wall with one pore row per intersept and upwardly projecting, S-shaped annuli; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.1–Bot.1):* Siberian Platform, Altay Sayan, Transbaikalia, Far East, Iberia.——Fig. 558,*4a–b*. **G. botomanensis* (Zhuravleva), Perekhod Formation, Atdabanian, Botoma River, Sakha (Yakutia), Russia, holotype, TsSGM 205/115a-b; *a,* transverse section, ×15; *b,* longitudinal section, ×15 (Zhuravleva & Zelenov, 1955).

Family KONJUSCHKOVICYATHIDAE Debrenne & Zhuravlev, 2000

[Konjuschkovicyathidae Debrenne & Zhuravlev, 2000, p. 49]

Inner wall with noncommunicating canals. *lower Cambrian (Bot.1–Bot.3).*

Konjuschkovicyathus Debrenne & Zhuravlev, 2000, p. 49 [**Jakutocyathus spinosus* Konyushkov, 1972, p. 140; OD; holotype, Konyushkov, 1972, pl. 14,*6*, not located; paratypes, Konyushkov, 1972, pl. 14,*5*, PIN 4755/5; Konyushkov, 1972, pl. 16,*3*, PIN 4755/6, Moscow]. Inner wall with downwardly projecting, straight stirrup canals only, bearing supplementary bracts on central cavity side; septa aporose to sparsely porous; pectinate tabulae may be present. *lower Cambrian (Bot.1–Bot.3):* Altay Sayan, Transbaikalia.——Fig. 558,*5a–b*. **K. spinosus* (Konyushkov), Verkhnemonok Formation, Botoman, Malyy Karakol River, West Sayan, Altay

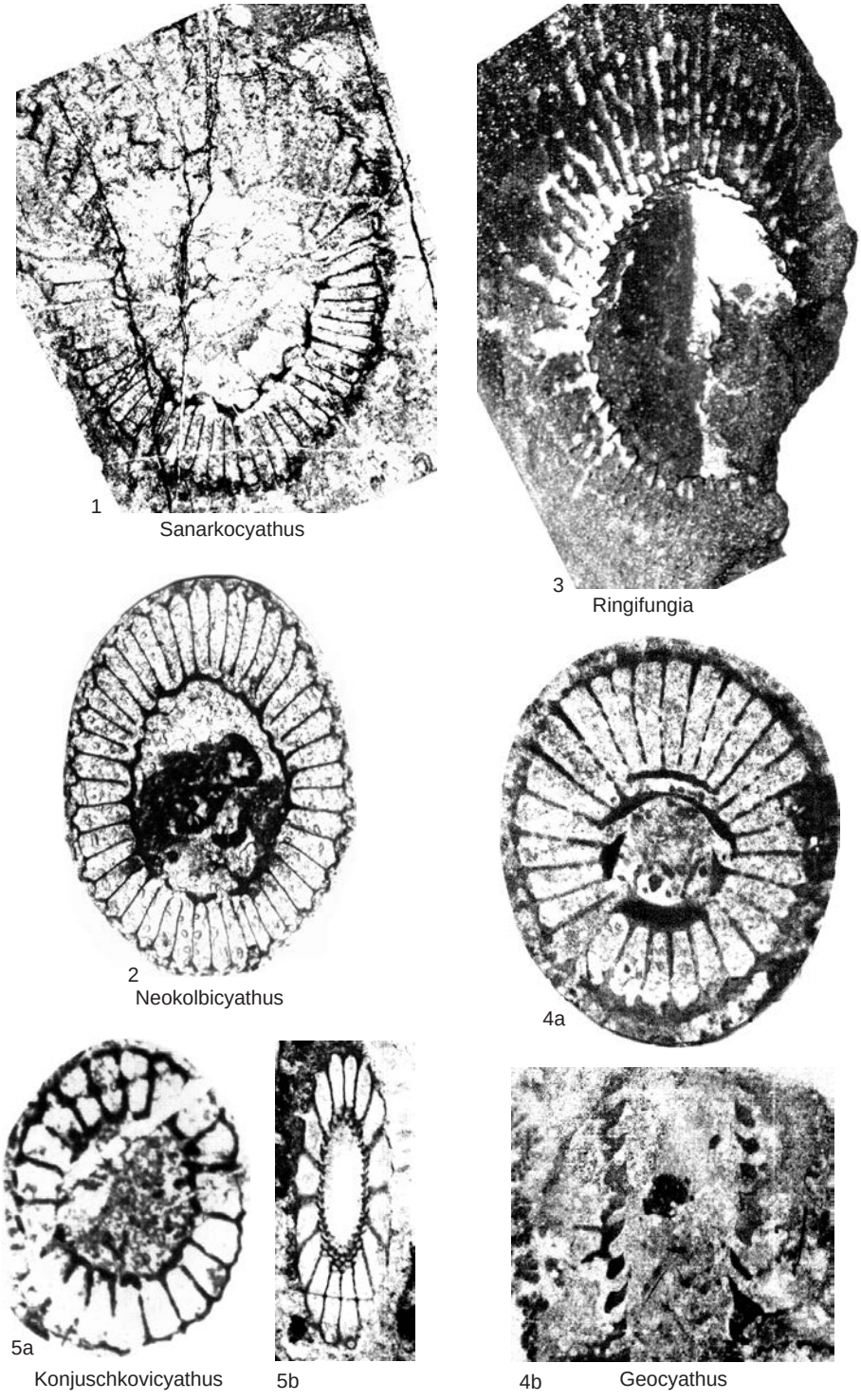
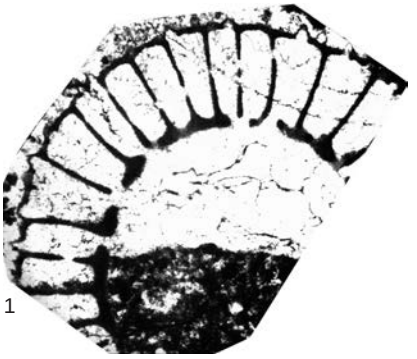
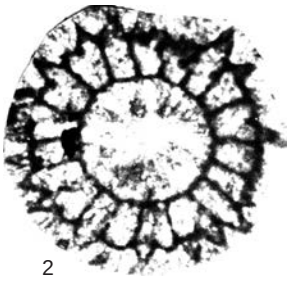


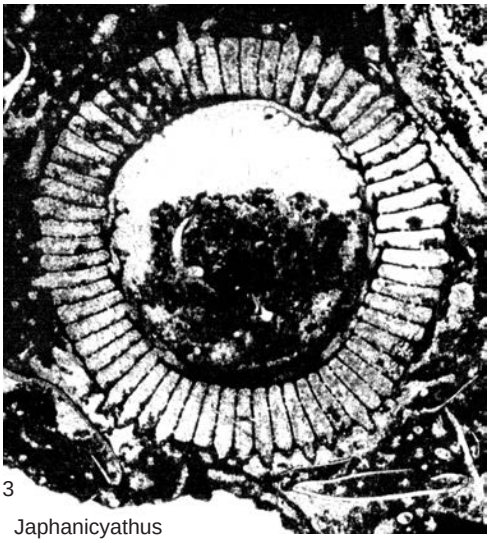
FIG. 558. Sanarkocyathidae, Geocyathidae, and Konjuschkovicyathidae (p. 970–973).



1 Torosocyathus

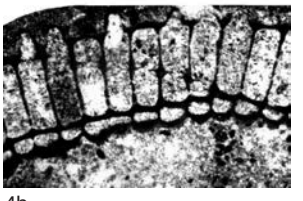


2 Torosocyathella



3 Japhanicyathus

4a



4b Lenocyathus

FIG. 559. Torosocyathidae, Japhanicyathidae, and Lenocyathidae (p. 973).

Sayan, Russia; *a,* holotype, transverse section, ×10; *b,* paratype, PIN 4755/6, oblique longitudinal section, ×10 (Konyushkov, 1972).

Superfamily LENOCYATHOIDEA Zhuravleva, 1956

[*nom. correct.* Debrenne, Zhuravlev, & Rozanov, 1989, p. 83, *pro* Lenocyathacea Zhuravleva, 1960b, p. 224, *nom. transl. ex* Lenocyathidae Zhuravleva in Vologdin, 1956, p. 879] [=Rewardocyathacea Rozanov, 1973, p. 86, *nom. nud.*]

Outer wall with multiperforate tumuli. *lower Cambrian (Atd.1–Bot.1).*

Family TOROSOCYATHIDAE Debrenne, Zhuravlev, & Kruse, 2002

[Torosocyathidae Debrenne, Zhuravlev, & Kruse, 2002, p. 1594] [=Rewardocyathidae Rozanov, 1973, p. 86, *nom. nud.*; =Rewardocyathidae Rozanov in Debrenne, Zhuravlev, & Rozanov, 1989, p. 83, *nom. nud.*, based on unavailable genus-group name]

Inner wall with simple pores. *lower Cambrian (Atd.1–Bot.1).*

Torosocyathus Kashina in Vologdin & Kashina, 1972, p. 153 [**T. provisus;* OD; holotype, Vologdin & Kashina, 1972, pl. 20a,*1*, KGU 19/729a, Krasnoyarsk] [=*Rewardocyathus* Rozanov, 1973, p. 59, 75, 161, *nom. nud.*]. Inner wall with stirrup pores only; septa completely porous. *lower Cambrian (Atd.1–Bot.1):* Altay Sayan, Mongolia.——Fig. 559,*1. *T. provisus*, Balakhtinson Formation, Atdabanian, Uyar River, East Sayan, Altay Sayan, Russia, holotype, KGU 19/729a, detail of transverse section, ×12 (Vologdin & Kashina, 1972).

Torosocyathella Kotel'nikov, 1995, p. 27 [**T. osadchajae*; OD; holotype, Kotel'nikov, 1995, pl. 2,5, TsNIGRm 12890/9, St. Petersburg]. Inner wall with several rows of simple pores per intersept; septa completely porous. *lower Cambrian (Atd.2):* Tuva.——Fig. 559,*2. *T. osadchajae*, Il'chir Formation, Atdabanian, Vadi-Bala, Tapsa River, Tuva, Russia, holotype, TsNIGRm 12890/9, transverse section, ×20 (Kotel'nikov, 1995).

Family JAPHANICYATHIDAE Rozanov, 1989

[Japhanicyathidae Rozanov in Debrenne, Zhuravlev, & Rozanov, 1989, p. 83] [=Japhanicyathidae Rozanov, 1973, p. 86, *nom. nud.*]

Inner wall with annuli. *lower Cambrian (Atd.2–Bot.1).*

Japhanicyathus Korshunov in Zhuravleva, Korshunov, & Rozanov, 1969, p. 45 [**J. genurosus*; OD; holotype, Zhuravleva, Korshunov, & Rozanov, 1969, pl. 17,*1–2*, TsSGM 323/67, Novosibirsk]. Inner wall with one pore row per intersept and upright, V-shaped annuli; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.2–Bot.1):* Siberian Platform, Far East.——Fig. 559,*3. *J. genurosus*, Oy-Muran reef massif, Atdabanian, Oy-Muran, Lena River, Sakha (Yakutia), Russia, holotype, TsSGM 323/67, transverse section, ×8 (Zhuravleva, Korshunov, & Rozanov, 1969).

Family LENOCYATHIDAE Zhuravleva, 1956

[Lenocyathidae Zhuravleva in Vologdin, 1956, p. 879]

Inner wall with noncommunicating canals. *lower Cambrian (Atd.2–Bot.1).*

Lenocyathus Zhuravleva in Zhuravleva & Zelenov, 1955, p. 73 (Zhuravleva, 1954, p. 12, *nom. nud.*) [**L. lenaicus*; OD; holotype, Zhuravleva & Zelenov, 1955, pl. 2,*5–6*, TsSGM 205/117, Novosibirsk]. Inner wall with one row of horizontal to upwardly projecting, S-shaped canals per intersept; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.2–Bot.1):* Siberian Platform, Far East, Morocco.——Fig. 559,*4a–b. *L. lenaicus*, Pestrotsvet Formation, Atdabanian, Yudyay, Botoma River, Sakha (Yakutia), Russia, holotype, TsSGM, 205/117; *a,* longitudinal section, ×7; *b,* detail of transverse section (outer wall at top), ×20 (Debrenne, Zhuravlev, & Kruse, 2002).

Superfamily ANNULOCYATHOIDEA Krasnopeeva, 1953

[*nom. correct.* Debrenne, Zhuravlev, & Rozanov, 1989, p. 83, *pro* Annulocyathacea Zhuravleva, 1960b, p. 171, *nom. transl. ex* Annulocyathidae Krasnopeeva, 1953, p. 56]

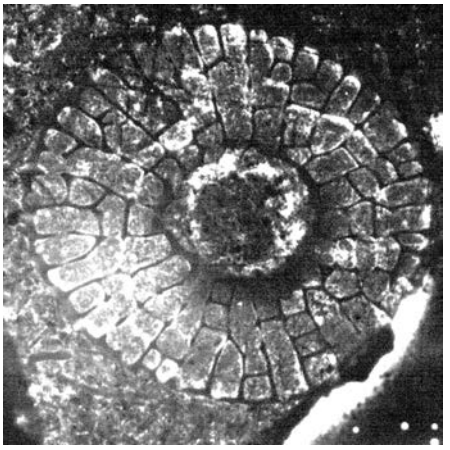
Outer wall with bracts or scales. *lower Cambrian (Tom.2–Bot.3).*

Family TUMULIFUNGIIDAE Rozanov, 1989

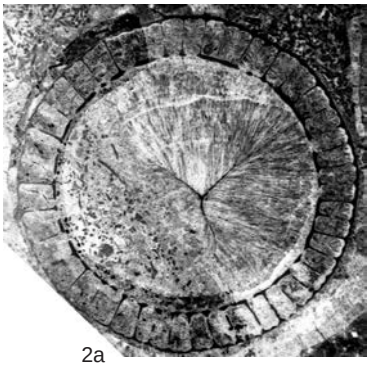
[Tumulifungiidae Rozanov in Debrenne, Zhuravlev, & Rozanov, 1989, p. 83] [=Tumulifungiidae Rozanov, 1973, p. 85, *nom. nud.*]

Inner wall with simple pores. *lower Cambrian (Tom.2–Bot.3).*

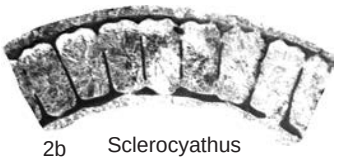
Tumulifungia Zhuravleva in Datsenko & others, 1968, p. 144 (Zhuravleva in Zhuravleva & others, 1967, p. 68, *nom. nud.*) [**T. datzenkoi*; OD; holotype, Datsenko & others, 1968, pl. 4,*2–3*, TsSGM 277/30, Novosibirsk]. Outer wall with upwardly projecting cupped bracts; inner wall with one row of simple pores per intersept; septa completely porous, linked by synapticulae. *lower Cambrian (Atd.1–Bot.3):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Far East, Morocco, Iberia.——Fig. 560,*1. *T. datzenkoi*, Shumnoy Formation, Botoman, Sukharikha River, Krasnoyarsk region,



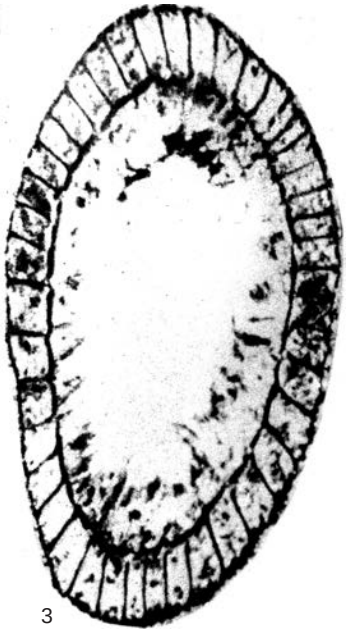
1 Tumulifungia



2a



2b Sclerocyathus



3

Subtumulocyathellus

4

Tologoicyathus

FIG. 560. Tumulifungiidae (p. 973–975).

Russia, holotype, TsSGM 277/30, transverse section, ×11 (Datsenko & others, 1968).

Sclerocyathus VOLOGDIN, 1960, p. 424 [**S. scrofulosus*; OD; holotype, VOLOGDIN, 1960, fig. 1z-i, PIN 4754/1, Moscow]. Outer wall with upwardly projecting, cupped bracts; inner wall with one row of simple pores per intersept; septa completely porous. *lower Cambrian (Tom.2–Bot.1):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Far East, Iberia.——FIG. 560,*2a–b*. **S. scrofulosus*, Bayan-Kol Formation, Atdabanian, Yenisey River, Shagonar Mountains, Tuva, Russia, holotype, PIN 4754/1; *a,* transverse section, ×4; *b,* detail of transverse section, ×8 (Debrenne, Zhuravlev, & Kruse, 2002).

Subtumulocyathellus OSADCHAYA in OSADCHAYA & others, 1979, p. 129 [**S. vulgaris*; OD; holotype, OSADCHAYA & others, 1979, pl. 11,*1*, VSEGEI

11594, St. Petersburg] [=*Arturocyathus* Rozanov, 1973, p. 61, 162, *nom. nud.*; =*Arturocyathus* Rozanov in Debrenne, Zhuravlev, & Rozanov, 1989, p. 95 (type, *A. borisovi* Rozanov, 1973, p. 162, OD)]. Outer wall with upwardly projecting, cupped bracts; inner wall with stirrup pores only; septa aporose to sparsely porous. *lower Cambrian (Atd.1–Bot.1):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Far East.——Fig. 560,*3*. **S. vulgaris*, Usa Formation, Atdabanian, Krutoy Log, Batenev Range, Kuznetsk Alatau, Russia, holotype, VSEGEI 11594, oblique transverse section, ×10 (Osadchaya & others, 1979).

Tologoicyathus Voronin, 1988, p. 9 [**T. ichituinicus*; OD; holotype, Voronin, 1988, pl. 2,*3*, PIN 3301/516, Moscow]. Outer wall with upwardly projecting, cupped bracts; inner wall with several rows of simple pores per intersept; septa completely porous. *lower Cambrian (Tom.4–Bot.1):* Mongolia, Far East.——Fig. 560,*4*. **T. ichituinicus*, Ichituin Formation, Atdabanian, Boro-Khairkhan-Obo Mountain, Khan-Khukhiy Range, Mongolia, paratype, PIN 3301/515, transverse section, ×5 (Voronin, 1988).

Family ANNULOCYATHIDAE Krasnopeeva, 1953

[Annulocyathidae Krasnopeeva, 1953, p. 56]

Inner wall with annuli. *lower Cambrian (Atd.2–Bot.3).*

Annulocyathus Vologdin, 1937b, p. 468 [**A. pulcher*; M; lectotype, Debrenne, Zhuravlev, & Kruse, 2002, fig. 32E; SD Debrenne, Zhuravlev, & Kruse, 2002, p. 1597, PIN 4754/5, Moscow]. Outer wall with upwardly projecting, cupped bracts; inner wall with one pore row per intersept and upright V-shaped annuli; septa completely porous. *lower Cambrian (Bot.1):* Altay Sayan, Far East.——Fig. 561,*1a–b*. **A. pulcher*, Verkhnemonok Formation, Botoman, Sanashtykgol River, West Sayan, Altay Sayan, Russia, lectotype, PIN 4754/5; *a,* transverse section, ×11 (Debrenne, Zhuravlev, & Kruse, 2002); *b,* sketch of longitudinal section (outer wall to left), ×5.5 (Vologdin, 1937b).

Annulocyathella Vologdin, 1962a, p. 123 [**Annulocyathus lavrenovae* Krasnopeeva, 1955, p. 99; OD; holotype, Krasnopeeva, 1955, pl. 3,*2;* Vologdin, 1962a, fig. 86, not designated; =*Anulocyathus lavrenovi* Krasnopeeva, 1937, p. 33; holotype, Krasnopeeva, 1937, pl. 4,*38–39,41,43–44;* pl. 16,*109;* pl. 19,*118*, not designated]. Outer wall with upwardly projecting, cupped bracts; inner wall with one pore row per intersept and upwardly projecting, S-shaped annuli; septa aporose to sparsely porous. *lower Cambrian (Atd.4–Bot.3):* Altay Sayan.——Fig. 561,*2a–b*. **A. lavrenovae* (Krasnopeeva), Usa Formation, Botoman, Bol'shaya Erba, Batenev Range, Kuznetsk Alatau, Russia; *a,* unlocated syntype, oblique transverse section, ×8; *b,* unlocated syntype, sketch of longitudinal section (outer wall to left), ×8 (Krasnopeeva, 1955).

Annulofungia Krasnopeeva, 1955, p. 99 (Krasnopeeva, 1953, p. 56, *nom. nud.*) [**Anulocyathus taylori* Krasnopeeva, 1937, p. 34; OD; holotype, Krasnopeeva, 1937, pl. 4,*46–47;* pl. 18,*115–116;* pl. 22,*130;* pl. 24,*137*, not designated, collection not located] [=*Kiyafungia* Boyarinov in Zhuravleva & others, 1997b, p. 130 (type, *K. concinna,* OD)]. Outer wall with upwardly projecting, cupped bracts; inner wall with one pore row per intersept and upright, V-shaped annuli; septa completely porous, linked by synapticulae. *lower Cambrian (Atd.4–Bot.1):* Altay Sayan.——Fig. 561,*3a–b*. **A. taylori* (Krasnopeeva), Usa Formation, Botoman, Mt. Aydachikha, Batenev Range, Kuznetsk Alatau, Russia, unlocated specimen; *a,* longitudinal section, ×6; *b,* transverse section, ×6 (Debrenne, Zhuravlev, & Kruse, 2002).

Hemithalamocyathus Ting, 1937, p. 367 [**Archaeocyathus sibiricus* Toll, 1899, p. 40; M; lectotype, Toll, 1899, pl. 6,*5;* SD Debrenne, Zhuravlev, & Kruse, 2002, p. 1598, TsNIGRm 24a/11533, St. Petersburg]. Outer wall with upwardly projecting, cupped bracts; inner wall with several pore rows per intersept and upright, V-shaped annuli; septa completely porous. *lower Cambrian (Atd.4–Bot.1):* Altay Sayan.——Fig. 561,*4*. **H. sibiricus* (Toll), Torgashino Formation, Torgashino, Krasnoyarsk region, East Sayan, Altay Sayan, Russia, unnumbered paralectotype, oblique longitudinal section (outer wall to left), ×10 (Toll, 1899).

Family JAKUTOCARINIDAE Debrenne, Rozanov, & Zhuravlev, 1989

[Jakutocarinidae Debrenne, Rozanov, & Zhuravlev in Debrenne, Zhuravlev, & Rozanov, 1989, p. 83]

Inner wall with noncommunicating canals. *lower Cambrian (Atd.1–Bot.3).*

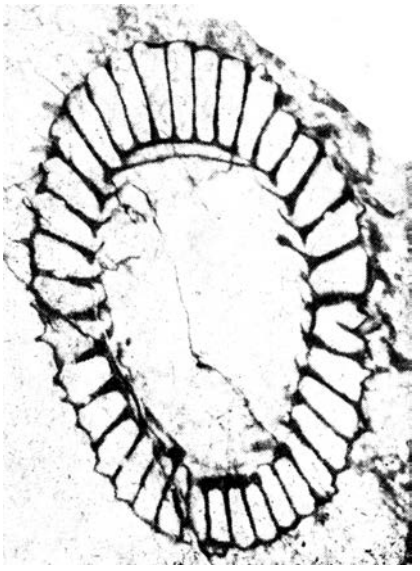
Jakutocarinus Zhuravleva, 1960b, p. 232 [**Jakutocyathus (Jakutocarinus) jakutensis*; OD; holotype, Zhuravleva, 1960b, pl. 20,*2*, TsSGM 205/113, Novosibirsk]. Outer wall with upwardly projecting, cupped bracts; inner wall with several rows of downwardly projecting, straight canals per intersept, bearing supplementary bracts on central cavity side; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.1–Bot.1):* Siberian Platform, Altay Sayan, Tuva, Mongolia, Transbaikalia.——Fig. 562,*1*. **J. jakutensis*, Pestrotsvet Formation, Atdabanian, Mukhatta River, Sakha (Yakutia), Russia, holotype, TsSGM 205/113, detail of oblique transverse section (outer wall at top), ×15 (Debrenne, Zhuravlev, & Kruse, 2002).

Kosticyathus Debrenne & Zhuravlev, 2000, p. 49 [**Porocyathus sheglovi* Konyushkov, 1972, p. 138; OD; holotype, Konyushkov, 1972, pl. 16,*4–5*, PIN 4755/9, Moscow]. Outer wall with upwardly projecting, cupped bracts; inner wall with one row of downwardly projecting, straight canals per intersept, bearing supplementary bracts on central cavity

1a

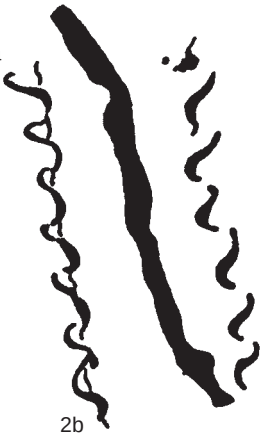
1b

Annulocyathus



2a

Annulocyathella

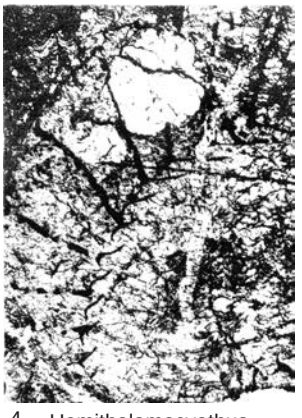


2b

3a

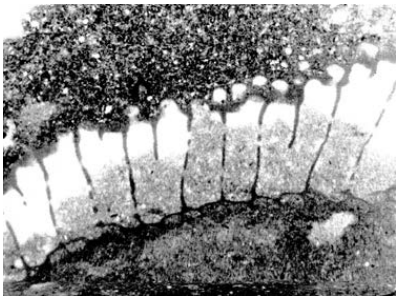
3b

Annulofungia

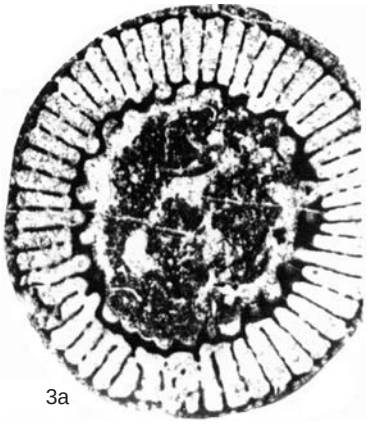


4 Hemithalamocyathus

Fig. 561. Annulocyathidae (p. 975).



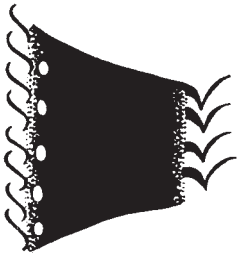
1 Jakutocarinus



3a

3b Kruseicyathus

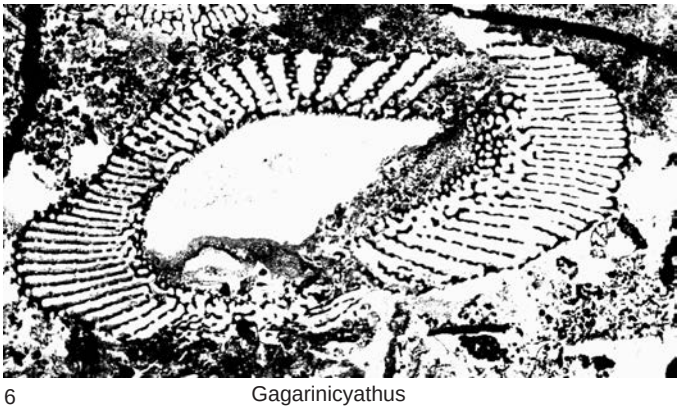
2 Kosticyathus



4a

4b Rossocyathella

5 Russocyathus



6 Gagarinicyathus

Fig. 562. Jakutocarinidae and Gagarinicyathidae (p. 975–978).

side; septa completely porous. *lower Cambrian (Bot.1–Bot.3):* Altay Sayan.——FIG. 562,*2. *K. sheglovi* (KONYUSHKOV), Verkhnemonok Formation, Botoman, Malyy Karakol River, West Sayan, Altay Sayan, Russia, holotype, PIN 4755/9, longitudinal section, ×6 (Konyushkov, 1972).

Kruseicyathus BOYARINOV & KONYAEVA in ZHURAVLEVA & others, 1997b, p. 134 [**K. notabilis*; OD; holotype, ZHURAVLEVA & others, 1997b, pl. 4,*5*, ZSGGU 2329/86, Novokuznetsk]. Outer wall with upwardly projecting, cupped bracts; inner wall with horizontal to upwardly projecting, S-shaped canals, each canal spanning several intersepts; septa completely porous. *lower Cambrian (Bot.1):* Altay Sayan.——FIG. 562,*3a–b*. **K. notabilis*, Usa Formation, Botoman, Malaya Belokamenka River, Kiya River, Kuznetsk Alatau, Russia; *a,* paratype, ZSGGU 2329/85, transverse section, ×10; *b,* holotype, ZSGGU 2329/86, oblique longitudinal section, ×10 (Zhuravleva & others, 1997b).

Rossocyathella ZHURAVLEVA, 1960b, p. 178 [**R. ninaekosti*; OD; holotype, ZHURAVLEVA, 1960b, pl. 12,*5*, PIN 1038, Moscow, not located]. Outer wall with upwardly projecting, cupped bracts; inner wall with one row of downwardly projecting, straight canals per intersept, bearing supplementary bracts on central cavity side; septa aporose to sparsely porous. *lower Cambrian (Bot.1):* Siberian Platform, Altay Sayan, Tuva.——FIG. 562,*4a–b*. **R. ninaekosti*, Perekhod Formation, Botoman, Botoma River, Sakha (Yakutia), Russia, holotype, PIN 1038; *a,* sketch of longitudinal section (outer wall to left), ×40; *b,* detail of transverse section (outer wall at bottom), ×15 (Zhuravleva, 1960b).

?Russocyathus ZHURAVLEVA, 1955b, p. 628 [**R. basaichensis*; OD; holotype, ZHURAVLEVA, 1955b, fig. 1E, 2v; REPINA & others, 1964, pl. 19,*2*, PIN 1039, Moscow, not located]. Outer wall with probable upwardly projecting, cupped bracts; inner wall with one row of probable horizontal to upwardly projecting, S-shaped canals per intersept; septa aporose to sparsely porous. [Limited type material does not provide certainty as to orientation of cup and hence as to presence or absence of canals and/or bracts in walls.] *lower Cambrian (Atd.3–Bot.1):* Altay Sayan, Tuva.——FIG. 562,*5. **R. basaichensis*, Torgashino Formation, Atdabanian, Torgashino, Krasnoyarsk region, East Sayan, Altay Sayan, Russia, holotype, PIN 1039, sketch of oblique longitudinal section, ×20 (Zhuravleva, 1955b).

Family GAGARINICYATHIDAE Debrenne, Rozanov, & Zhuravlev, 1989

[Gagarinicyathidae DEBRENNE, ROZANOV, & ZHURAVLEV in DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 84]

Inner wall with communicating canals. *lower Cambrian (Atd.3–Bot.1).*

Gagarinicyathus ZHURAVLEVA in DATSENKO & others, 1968, p. 146 [**G. ethmophylloides*; OD; holotype, DATSENKO & others, 1968, pl. 5,*1*, TsSGM 277/36, Novosibirsk]. Outer wall with upwardly projecting, cupped bracts; inner wall with one row of horizontal to upwardly projecting, straight porous canals per intersept; septa completely porous. *lower Cambrian (Atd.3–Bot.1):* Siberian Platform.——FIG. 562,*6. **G. ethmophylloides*, Shumnoy Formation, Botoman, Sukharikha River, Krasnoyarsk region, Russia, holotype, TsSGM 277/36, oblique longitudinal section, ×4.5 (Datsenko & others, 1968).

Superfamily ETHMOPHYLLOIDEA Okulitch, 1937

[*nom. transl.* ZHURAVLEV in VORONOVA & others, 1987, p. 23, *ex* Ethmophyllidae OKULITCH, 1937b, p. 358] [=Carinacyathoidea KRASNOPEEVA, 1953, p. 52, *nom. transl.* ZHURAVLEV in VORONOVA & others, 1987, p. 23, *ex* Carinacyathidae ZHURAVLEVA, 1960b, p. 240, *nom. correct. pro* Carinocyathidae KRASNOPEEVA, 1953, p. 52; =Fansycyathacea KORSHUNOV & ROZANOV in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 46; =Hupecyathelloidea ROZANOV, 1969, p. 111, *nom. correct.* DEBRENNE, ZHURAVLEV, & ROZANOV, 1989, p. 84, *pro* Hupecyathellacea ROZANOV, 1969, p. 111]

Outer wall with canals. *lower Cambrian (Atd.1–Toy.1).*

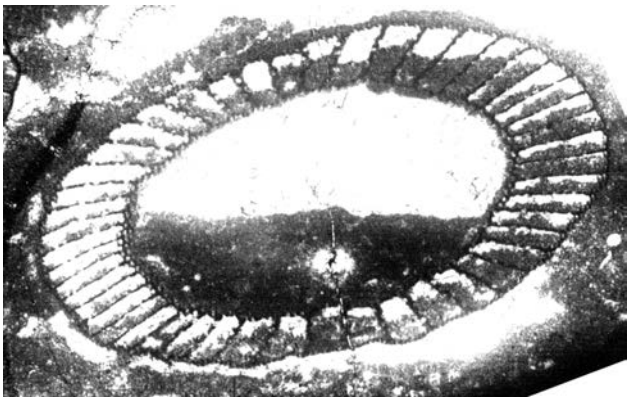
Family FALLOCYATHIDAE Rozanov, 1969

[Fallocyathidae ROZANOV in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 47] [=Sekwicyathidae ROZANOV, 1973, p. 85, *nom. nud.*]

Inner wall with simple pores. *lower Cambrian (Bot.1–Bot.2).*

Fallocyathus ROZANOV in ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, p. 47 [**F. dubius*; OD; holotype, ZHURAVLEVA, KORSHUNOV, & ROZANOV, 1969, pl. 18,*5–6;* pl. 19,*2*, PIN 4297/84, Moscow]. Outer wall with horizontal to upwardly projecting, straight canals, bearing supplementary bracts externally (imparting overall inverted V-shaped appearance to outer wall); inner wall with several rows of simple pores per intersept; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Bot.1):* Siberian Platform, Iberia.——FIG. 563,*1. **F. dubius*, Oy-Muran reef massif, Atdabanian, Oy-Muran, Lena River, Sakha (Yakutia), Russia, holotype, PIN 4297/84, oblique transverse section, ×12 (Zhuravleva, Korshunov, & Rozanov, 1969).

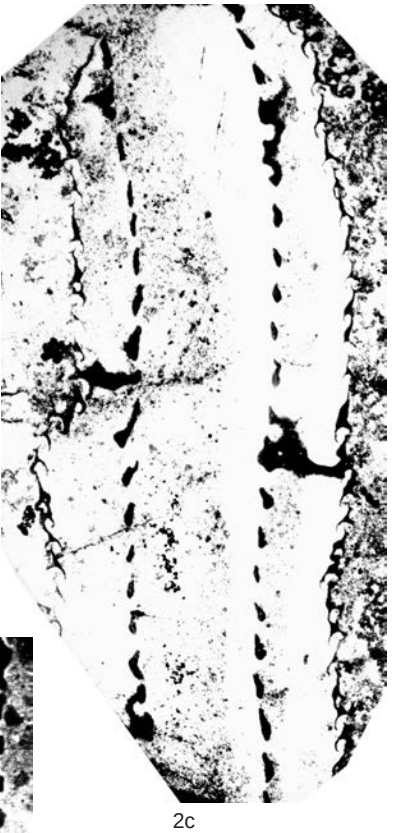
Sekwicyathus HANDFIELD, 1971, p. 34 [**S. nahanniensis*; OD; holotype, HANDFIELD, 1971, p. 34, pl. 2,*5*, GSC 25317, Ottawa; ?=*Archaeocyathus nevadensis* OKULITCH, 1935b, p. 101]. Outer wall with subspherical chambered canals each with base commencing in intervallum, canals subdivided by stipules (imparting overall inverted V-shaped appearance to outer wall); inner wall with several rows of simple pores per intersept; septa aporose to sparsely porous. *lower Cambrian (Bot.1–Bot.2):* Altay Sayan, Iberia, Canada, United States.——FIG. 563,*2a–c*. **S. nahanniensis*; *a,* Sekwi Formation, Botoman, Mackenzie Mountains, Northwest Territories, Canada, holotype, GSC 25137, oblique longitudinal section, ×15 (Handfield, 1971); *b,* Atan Group, Botoman, Gataga River,



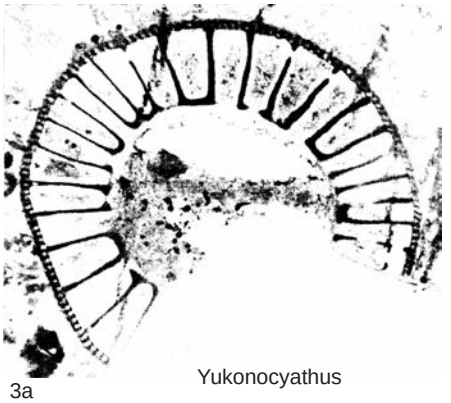
1 Fallocyathus

2a

2b Sekwicyathus



2c



3a Yukonocyathus

3b

FIG. 563. Fallocyathidae (p. 978–980).

British Columbia, Canada, specimen GSC 69260, transverse section, ×10 (Debrenne, Zhuravlev, & Kruse, 2002); *c,* Sekwi Formation, Botoman, Mackenzie Mountains, Northwest Territories, Canada, specimen GSC 90132, longitudinal section, ×10 (Voronova & others, 1987).

Yukonocyathus Handfield, 1971, p. 51 [**Y. francesi*; OD; holotype, Handfield, 1971, pl. 8,*1a–c*, GSC 25351, Ottawa]. Outer wall with horizontal to upwardly projecting, S-shaped canals, bearing supplementary bracts externally (imparting overall inverted V-shaped appearance to outer wall); inner wall with one row of simple pores per intersept, formed by fluting of inner edges of septa; septa aporose to sparsely porous. *lower Cambrian (Bot.1):* Canada, United States.——Fig. 563,*3a–b*. **Y. francesi*, Sekwi Formation, Botoman, Frances Lake, Yukon Territory, Canada, holotype, GSC 25351; *a,* transverse section, ×6; *b,* longitudinal section (outer wall to left), ×6 (Handfield, 1971).

Family GLORIOSOCYATHIDAE Rozanov, 1969

[Gloriosocyathidae Rozanov, 1969, p. 108]

Inner wall with bracts or scales. *lower Cambrian (Atd.1–Bot.1).*

Gloriosocyathus Rozanov, 1969, p. 108 [**G. permultus*; OD; holotype, Rozanov, 1969, pl. 40,*3*, PIN 4297/95, Moscow]. Outer wall with horizontal to upwardly projecting, S-shaped canals; inner wall with one row of pores per intersept, bearing upwardly projecting, S-shaped scales; septa completely porous. *lower Cambrian (Bot.1):* Siberian Platform, Iberia.——Fig. 564,*1. *G. permultus*, Erkeket Formation, Botoman, Khorbusuonka River, Olenek Basin, Sakha (Yakutia), Russia, holotype, PIN 4297/95, oblique transverse section, ×10 (Debrenne, Zhuravlev, & Kruse, 2002).

Gandinocyathus F. Debrenne & M. Debrenne in Gandin, F. Debrenne, & M. Debrenne, 2007, p. 41 [**G. gravestocki*, OD; holotype, F. Debrenne, Gandin, & M. Debrenne, 1993, pl. 3,*1*, MNHN M84234, Paris]. Outer wall with horizontal to upwardly projecting, straight canals, bearing supplementary bracts externally (imparting overall inverted V-shaped appearance to outer wall); inner wall with one row of pores per intersept, bearing upwardly projecting, cupped bracts; septa completely porous. *lower Cambrian (Atd.3–Bot.1):* South China, Sardinia.——Fig. 564,*2. **G. gravestocki*, Matoppa Formation, Botoman, Matoppa Valley, Sardinia, Italy, holotype, MNHN M84234, oblique longitudinal section, ×10 (F. Debrenne, Gandin, & M. Debrenne, 1993).

Nalivkinicyathus Boyarinov & Osadchaya in Osadchaya & Ganachkova, 1986, p. 170 [**Porocyathellus cyroflexus* Boyarinov & Osadchaya in Osadchaya & others, 1979, p. 132; OD; holotype, Osadchaya & others, 1979, pl. 8,*1–2;* Osadchaya & Ganachkova, 1986, pl. 18,*1–2*, VSEGEI 11594, St. Petersburg] [=*Nalivkinicyathus* Osadchaya in Debrenne & Rozanov, 1983, p. 735, *nom. nud.*, *nom. nov. pro Porocyathellus* Boyarinov & Osadchaya in Osadchaya & others, 1979, p. 131, *non* Debrenne, 1977a, p. 107, archaeocyath]. Outer wall with downwardly projecting, straight canals, bearing supplementary bracts externally (imparting overall upright V-shaped appearance to outer wall); inner wall with one row of pores per intersept, bearing upright, V-shaped scales; septa completely porous. *lower Cambrian (Atd.1–Bot.1):* Altay Sayan, Iberia.——Fig. 564,*3a–b*. **N. cyroflexus* (Boyarinov & Osadchaya), Usa Formation, Atdabanian, Krutoy Log, Batenev Range, Kuznetsk Alatau, Russia, holotype, VSEGEI 11594; *a,* transverse section, ×4; *b,* detail of septum in longitudinal section (outer wall to right), ×12 (Osadchaya & others, 1979).

Family KIJACYATHIDAE Zhuravleva, 1964

[Kijacyathidae Zhuravleva in Repina & others, 1964, p. 195] [=Fansycyathidae Korshunov & Rozanov in Zhuravleva, Korshunov, & Rozanov, 1969, p. 47]

Inner wall with annuli. *lower Cambrian (Atd.2–Bot.3).*

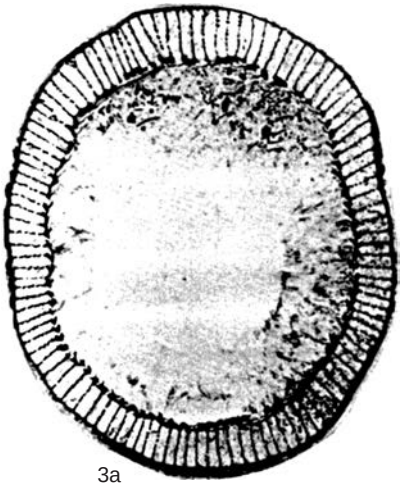
Kijacyathus Zhuravleva, 1959, p. 424 [**K. chomentovskii*; OD; holotype, Zhuravleva, 1959, fig. 2b–g, PIN 1431, Moscow, not located]. Outer wall with horizontal to upwardly projecting, S-shaped canals; inner wall with one pore row per intersept and upright, V-shaped annuli; septa completely porous. *lower Cambrian (Atd.3–Bot.1):* Altay Sayan, Mongolia, Far East.——Fig. 565,*1a–b*. **K. chomentovskii*, Usa Formation, Atdabanian, Kiya River, Kuznetsk Alatau, Russia, holotype, PIN 1431; *a,* transverse section, ×8 (Debrenne, Zhuravlev, & Kruse, 2002); *b,* detail of septum in longitudinal section (outer wall to left), ×13 (Zhuravleva, 1959).

Aporosocyathus Kruse, 1978, p. 32 [**A. mucroporus*; OD; holotype, Kruse, 1978, fig. 4A–B, AM FT.15203, 15204, Sydney]. Outer wall with horizontal to upwardly projecting, S-shaped canals, bearing supplementary bracts externally (imparting overall inverted V-shaped appearance to outer wall); inner wall with one pore row per intersept and upright, V-shaped annuli; septa aporose to sparsely porous; pectinate tabulae may be present. *lower Cambrian (Bot.2–Bot.3):* ?Mongolia, Australia, Antarctica, ?Canada.——Fig. 565,*2a–b*. **A. mucroporus*, Cymbric Vale Formation, Botoman, Mt. Wright, New South Wales, Australia, holotype, AM FT.15203, 15204; *a,* oblique transverse section, AM FT.15204, ×6 (Kruse, 1978); *b,* detail of longitudinal section (outer wall to right) AM FT.15203, ×8 (Kruse, 1982).

Fansycyathus Korshunov & Rozanov in Zhuravleva, Korshunov, & Rozanov, 1969, p. 48 [**F. lermontovae*; OD; holotype, Zhuravleva, Korshunov, & Rozanov, 1969, pl. 17,*7;* Rozanov, 1973, pl. 20,*2*, PIN 4297/83, Moscow]. Outer wall with horizontal

1 Gloriosocyathus

2 Gandinocyathus



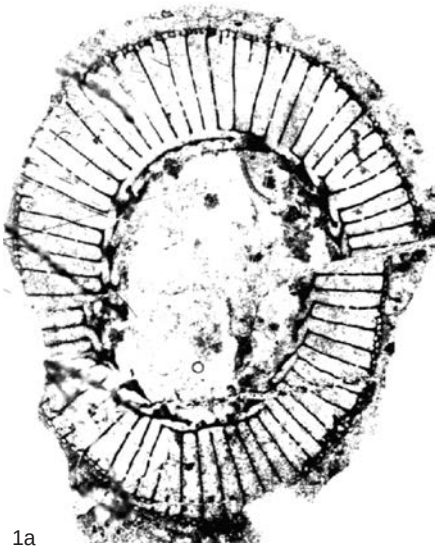
3a

3b
Nalivkinicyathus

FIG. 564. Gloriosocyathidae (p. 980).

to upwardly projecting, S-shaped canals, bearing supplementary bracts externally (imparting overall inverted V-shaped appearance to outer wall); inner wall with one pore row per intersept and upright, V-shaped annuli; septa completely porous; pectinate tabulae may be present. *lower Cambrian (Atd.2–Bot.1):* Siberian Platform.——FIG. 565,*3. *F. lermontovae*, Oy-Muran reef massif, Atdabanian, Oy-Muran, Lena River, Sakha (Yakutia), Russia, holotype, PIN 4297/83, longitudinal section, ×12 (Zhuravleva, Korshunov, & Rozanov, 1969).

Flexanulus DEBRENNE, 1975, p. 335 [**F. oosthuizeni*; OD; holotype, DEBRENNE, 1975, fig. 3a–b, SAM(C) K4495 B-12a, Cape Town]. Outer wall with horizontal to upwardly projecting, S-shaped canals, each with base commencing in intervallum,



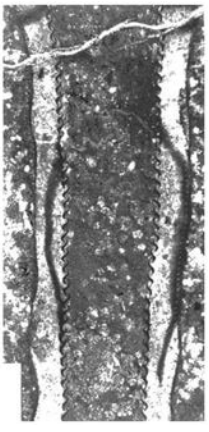
1a

1b Kijacyathus

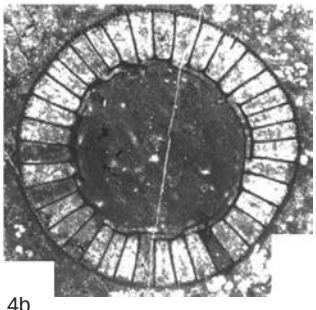
2a

3 Fansycyathus

2b Aporosocyathus



4a



4b Qinlingocyathus

FIG. 565. Kijacyathidae (p. 980–984).