Order STROMATOPORELLIDA
Stearn, 1980

[Stromatoporellida Stearn, 1980, p. 891]

Stromatoporoids with extensive, thick, prominent laminae, marked by an axial zone or zones (light or dark, ordinicellular, cellular, or tubulate) and short, generally simple pillars confined to an interlaminar space. Silurian (Pridoli)–Upper Devonian (Famennian).

Family STROMATOPORELLIDAE
Lecompte, 1951


Genera of stromatoporellids with short pillars, not superposed from one interlamellar space to another. Silurian (Wenlock)–Devonian (Frasnian) (Famennian).

Stromatoporella Nicholson, 1886a, p. 92 [*Stromatopora granulata Nicholson, 1873, p. 94; OD: =Stromatopora (Coenostroma?) granulata Nicholson & Murie, 1878, p. 218–219, pl. 1; =Stromatoparella granulata Nicholson, 1886a, p. 93; neotype, NHM P6021 (Nicholson No. 329), Melville, 1982, p. 126] [*Stichostroma Galloway & St. Jean in Fritz & Waines, 1956, p. 92 (no type specified, but Stichostroma erienne Ponds, 1936, p. 81, implied), genus proposal withdrawn, p. 126; =Pseudostictostroma Flebova, 1969, p. 26 (type, P. nitriformis, OD); =Cancellatodictyon KHALFINA & Yavorsky, 1971, p. 119 (type, Stromatoporella granulata sensu Yavorsky, 1951, p. 14, SD KHALFINA & Yavorsky, 1971, p. 119); =Pseudostromatoporella KAZMIERCZAK, 1971, p. 76 (type, Stichostroma huronense Ponds, 1936, p. 83, OD)]. Extensive, thick laminae and short pillars confined to interlaminar space, not superposed, many formed by upward inflection of laminae into cones (ring pillars), others simple, spool-shaped posts; microstructure of laminae ordinicellular but appearing in various states of preservation as transversely porous, tripartite, cellular, tubulate, or fibrous. Pillars cellular to fibrous. [The wide range of microstructures shown by the laminae may be partially accounted for by diagenesis but is likely also to be influenced by original variation. Controversy over the definition of the genus has focused on the correlation, or lack of it, between the ring pillars and the microstructures. Summaries of these discussions can be found in the work of ST. JEAN (1962, 1977), STEARN (1966), KAZMIERCZAK (1971), and MIŠTAEN (1985).] Lower Devonian (Pragian)–Upper Devonian (Frasnian): Australia (Victoria), Czech Republic (Bohemia), Pragian; Afghanistan, Australia (Queensland), Canada (Arctic Island, Ontario), Russia (Salair), USA (Kentucky), Emsian–Eifelian; Belgium, Eifelian; Canada (Ontario), Russia (Kuznetsk Basin, Tyrgan), USA (Michigan), Ukraine, Givetian; Belgium (Ardennes), Kazakhstan, Poland, Frasnian; England (Devon), Germany (Büchel), Mongolia, Russia (Kuznetsk Basin, Urals), USA (Missouri, Indiana, Kentucky, Michigan), Middle Devonian.—Fig. 434e–d. *S. granulata (NICHOLSON), Hamilton Formation, Arkona, Ontario, holotype, NHM P6021: a. longitudinal section, Nicholson slide 329b, ×10; b. tangential section showing ring pillars, Nicholson slide 329, ×10; c. tangential section, Nicholson slide 329a, showing cellular nature of pillars, ×70; d. longitudinal section, Nicholson slide 329c, showing ordinicellular laminae, ×60 (Stearn, 2011b).—Fig. 434e. S. perannulata GALLOWAY & ST. JEAN, Blue Fiord Formation, Ellesmere Island, arctic Canada, GSC no. 108175, tangential section showing ring pillars, ×10 (Prosh & Stearn, 1996).

Clathrocoilona Yavorsky, 1931, p. 1394 [*C. aborea; OD: holotype, CNIGR 3338/8a,b; KOSAREVA, 1976]. Laminae extensive, thick (of thickness comparable to gallery height) of tripartite, ordinicellular, microreticulate or tubulate microstructure. Pillars postlike, commonly spool shaped, confined to interlaminar spaces, not superposed, compact or obscurely cellular. Commonly irregular, incrusting in growth, with algal interlayers. [The laminae may appear to be stranded, showing less opaque zones. Several layers of cells in the laminae may give the appearance of microreticulation. In tangential section, the thick skeletal material may appear to be tubulate (described as felted by KOSAREVA, 1976). The genus has been confused with Synthetostruma, but in this genus the pillars are well superposed.] Lower Devonian (?Emsian), Middle Devonian (Eifelian)–Upper Devonian (Frasnian): Austria (Carnic Alps), Canada (Arctic Island), Russia (northeastern Siberia, Salair), ?Emsian; Belgium (Ardennes), Canada (Arctic Island, Manioba), Central Asia (Altaï), Germany (Eifel), Russia
Porifera—Hypercalcified Sponges

Fig. 434. Stromatoporellidae (p. 781).
Fig. 435. Stromatoporellidae (p. 781–784).
Porifera—Hypercalcified Sponges

(northeastern Siberia, Salair), Eifelian; Belgium (Ardennes), Canada (northern Alberta, Manitoba), Czech Republic (Moravia), France (Boulonnais), Iran (central), USA (Indiana, Michigan), Givetian; Australia (Queensland), China (Guangxi, Sichuan), Czech Republic (Moravia), Germany (Eifel), Russia (Kuznetsk Basin, northeastern Siberia, Salair), Middle Devonian; Australia (Canning Basin), Belgium (Ardennes), Canada (Alberta, Manitoba), Czech Republic (Moravia), France (Boulonnais), Russia (Russian platform, Kuznetsk Basin), USA (Iowa), Frasnian.—Fig. 435a–d. C. abeona, Middle Devonian, Kuznetsk Basin, Russia, holotype, CNIGR 3338/8; a, longitudinal section, ×10; b, tangential section, ×10; c, longitudinal section showing thick, tripartite laminae, ×25; d, tangential section showing round pillars, ×25 (Stearn, 2011b).

Dendrostroma Lecompte, 1952 in 1951–1952, p. 320–321 [*Idiostroma oculatum Nicholson, 1886a, p. 101; OD; holotype, NHM P6073 (Nicholson No. 403)]. Dendroid skeleton with axial tube; laminae distinct, thick, extensive, compact to fibrous, commonly obscurely tripartite with axial dark or light zone; pillars postlike, confined to interlaminar spaces, not superposed, compact to fibrous. Lower Devonian (Pragian)—Upper Devonian (Frasnian, upper Famennian); Australia (Victoria), Pragian; Canada (Manitoba), Czech Republic, France (Boulonnais), Germany (Eifel), Russia.
Stromatoporellida—Stromatoporellidae

(northeastern Siberia), USA (Michigan), Givetian: Germany (Eifel), India (Himalaya), Russia (Urals), Vietnam, Middle Devonian: Australia (Canning Basin, Carnarvon Basin), Czech Republic, Iran (Kerman), Russia (Kuznetsk Basin), Frasnian: Kazakhstan, Russia (?Donets Basin), ?upper Famennian.—Fig. 436a–b. *D. oculatum* (Nicholson), Middle Devonian, Büchel, Germany, holotype, NHM P6073; a, complete transverse section of dendroid skeleton showing central and radiating canals and continuous laminae, ×6; b, transverse section of columnar skeleton showing short pillars, ×10 (Stearn, 2011b).——Fig. 437a–b. *D. oculatum* (Nicholson), Middle Devonian, Büchel, Germany, holotype, NHM P6073; a, longitudinal axial section showing axial canal with tabulae, ×10; b, tangential section showing fibrous microstructure, ×50 (Stearn, 2011b).

Simplexodictyon Bogoyavlenskaya, 1965b, p. 110 [*Clathrodicyton regulare* var. nov. Yavorsky, 1929, p. 83; OD; CNIGR 2595/30(6); =C. regulare podolica Yavorsky, 1955, p. 43; see Stearn, 1991, for full discussion of the type. Although some authors have attributed the varietal name *podolica* to Yavorsky, 1929, it was not formally proposed until 1955] [=Diplostroma Nestor, 1966a, p. 27–28 (type, Clathrodicyton pseudobilaminatum Khalfina, 1961b, p. 47); =Nuratadictyon Lessova, 1972, p. 48 (type, N. duplexolaminum, OD)]. Laminae extensive, composed of two compact layers separated (in the same skeleton) by either or all of 1) spar cement, 2) sediment, 3) epibionts, 4) a line of cellules; or fused into a single layer. Pillars compact, simple, postlike, commonly incomplete or oblique. Silurian (Wenlock)—Middle Devonian (Eifelian): Estonia (Saaremaa), Russia (Moiero River, Siberian
Porifera—Hypercalcified Sponges

platform), USA (Kentucky), Wenlock; Australia (Queensland), Central Asia (Tien Shan), Estonia, Russia (Salair, Altai), Ukraine (Podolia), Ludlow; Australia (Victoria, northern Queensland), Emsian; Canada (Arctic Island, Yukon), Eifelian. — Fig. 438a–c. *S. podolicum* (Yavorsky), holotype, Ludlow, Smotrich River, Ukraine; a, longitudinal section, ×10; b, topotype, tangential section, ×10 (Stearn, 2011b); c, longitudinal section, ×10 (Yavorsky, 1929). — Fig. 438d. *S. vermiciformis* (Stearn & Mehrotra, 1970), Eifelian, Blue Fiord Formation, Cameron Island, Canada, GSC.
Stromatoporellida—Stromatoporellidae

116284, longitudinal section, showing separated laminae, ×10 (Stearn, 2011b).

**Stictostroma** Parks, 1936, p. 78 [*Stromatopora mammillata* Nicholson, 1873, p. 94; OD; non Schmidt, 1858; holotype, ROM 9360; =*Stromatopora mamilliferum* Galloway & St. Jean, 1957, p. 125; =*Stictostroma gorriense* Stearn, 1995a, p. 26, designated the type in a ruling by ICZN (1996). The type specimen that Parks (1936) designated as *Stromatopora mammillata* Nicholson, 1873, and renamed *S. mamilliferum* Galloway & St. Jean by Galloway and St. Jean (1957) to avoid homonymy,
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had unknown internal structure, because Nicholson’s (1873) types were not sectioned. Parks’s (1936) descriptions were based on specimens from Gorrie, Ontario, recognized as holotypes by ICZN Opinion 1843, Case 2109 (1996), because Nicholson’s (1873) specimens, when sectioned, were indeterminate in diagnostic internal structure. Laminae thick, extensive, ordinicellular in microstructure but commonly appearing transversely porous, tripartite, fibrous, rarely tubulate; pillars confined to interlaminar spaces, not systematically superposed, postlike, only rarely ring pillars, cellular where best preserved, commonly fibrous. Lower Devonian (Pragian)—Upper Devonian (Frasnian): Czech Republic (Bohemia), Pragian; Australia (Victoria), Canada (Arctic Island, Northwest Territories, Ontario), New Zealand (Reefton), Emsian; Australia (Queensland), Belgium (Ardennes), Canada (Manitoba, Ontario), Czech Republic, western Germany (western), Russia (Kuznetsk Basin, Salair), USA (Michigan, Ohio),

Styloporella

Fig. 440. Stromatoporellidae (p. 789).
Stromatoporellida—Trupetostromatidae

789

Eifelian: Afghanistan, Belgium (Ardennes), Canada (British Columbia, Ontario), France (Boulo-nnais), Germany (Sauerland), Russia (Kuznetsk Basin), USA (Missouri), Givetian: Canada (northern Ontario), China (Guanxi), Russia (Kuznetsk Basin, Urals), USA (Missouri), Vietnam, Middle Devonian: Belgium (Ardennes), Canada (Alberta), China (Xizang), France (Boulo-nnais), Iran (Kerman), Russia (Kuznetsk Basin), USA (Iowa), Frasnian.—Fig. 439a–d. *S. gorriense STEARN, holotype, ROM 9360, Bois Blanc Formation, Gorrie, Ontario; a, longitudinal section 2149, ×10; b, tangential section 2152, ×10; c, longitudinal section 2151, showing microstructure of laminae, ×55; d, tangential section 2150, showing microstructure of pillars, ×55 (Stearn, 2011b).

Styloporella KHALFINA, 1956, p. 62 (as subgenus of Stromatoporella, elevated to generic rank by KHALFINA, 1961d, p. 338) [*Stromatoporella (Stylo-porella) grata KHALFINA, 1956, p. 62; OD; holotype, SOAN 402/67b]. Similar to Stromatoporella but with structural elements thickened into astrorhizal columns with prominent axial canals where laminae inflected upward. Upper Devonian (Frasnian): Russia (Kuznetsk Basin, eastern Siberia).—Fig. 440a–b. *S. grata, holotype, SOAN 402/67b, Kuznetsk Basin; a, longitudinal section showing column with axial canal, ×10; b, tangential section showing cross sections of columns, ×10 (Stearn, 2011b).

Syringodictyon ST. JEAN, 1986, p. 1050 [*Stromatopora tuberculata NICHOLSON, 1873, p. 92–93; OD; NHM P5627 (type specimen never illustrated in thin section)]. Laminae extensive, thick, inflected upward in invaginating cones into vertically extensive columns with narrow openings. Pillars formed by superposition of upward extensions of laminae, other pillars scarce. [The difference between Syringodictyon and Tubuliporella is in the size and nature of the vertical tubes formed by the upwardly inflected laminae—small and formed of invaginating cones in the former, and large and continuous in the latter—and in the absence of ring pillars between the columns in the former.] Middle Devonian (lower Eifelian): Canada (southern Ontario).—Fig. 441a–c. *S. tuberculatum (NICHOLSON), topotypes, Onondaga Formation, Empire Beach; a, longitudinal section showing columns of skeletal material, topotype, YPM222128; b, longitudinal section, showing inverted cones of laminae inflected into columns, topotype, YPM222129; c, tangential section showing cross sections of columns and lack of other pillars, topotype, YPM222128, ×10 (St. Jean, 1986).

Tubuliporella KHALFINA, 1968a, p. 150 [*T. lecompti; OD (as T. lecomti, lapsus calami)]. Similar to Stromatoporella, but some ring pillars superposed, forming vertical open channels crossed by thin dissepiments. Lower Devonian–Middle Devonian (Eifelian): Russia (Altai), Lower Devonian; Australia (Victoria), Progon; Russia (Kuznetsk Basin, Altai, Salair), Eifelian.—Fig. 442a–c. *T. lecompti, holotype, CSGM409/3a, Salair, Efelian, Shandinskie Stage; a, longitudinal section, ×10; b, tangential section, ×10; c, tangential section through a mamelon, ×10 (Khalfina, 1968a).

Family TRUPETOSTROMATIDAE

Germovsek, 1954


Stromatoporellids with superposed, postlike pillars or, rarely, pachysteles and
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Tripartite or ordicellular laminae forming a grid in longitudinal section. [Many of the genera of this family contain species that have compact-vacuolate microstructure and some that are cellular. Microstructure is therefore not considered diagnostic of the family.] Silurian (Pridoli)—Upper Devonian (Famennian).

**Trupetostroma** Parks, 1936, p. 55 [*T. warreni*; OD; holotype, ROM 12197 (thin sections only), specimen DU677, referred to by Parks as the type, is lost] [=Flexiostroma Khalfina, 1961d, p. 345 (type, F. flexuosum Khalfina, 1961d, p. 346, OD, see also Stock, 1982, p. 666); =Imponodicton Khalfina & Yavorsky, 1971, p. 119 (type, Stromatoporella loutouguini var. posteria Khalfina, 1956, p. 60, OD)]. Laminae extensive, thick, typically ordicellular but commonly showing a central clear zone or opaque axis, pierced by large pores joining the galleries above and below. Pillars short, expanded above and below at laminae, systematically superposed across successive laminae, forming grid with laminae; microstructure vacuolate, cellular, compact. *Lower Devonian, Middle Devonian (Eifelian)—Upper Devonian (Famennian):* China (Guangxi), *Lower Devonian;* Australia (Broken River), China (Guangxi, Guizhou, Hunan, Yunnan), Czech Republic (Bohemia), Mongolia, Poland (Holy Cross), Russia (Kuznetsk Basin, Salair, South Urals), USA (Missouri), *Middle Devonian;* Canada (Arctic Island, Northwest Territories), China (Guangxi), Russia (Magadan), USA (Indiana), *Eifelian;* Belgium (Ardennes), Canada (Manitoba, Northwest Territories, northeastern British Columbia), China (Guangxi, Yunnan), Germany (Sauerland), Russia (Kuznetsk Basin, Salair, Ursals), Vietnam, Givetian; Germany (Sauerland), Belgium (Ardennes), Canada (Alberta, Manitoba, Saskatchewan), China (Guangxi, Guizhou), Russia (Kolymy, West pre-Urals), Vietnam, Frasnian; Kazakhstan, Famennian; China (Guangxi), Poland (Sudetes Mountains), upper Famennian.—Fig. 443a–d. *T. warreni* holotype, ROM 12197, Presqu’ile Dolomite, Great Slave Lake, Canada; a, longitudinal section showing thin laminae and superposed pillars, ×10; b, tangential section showing large circular pores through cut laminae, ×10; c, longitudinal section showing compact vacuolate pillars and tripartite laminae, ×30; d, tangential section showing vacuolate pillars, round in cross section; a lamina is cut obliquely on right side, ×30 (Stearn, 2011b).

**Hermatostroma** Nicholson, 1886a, p. 105 [*H. schluteri* Nicholson, 1886a, p. 105–106; OD; Nicholson, 1892, p. 215–219, holotype, NHM P5527] [=Argostroma Yang & Dong, 1979, p. 45 (type, A. typicum, OD); Mistiaen (1985, p. 189–190) showed that *Argostroma* is a diagenetic phase of...
Fig. 443. Trupetostromatidae (p. 790).
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Fig. 444. Truperostromatidae (p. 790–794).
Hermatostroma. Laminae extensive, prominent, tripartite with central dark zone, or light zone and more opaque lateral zones, penetrated by large pores between the pillars; pillars spool shaped, confined to interlamellar spaces, regularly superposed in longitudinal section, subcircular in tangential section, surrounded by peripheral cyst plates or bordered by peripheral vesicles. Microstructure compact, vacuolate, cellular. [Hermatostroma may grade into Trupetostroma through forms with lines of vacuoles along the pillar edges.]

Middle Devonian (Eifelian)–Upper Devonian (Frasnian):
Australia (Queensland), Russia (Kuznetsk Basin), Eifelian; Australia (Canning Basin, Queensland), Belgium (Ardenes), China (Guangxi, Guizhou, Yunnan), France (Boulonnais, Ancenis), Poland (Holy Cross Mountains), Thailand, Givetian; Czech Republic (Bohemia), England (Devon), Germany (Eifel), China (Guangxi, Sichuan, Yunnan), USA (Missouri), Middle Devonian; Australia (Canning Basin), Belgium (Ardenes), Canada (Alberta, Manitoba, Saskatchewan), China.
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fig. 446. Trupetostomatidae (p. 794–796).

Hermatoporella

(Sichuan, Yunnan), Czech Republic (Moravia), Germany, Poland (Holy Cross Mountains), Russia (northeastern Siberia), USA (Iowa), Frasnian.—Fig. 444a–d. *H. schluteri, holotype, NHM P5527, Middle Devonian, Hebborn, Paffrath District, Germany; a, longitudinal section, showing grid of pillars and laminae; b, tangential section, showing pillars, round in cross section, ×10; c, longitudinal section showing peripheral vesicles and compact pillars, ×50; d, tangential section, showing peripheral vesicles, ×50 (Stearn, 2011b).

Hermatoporella Khromykh, 1969, p. 34 [*Trupetostroma maillieuxi Lecompte, 1952 in 1951–1952, p. 237–239; OD; holotype, IRScNB 5760a]. Irregular grid formed by pachysteles and microlaminae intersecting pachysteles, locally replaced by aligned dissepiments; pachysteles superposed systematically, with peripheral vacuoles in parts of type, in tangential section forming a labyrinthine network, rarely cut as isolated subcircular masses; microstructure compact, vacuolate, or cellular. Middle Devonian (†Eifelian, Givetian)—Upper Devonian (Frasnian): Morocco, †Eifelian; Canada (Northwest Territories, northeastern British Columbia), Russia (Omolon, South Urals), Vietnam, Givetian; China (Guizhou), Russia (Salair), Middle Devonian; Australia

Fig. 446. Trupetostomatidae (p. 794–796).
Stromatoporellida—Trupetostromatidae

Fig. 447. Trupetostromatidae (p. 796–797).
Hermatostromella Khalfina, 1961a, p. 52 [*H. parasitica; OD; holotype, CSGM 401/33] [=Amnestostroma Bogoyavlenskaya, 1969b, p. 22 (type, Syringostroma federovi Yavorsky, 1929, p. 109, OD; Stearn & others, 1999, p. 45); =Geronostroma Khalfina & Yavorsky, 1971, p. 119 (type, Gerronostroma kitatense Yavorsky, 1961, p. 12, OD; Stearn & others, 1999, p. 45)]. Laminae and pillars subequal in thickness forming grid; laminae extensive, locally with axial dark or light zone, or ordinicellular; pillars postlike, locally appearing continuous, locally superposed and interrupted by lighter central zone in laminae, mostly discrete and subcircular in tangential section; microstructure compact, vacuolate, rarely cellular. [The most extensive discussion of this genus is that of Khromykh (1974a) who emphasized as diagnostic characters the equal thickness of pillars and laminae, the dark or light central line in the laminae, the superposed pillars, and the cellular microstructure. Amnestostroma is intermediate between Hermatostromella
and *Trupetostromata*; however, the features of the type species are basically those of *Hernatostromella* and therefore difficult to justify as a separate genus. See *Stearn* and others (1999, p. 45) for discussion.

*Silurian (Pridoli)—Lower Devonian (Emsian), Middle Devonian (Givetian):* Russia (eastern Siberia, Ural's), Pridoli; Canada (Arctic Island), Central Asia (Tien Shan), Russia (Salair, Ural's), Lockkovian; Australia (Victoria), *Pragian*; Australia (New South Wales), *Emsian*: Russia (eastern Siberia, Altai Sayan), Central Asia (Tien Shan), *Lower Devonian (Givetian):* Queensland, *Emsian*: Russia (Urals), *Lower Devonian (Eifelian):* China (Sichuan), western Germany, *Middle Devonian (Eifelian):* Germany (Sauerland), *Eifelian*: Australia (Queensland), China (Guizhou, Guangxi, Hunan, southern Tien Shan, Xizang), Mongolia, Spain (Cantabria), *Eifelian*: USA (Iowa, Michigan), Vietnem, *Givetian*: Uzbekistan, China (Sichuan), Germany, Russia (Ural's), *Middle Devonian, Australia (Canning Basin),* Canada (northern Alberta), Uzbekistan, China (Sichuan), *Cretaceous, Russia (Urals), Central Asia (Tien Shan)*.

Genera of the Stromatoporida dominated by pachysteles and pachystromes forming amalgamate networks. Silurian (upper Llandovery)—Upper Devonian (Frasnian).

**Order STROMATOPORIDA**

*Stearn*, 1980

Stromatoporoids with cellular or obscurely cellular microstructure and structure dominated by pachysteles and pachystromes forming amalgamate networks. *Silurian (upper Llandovery)—Upper Devonian (Frasnian).*

**Family STROMATOPORIDAE**

*Winchell*, 1867

*Genua of the Stromatoporida dominated by pachysteles, laminae, and/or cusciculate structure. Silurian (upper Llandovery)—Upper Devonian (Frasnian).*
Fig. 449. Idiostromatidae (p. 797).
Stromatoporellida—Idiostromatidae, Stromatoporida—Stromatoporidae

Fig. 450. Idiostromatidae (p. 797).
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Stromatopora *GOLDFUSS*, 1826, p. 21 [*S. concentrata* *GOLDFUSS*, 1826, p. 22; OD; holotype, IPB 80] [*Angulatohroma KHALFINA, 1968a, p. 152, lapsus calami pro Angulatohroma (type, Stromatopora angulata YANORSKY, 1947, p. 10, OD)]. Skeleton of cellular, caccisulate, oblique pachystromes and scattered dissepiments, in some successive phases including short pachystele; structural elements in tangential section cut as labyrinthine network or discrete verriform elements. [Problems concerning the type and definition of the genus have been discussed by STEARN (1993)]. *Silurian (Wenlock)—Upper Devonian (Frasnian):* Czech Republic (Bohemia), Russia (Kuznetsk Basin, Lena River, Vaigach Island), Ukraine (Podolia), *Wenlock*; Czech Republic (Bohemia), Estonia, Russia (Vaigach Island, Siberian platform), USA (New York), *Ludlow—Pridoli*; Australia (Victoria, New South Wales), Canada (Arctic Island), China (Guangxi), Spain (south), *Lower Devonian;* Australia (Queensland), Belgium (Ardenne), Canada (Arctic Island, Northwest Territories), China (Sichuan, Guangxi, Yunnan), Morocco, New Zealand (Reefton), Russia (Kuznetsk Basin, Petchora Basin, Salair), USA (Missouri), *Middle Devonian;* Belgium (Ardenne), Canada (Alberta, Saskatchewan, Northwest Territories), Poland (Holy Cross Mountains), Russia (Novaya Zemlya), *Frasnian.*——Fig. 451a–b. *S. concentrata*, holotype, IPB 80, *Middle Devonian, Gerolstein, Eifel, Germany; a, longitudinal section*
Stromatoporida—Stromatoporidae

showing cassiculate structure, ×10; b, longitudinal section showing cellular microstructure, ×25 (Stearn, 2011b).——Fig. 452a–b. *S. concentrica; a, holotype, longitudinal section cut for Lecompte (1952 in 1951–1952) showing microstructure, ×25; b, specimen IRScNB 6212a of Lecompte (1952 in 1951–1952), Eifelian, Chimay, Ardennes, Belgium, longitudinal section showing latilamination and cassiculate structure, ×10 (Stearn, 2011b).

Climacostroma Yang & Dong, 1979, p. 72 [*C. guangxiense; OD; holotype, NIGP 33129, 33130] [=Lineastroma Khalfina & Yavorsky, 1973, p. 31, partim (type, Stromatopora vorkutenis Yavorsky, 1961, p. 39, of Stearn, 1993, p. 213) see Lineastrona below and Stearn (in Stearn & others, 1999, p. 47) for further discussion]. Structure dominated by thick, discontinuous pachystromes associated with microlaminae. Pachysteles short, confined to space between pachystromes, not superposed, forming a closed network in tangential section. Microstructure cellular. Middle Devonian: Belgium (Ardennes), Canada (Northwest Territories), China (Guangxi, Sichuan), Poland (Holy Cross Mountains), Russia (Pechora Basin, South Urals, Kuznetsk Basin), USA (Missouri).——Fig. 453a–b. *C. guangxiense, holotype, 331229-30, Guangxi, China; a, longitudinal section, ×10; b, tangential section, ×10 (Dong, 2001).
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Glyptostromoides Stearn, 1983a, p. 553 [*Glyptostroma simplex* Yang & Dong, 1979, p. 66; OD; holotype, NIGP33083-4] =*Glyptostroma* Yang & Dong, 1979, p. 65 (based on *Stromatopora beuthii* sensu Yavorsky, 1955, p. 106; non *S. beuthii Bargatzky, 1881a*]. Structure in longitudinal section cassicate, formed by network of oblique structural elements penetrated by thick, cellular, long pachysteles; in tangential section, pachysteles merging into labyrinthine network with oblique structural elements. [The type species of *Glyptostromoides* was designated by Yang and Dong (1979) as *Stromatopora beuthii* Bargatzky, and they referred to the citation of this species by Yavorsky (1955). However, the type specimens of *S. beuthii* had been identified as a species of the much different genus *Hermatostroma* Nicholson by Lecompte (1952 in 1951–1952, p. 253) and Stearn (1980, p. 898–899). *Glyptostroma* therefore became a junior synonym of *Hermatostroma* and the generic grouping distinguished by Yang and Dong required a new name.] Lower Devonian (Emian–Middle Devonian (Givetian): Canada (Arctic Island), Emsian; Spain (Cantabria), Emsian–Eifelian; China (Guangxi), Russia (Kuznetsk Basin, Salair), Middle Devonian; Canada (British Columbia), Russia (Kuznetsk Basin), *Givetian*.——*Fig. 455a–d, *G. simplex* (Yang & Dong); a–b, holotype, NIGP33083-4, Middle Devonian, Guangxi, China; a, longitudinal section, 10; b, tangential section, 10 (Yang & Dong, 1979); c, hypotype, GSC108894, Blue Fiord Formation, Ellesmere Island, arctic Canada, longitudinal section, 10; d, drawings of type specimen, 10 (Stearn, 1993).]

**Lineastroma** Khalfina & Yavorsky, 1973, p. 31 [*Stromatopora vorkutenis* Yavorsky, 1961, p. 39; OD; holotype, CNIGR 7354/420; the type is synonymized with *Stromatopora sibirica* Riabinin, 1928, p. 1046, and *Stromatopora elegestica* Riabinin, 1937, p. 16; Nestor, 1976, p. 78; if the synonymy is confirmed by comparison of the type specimens, then *L. sibirica* Riabinin, 1928, is the type species.] Structure of prominent, extensive but interrupted pachystromes and short, mostly longitudinal but locally oblique pachysteles, mostly confined to space between pachystromes, only locally superposed or more continuous longitudinally; in tangential section cut as isolated dots or irregular vermiform masses, rarely joined. Microstructure finely and inconspicuously cellular. [Stearn (1993) included both forms with postlike pillars and pachysteles in the genus, which resulted in a widely split temporal range, with a gap of late Silurian and Early Devonian. Transferring the species that have pachysteles forming a closed network in tangential section to *Climacostroma* makes better sense of the stratigraphic distribution of *Lineastroma* and *Climacostroma*, middle Silurian: Russia (Siberian platform, Pre-Urals, Tuva), Ukraine (Podolia).——*Fig. 456a–b, *L. vorkutenense* (Yavorsky), holotype, CNIGR 7354/420, Pre-Urals, Russia; a, longitudinal section, 10; b, tangential section, 10 (Khalchina & Yavorsky, 1973).]

**Neosyringostroma** Kazimierczak, 1971, p. 117 [*Hermatostroma leaguaistentense* Galloway & St. Jean, 1957, p. 219; OD; holotype, YPM222127]. Long pillars of cellular-melanospheric microstructure pass through amalgamate structure of
Stromatoporida—Stromatoporidae

Fig. 454. Stromatoporidae (p. 802).
short pachysteles, pachystromes, and cassiculate structural elements, commonly chevron shaped in longitudinal section. In tangential section, pillars circular within amalgamate structural elements. Lower Devonian (Emsian–Middle Devonian (Givetian): Spain (Cantabria), Emsian–Eifelian; Afghanistan, upper Emsian; Belgium (Ardennes), Russia (Kuznetsk Basin), Eifelian; China (Guangxi, Guizhou, Hunan), Middle Devonian; Afghanistan, Canada (British Columbia, Manitoba), Poland, USA (Indiana), Givetian.—Fig. 457a–d. *N. logansportense (Galloway & St. Jean), hypotype, GSC 104075 (illustrated as Taleastroma logansportense in Qi & Stearn, 1993), Slave Point Formation, Evie Lake Field, northeastern British Columbia, Canada; a, longitudinal section, ×10; b, tangential section, ×10 (Qi & Stearn, 1993); c–d, holotype, original illustrations highly retouched; c, longitudinal section; d, tangential section, ×10 (Galloway & St. Jean, 1957).

**Pseudotrupetostroma** Khalfina & Yavorsky, 1971, p. 120 [*Stromatopora pellucida artyschtensis* Yavorsky, 1955, p. 100; OD; holotype (apparently lost), CNIGR 7351/132, elevated to species rank by Khalfina and Yavorsky (1971, p. 120)]. Pachysteles confined to interlaminar space, commonly well superposed, very coarsely cellular. Tangential elements fine microlaminae coated with coarsely cellular material like that of pillars. In tangential section, longitudinal elements (pachysteles) cut as a closed network or as vermiciform isolated masses. [The type specimen of *P. artyschtensis* is apparently lost, but as originally defined as a variety, it had the same specimen and
type number as the species \textit{S. pellucida} Yavorsky from the same locality and was very similar in form (\textit{fide} Nestor, personal communication, 2003). The figures of the variety from Yavorsky, 1955, and of the species \textit{S. pellucida} are therefore used here to illustrate the genus.\] Lower Devonian (?Pragian, Emsian)–Middle Devonian (Givetian): Australia (Victoria), Pragian; Australia (New South Wales, Victoria), Pragian; Spain (Moreno Mountains), Emsian; Canada (Arctic Island), Emsian–Eifelian; Russia (Kuznetsk Basin), Eifelian; Russia (Salair), Middle Devonian; Australia (Queensland), Canada (northeastern British Columbia, Northwest Territories), China (Guizhou), Russia (Kuznetsk Basin, Salair), Givetian.\]—— fig. 458a–c. \textit{*P. artyschtense} (Yavorsky), holotype, 7351/132, Givetian, Artyscht River, Kuznetsk Basin, Russia; a–b, longitudinal and tangential sections, ×10; c, longitudinal section, ×25 (Yavorsky, 1955).—— Fig. 458d–e. \textit{P. pellucida} Yavorsky, holotype, CNIGR 7351/132, locality as for \textit{P. artyschtense}; d, tangential section, ×10; e, longitudinal section, showing coarsely cellular microstructure, ×25 (Yavorsky, 1955).

\textbf{Taleastroma} Galloway, 1957, p. 448 \textit{[Stromatopora} cumingsi \textit{Galloway \& St. Jean, 1957, p. 182; OD; holotype, YPM222129]. Structure amalgamate with small, round galleries, dominated by thick pachystromes, commonly showing microlaminae and traces of microreticulation. Pillars penetrate the structure, of melanospheric microstructure, commonly with clear axes, probably originally cellular. Round ends of pillars cut tangentially within amalgamate, melanospheric structural elements. \textit{Taleastroma} is similar to \textit{Neosyringostroma} but has more prominent pachystromes. The clear zones in the pillar axes, which are exaggerated in the retouched original illustration, may be diagenetic in origin.] Middle Devonian: Belgium (Ardennes), Germany (Hebhorn), USA (Indiana).—— Fig. 459a–b. \textit{*T. cumingsi} (Galloway \& St. Jean), Logansport Limestone, holotype, YPM222129, unretouched; a, longitudinal section, ×10; b, tangential section, ×10 (Stearn, 2011b).

\textbf{Family FERESTROMATOPORIDAE} Khromykh, 1969 \textit{[Ferestromatoporidae} Khromykh, 1969, p. 30]

Stromatoporids of melanospheric to obscurely cellular microstructure composed of oblique structural elements forming a closely spaced, cassiculate network. The microstructure commonly appears to be finely melanospheric or compact and vacuolate. Uncertainty about its microstructure is reflected in the original description of Yavorsky (1955) and in the discussion of

\textbf{Fl"ugel} and \textbf{Fl"ugel-Kahler} (1968)\]. Lower Devonian (?Emsian), Middle Devonian–Upper Devonian (Franian).

\textbf{Taleastroma} Yavorsky, 1955, p. 109 \textit{[*E krupennikovi; OD; holotype, CNIGR 7351/165]. Structural elements largely oblique, forming cassiculate network traversed by thin, continuous paralaminae, forming a labyrinthine network in tangential section. Pachysteles absent. Microstructure obscurely cellular, commonly melanospheric. Lower Devonian (?Emsian), Middle Devonian–Upper Devonian (Franian): Canada (Arctic Island), Emsian; Canada (Sichuan, Guangxi), Middle Devonian; Germany (Rhineland), Poland (Holy Cross Mountains), Russia (Kuznetsk Basin, Salair), USA (Missouri), Givetian; Canada (Alberta), Poland (Holy Cross Mountains), Russia (eastern Siberia), Franian.—— Fig. 460a–c. \textit{*E. krupennikovi} holotype, CNIGR 7351/165, Givetian, near Safonov, southwest of Kuznetsk Basin, Russia; a, longitudinal section, ×6; b, tangential and oblique section, ×12; c, longitudinal section showing microstructure, ×25 (Yavorsky, 1955).
Fig. 457. Stromatoporidæ (p. 802–804).
Fig. 458. Stromatoporidae (p. 804–805).
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Arctostroma Yavorsky, 1967, p. 30 [*A. ignotum; OD; holotype, CNIGR No. unknown; =Ferestromatopora contexta Stearn, 1963, p. 666; Stearn, 1980, p. 898]. Oblique structural elements forming continuous cassinicate network in longitudinal section, enclosing galleries arched at top; neither pachysacles nor pachystromes prominent, but structural elements may align tangentially locally; structural elements cut as labyrinthine network in tangential section. Microstructure cellular, commonly altered to melanospheric with vertical alignment of melanospheres. [Nestor (personal communication, 2009) asserted that until the identity of the two species is proven, A. ignotum should remain the type species.] Middle Devonian (Givetian)—Upper Devonian (Frasnian): Australia (Queensland), Belgium (Ardennes), Givetian; Australia (Canning Basin), Canada (Alberta, Manitoba, Saskatchewan), China (Guangxi), Germany (Rhineland), Russia (western Pre-Urals), Frasnian.—Fig. 461a–b: *A. contextum (Stearn), holotype, GSC 29150, Mikkwa Formation, Frasnian, Mikkwa River, northern Alberta, Canada; a, longitudinal section, ×10; b, longitudinal section showing microstructure, ×25 (Stearn, 2011b).—Fig. 461c–e: A. ignotum; holotype, Frasnian, western Pre-Urals, Tshernysheva Mountains, Russia; c–d, longitudinal and tangential sections, ×10; e, longitudinal section, showing microstructure, ×25 (Yavorsky, 1967).
Stromatoporida—Ferestromatoporidae

Fig. 460. Ferestromatoporidae (p. 805).
Family SYRINGOSTROMELLIDAE Stearn, 1980

[Syringostromellidae Stearn, 1980, p. 892]

Sylmatoporida with structure dominated by pachysteles and dissepiments. *Silurian (upper Llandovery)–Upper Devonian (Frasnian).*

*Syringostromella Nestor*, 1966a, p. 47 [*Stromatopora borealis* Nicholson, 1891b, p. 315; OD; holotype, NHM, P5894] [=Yavorskiiina Khalfina, 1968a, p. 148, nom. nud.]. Pachysteles long, continuous,
joining and dividing in longitudinal section; pachystromes rudimentary or absent, dissepiments common. In tangential section, pachysteles vermiciform or loose labyrinthine network. Microstructure cellular, some species may appear microreticulate. Silurian (upper Llandovery)–Lower Devonian, Middle Devonian (?Eifelian): Canada (Hudson Bay), Telychian; Canada (eastern Quebec), England (Wenlock), Japan, Russia (Moiero River, Tuva), Sweden (Gotland), Ukraine (Podolia), Wenlock; Canada (Chaleurs Bay), Turkestan Mountains, Estonia, Kazakhstan, Russia (Siberia), Sweden (Gotland), Ukraine (Podolia), Ludlow; China (Inner Mongolia), Mongolia, Ukraine (Podolia), Russia (eastern slope of Urals), USA (New York), Pridoli; Canada (Arctic Island), Lochkovian; Czech Republic (Bohemia), Pragian; Australia (Victoria), Canada (Arctic Island), Russia (Salair), Lower
Porifera—Hypercalcified Sponges

Devonian; Russia (Siberia, Omolov), ?Eifelian.—Fig. 462a–d. *S. borealis (Nicholson); a–d, holotype, NHM. P5894, Ludlow, Oesel Island, Estonia; a, longitudinal section showing long pachysteles, ×10; b, tangential section showing allotubes and autotubes, ×10; c, tangential section of pachysteles showing melanospheric microstructure, ×50 (Stearn, 2011b); d, toptype, IGTUT Co 3176, longitudinal section showing cellular microstructure and long pachysteles, ×25 (Nestor, 1966a).

Salairella Khalfina, 1961d, p. 330 [*S. multicea Khalfina, 1961d, p. 331; OD; holotype, CSGM 402/37] [=Lecomptella Khalfina, 1972, p. 151 (type, Stromatopora racemifera Khalfina, 1961d, p. 327, OD); =†Tubuliporellina Kosareva in Bogoyavlenskaya & Khromykh, 1985, p. 93 (type, T. crispa, ?SD)]. Pachysteles long, joining and dividing in longitudinal section, pachystromes rudimentary to absent, dissepiments common in autotubes between pachysteles. In tangential section, most pachysteles joined in closed network enclosing autotubes. Microstructure finely cellular. [Although the genus Tubuliporellina was attributed by Bogoyavlenskaya and Khromykh to Kosareva (1968), a generic diagnosis was not published until that in Bogoyavlenskaya and Khromykh in 1985, and the proposed type species was only illustrated at that time but not described. The status of the genus is therefore in doubt.] Lower Devonian (Pragian)—Upper Devonian (Frasnian); Austria (Carnic Alps),
Syringostromatida—Coenostromatidae

Czech Republic (Bohemia), Mongolia, Russia (Salair, eastern Siberia), Lower Devonian; Australia (Victoria), Czech Republic (Koneprusy), Pragian; Australia (New South Wales), Canada (Arctic Island), Emsian; Altai, Zeravshan Mountains, Czech Republic (Bohemia), Russia (Salair, Kuznetsk Basin), Eifelian; China (Guangxi, Yunnan), Russia (eastern slope of Urals, Salair), Middle Devonian; Australia (Queensland), Belgium ( Ardennes), Russia (Kuznetsk Basin), USA (Missouri), Givetian; Australia (Queensland), Belgium (Ardennes), Canada (Alberta, Manitoba), Russia (Russian platform), Frasnian.—Fig. 463a–b. *S. multicea, holotype, CSGM 402/37, Podshandinskie stage, Gur’evska district, Salair, Russia; a, longitudinal section, ×10; b, tangential section, showing prominent autotubes, ×10 (Stearn, 2011b).

?Zeravshanella LeSsovaJa, 1986, p. 36 [*Z. cavernosa; OD; holotype, GMU 270/7a-33/412]. Long pachysteles, highly irregular in outline in both longitudinal and tangential sections; tangential structural elements amalgamate, irregular, resembling those of Glyptostromoides and dissepiments. [Further study may show this genus to be based on a diagenetically altered specimen of Syringostromella; however, the microstructure of this genus resembles that of the Ferestromatoporidae. The name was first published by LeSsovaJa (1978a) as a _nomen nudum_ in a caption to plate 1.1. The name is very similar to Zeravshanella Lyashenko, 1969, a tentaculatid.] Lower Devonian: Tien Shan.—Fig. 464a–b. *Z. cavernosa, holotype, GMU 270a-33/412, Kushnovin horizon (approximately Pragian), Mount Bursykhirm, Zeravshan Range, Uzbekistan; a, longitudinal section, ×10; b, tangential section, ×10 (Stearn, 2011b).

Order SYRINGOSTROMATIDA Bogoyavlenskaya, 1969

[Syringostromatida Bogoyavlenskaya, 1969b, p. 21]

Stromatoporoids of microreticulate microstructure and skeleton composed of discrete structural elements rather than amalgamate networks, including commonly dominant pachystromes and microlaminae, pachysteles and pillars. [Microstructure alone does not define the order; several genera of the Stromatoporida also show traces of this microreticulation. The grouping of genera in the Syringostromatida is based partly on phylogenetic considerations that suggest that the order arose in Wenlock time from the actinostromatids: the Coenostromatidae from the Pseudolachiidae and the Parallelostromatidae from the Densastromatidae (Nestor, 1974).] Silurian (Wenlock)–Middle Devonian (Givetian), Upper Devonian (?Famennian).

Family COENOSTROMATIDAE Waagen & Wentzel, 1887


Syringostromatida of laminar, bulbous, and domical growth form with structure dominated by longitudinal structural elements (pachysteles and pillars) of clinoreticular and acosmoreticular microstructure. Silurian (Pridoli)—Upper Devonian (Frasnian).

Coenostroma Winchell, 1867, p. 99 [*Stromatopora monticulifera_ Winchell, 1866, p. 91; SD
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Miller, 1889, p. 157; lectotype, UMMP 32409A, Galloway & Ehlers, 1960, p. 51 [= Parallellestromella Kosareva, 1968, p. 80 (type, P. collina Kosareva, 1968, p. 80–81, OD, nom. nud., published without a diagnosis)]. Extensive, thick pachystromes, superposed pachysteles, and pillars forming an imperfect grid in longitudinal section; galleries small, irregular; microstructure of structural elements obscurely clinoetric, locally with microlaminae in pachystromes. In tangential section, structural elements forming an irregular network, or, in some species, longitudinal elements appear as dots (i.e., they are pillars). [Some of the species presently included in Coenostroma are acosmoretic in microstructure and could form the basis of a new genus. Lower Devonian (Lochkovian)—Middle Devonian (Givetian). USA (New York), Lochkovian; Australia (Victoria), Emsian; Canada (southern Ontario), Germany (Eifel), Russia (Kuznetsk Basin, northeastern Siberia, ?Salair), Eifelian; Australia (Queensland), Canada (Manitoba, Northwest Territories), Czech Republic, Poland (Holy Cross Mountains), Russia (Kuznetsk Basin), USA (Michigan), Givetian; China (Guangxi), Middle Devonian; Russia (Novaya Zemlya), Australia (Canning Basin), ?Famennian.—Fig. 465a–d. *C. monticuliferum (Winchell), Gravel Point Formation, Traverse Group, Petosky, Michigan, USA; a–c, lectotype, UMMP 32409A; a, tangential section, ×10; b, tangential section showing cellular microstructure, ×25; c, longitudinal section showing traces of microreticulate microstructure, ×25; d, paralectotype, UMMP 32409B, longitudinal section, ×10 (Stearn, 2011b).
Fig. 466. Coenostomatidae (p. 816).
**Atopostroma** Yang & Dong, 1979, p. 74 [*A. tuntouense*; OD; holotype, NIGP Bd343-9]. Laminae regular, extensive, formed of a single microlamina with skeletal material from pillars spread irregularly below; pillars typically superposed, narrow, subcircular in tangential section at base, composed of orthoreticular to clinoreticular skeletal material. **Lower Devonian (Lochkovian)–Middle Devonian (Eifelian, ?Givetian)**: Canada (Arctic Island), USA (New York), Lochkovian; **Pragian**: Czech Republic (Bohemia), Australia (New South Wales, Victoria), Canada (Arctic Island, Northwest Territories, Yukon), China (Sichuan, Yunnan, Guangxi), **Emsian**: Canada (Arctic Island), Russia (Kuznetsk Basin), **Eifelian**: **Afghanistan**; **?Givetian**. —— Fig. 466a–b. *A. tuntouense*, holotype, NIGP Bd343-9, Yujiang Formation, Emsian, Guangxi, China; *a*, longitudinal section, ×10; *b*, tangential section, ×10 (Dong, 2001). —— Fig. 466c. *A. n. sp.*, = *A. tuntouense* Stearn, 1990, p. 496 (see Webby, Stearn, & Zhen, 1993, p. 171–172), hypotype, GSC95786, Stuart Bay Formation, Bathurst Island, arctic Canada, longitudinal section, ×10 (Stearn, 2011b). —— Fig. 466d. *A. stearni* Webby & Zhen, 2008, holotype, Martin Wells Limestone, Queensland, Australia, AM.F 134883, longitudinal section, showing microstructure, ×35 (Webby & Zhen, 2008). —— Fig. 467a–b. *A. n. sp.* (= *A. tuntouense* Stearn, 1990, p. 496), hypotype, GSC95786, Stuart Bay Formation, Bathurst Island, arctic Canada; *a*, tangential section, ×10; *b*, longitudinal section showing microstructure, ×25 (Stearn, 2011b).

**Columnostroma** Bogoyavlenskaya, 1972b, p. 33 [*Coenostroma ristigouchense* Spencer, 1884, p. 399; OD; specimen repository unknown, type slide 309, NHM. P5591]. Pillars (subcolumns) long,
Syringostromatida—Coenostromatidae

Fig. 468. Coenostromatidae (p. 816–818).
Porifera—Hypercalcified Sponges

Continuous, rarely joining or dividing, clinoreticular, round in tangential section and joined by radial processes (colliculi) forming colliculate laminae or locally thicker pachystromes; dissepiments common; pillars (subcolumns) separated by autotubes. Lower Devonian (Lochkovian)–Middle Devonian (Givetian): Canada (New Brunswick), Lochkovian; Australia (Victoria), Pragian; Russia (eastern Urals), Lower Devonian; Canada (Hudson Bay), USA (Indiana, Ohio), Emsian–Eifelian; England (Devon), Russia (northern Urals, eastern slope of Urals, Kuznetsk Basin), Givetian. —Fig. 468a–d. *C. ristigouchense* (Spencer), holotype, NHM, P5591, ?Lochkovian, Dalhousie, New Brunswick, Canada; a, longitudinal section (section is thick), ×10; b, tangential section showing round pillars (subcolumns) joined by radial processes, ×10; c, longitudinal section showing clinoreticular nature of pillars (subcolumns), ×50; d, tangential section of microstructure, ×50 (Stearn, 2011b).

Habrostroma Fagerstrom, 1982, p. 11 [*Stromatopora proxilaminata* Fagerstrom, 1961, p. 8; OD; holotype, UMMP 36177]. Pachystele short, irregular, largely confined between pachystromes, forming an irregular network of cellular skeletal tissue with diffuse boundaries in tangential section; pachystromes prominent, of similar cellular-to-acosmoreticular material containing one or more microlaminae. [This genus has been difficult to define, and at the beginning of its range near the Silurian-Devonian boundary, it is difficult to distinguish from *Parallelostroma* (Fagerstrom, 1982; Stock & Holmes, 1986; Stock, 1989).] Silurian (Pridoli)–Upper Devonian (Frasnian): Estonia, USA (New York, Virginia), Pridoli; Canada (Arctic Island), USA (New York, Virginia), Lochkovian;
Syringostromatida—Parallelostromatidae

Australia (Victoria), Pragian; Australia (New South Wales), Canada (Arctic Island), Emsian; Belgium (Ardennes), Canada (Arctic Island, southern Ontario), Poland, Russia (Kuznetsk Basin, Russian platform, Urals), USA (Indiana, Missouri, Ohio), Eifelian; Belgium (Ardennes), China (Guizhou), Germany (Sauerland), USA (Indiana), Givetian; Canada (northern Alberta, Northwest Territories), France, Iran (Kerman), Russia (St. Petersburg), Frasnian.—Fig. 469a–b. *H. proxilaminatum (Fagerstrom), holotype, UMMP36177, Formosa Reef Limestone, 4 km north of Formosa, Ontario, Canada; a, longitudinal section, ×10; b, tangential section, ×10 (Stearn, 2011b).—Fig. 470a–b. *H. proxilaminatum (Fagerstrom), holotype, UMMP36177, Formosa Reef Limestone, 4 km north of Formosa, Ontario, Canada; a, longitudinal section showing microstructure and microlaminae, ×25; b, tangential section showing diffuse skeletal material of pillars, ×25 (Stearn, 2011b).

Syringostroma Nicholson, 1875, p. 251 [*S. densum; SD Nicholson, 1886a, p. 98; holotype, NHM. P5598] [=Stylodictyon Nicholson & Murie, 1878, p. 221–222 (type, Syringostroma columnaris Nicholson, 1875, p. 263, OD); Galloway, 1957, p. 450; Stearn, 1966, p. 116]. Pachystromes short, irregular, coarsely cellular, without well-defined boundaries, irregular in shape in tangential section; subcolumns long, continuous, clinoreticular, round in tangential section; pachystromes persistent, thick, appearing cellular or acosmoreticular, containing one or more microlaminae; dissepiments rare. [A great majority of species that have been assigned to this genus do not have the prominent subcolumns characteristic of the type species and should be assigned to other genera, notably Coenostroma and Habrostroma (Stearn, 1993).] Lower Devonian (Lochkovian)–Middle Devonian (Givetian): Canada (Arctic Island), Lofkovian; Canada (southern Ontario, Hudson Bay), USA (Michigan, Ohio), Emsian–Eifelian; USA (Missouri), Middle Devonian; USA (Indiana, Ohio), Givetian.—Fig. 471a–c. *S. densum; a–b, holotype, NHM. P5598, Corniferous limestone (Columbus Limestone), Kelley's Island, Lake Erie, Ohio, USA; a, longitudinal section, ×10; b, tangential section, showing round cut ends of subcolumns, ×10; c, toptype, YPM 452617, longitudinal section showing loosely open microreticular microstructure, ×50 (Stearn, 2011b).

Family PARALLELOSTROMATIDAE

Bogoyavlenskaya, 1984

[Parallelostromatidae Bogoyavlenskaya, 1984, p. 73]

Syringostomatida of laminar, bulbous, and domical growth forms with structure dominated by pachystromes and microlaminae; microstructure largely orthoreticular.

Parallelostroma Nestor, 1966a, p. 52 [*Stromatopora typica Rosen, 1867, p. 58; OD; holotype, IGTUT Co3009]. Pachystromes thick, composed of orthoreticular skeletal material enclosing multiple microlaminae and micropillars; short autotubes separate pachysteles at their base. Pachysteles of orthoreticular microstructure, largely confined to space between pachystromes, some superposed; in tangential section forming closed network penetrated by autotubes. Silurian (Wenlock)–Middle Devonian (Givetian), Upper Devonian (?Frasnian).
Porifera—Hypercalcified Sponges

Sweden (Gotland), Ukraine (Podolia), USA (New York), Ludlow–Pridoli; Canada (Arctic Island), Estonia, Ukraine (Podolia), USA (New York), Llandovery; China (Guangxi, Inner Mongolia, Sichuan), Russia (eastern Urals), Lower Devonian; China (Guangxi), Russia (western Urals, Arctic Island), Middle Devonian; China (Guangxi), Russia (eastern Urals), Lower Devonian; China (Guangxi), Russia (eastern Urals, Arctic Island), Middle Devonian; China (Guangxi), Russia (eastern Urals), Lower Devonian; China (Guangxi), Russia (eastern Urals, Arctic Island), Middle Devonian.

Hypercalcified Sponges

Parallelopora Bargatzky, 1881a, p. 291 [*P. ostioluta Bargatzky, 1881a, p. 292; OD; holotype, IPB 571b, also NHM. P5936, slides 125); type illustrated by Nicholson (1886a, pl. 2), Lecompte (1952 in 1951–1952, pl. 51)]. Pachysteles long, continuous, branching and joining in longitudinal section, in tangential section mostly joined into closed network, enclosing autotubes; pachystremes suppressed or absent; dissepiments abundant. Microstructure of pachysteles coarsely microreticulate (orthoreticular), apparently formed of closely spaced, opaque micropillars and more widely spaced, short microcolliculi. Silurian (upper Ludlow–Middle Devonian (Givetian): Sweden (Scania, Gotland), upper Ludlow; Czech Republic (Bohemia), Pragian; Australia (Victoria), Canada (Arctic Island), Emsian; Canada (Arctic Island), Emsian; Canada (Arctic Island), Emsian; Russia (Kuznetsk Basin), Givetian; China (Guangxi, Hunan, Sichuan), Germany (Eifel), Russia (South Urals), Middle Devonian.——Fig. 473a–d. *P. ostioluta, Holotype, slides NHM. P5936, Middle Devonian, Büchel, Eifel, Germany; a, longitudinal section of Nicholson’s sample of holotype, X10; b, tangential section, showing continuous network of pachysteles, X10; c, longitudinal section showing microstructure of micropillars, X50; d, tangential section showing coarsely melanospheric microstructure, X50 (Stearn, 2011b).
Fig. 472. Parallelostromatidae (p. 819–820).
Fig. 473. Parallelostromatidae (p. 820).
Fig. 474. Stachyoditidae (p. 824).
Family STACHYODITIDAE

Khromykh, 1967

Syringostromida of almost exclusively dendroid growth form with structure of prominent pachysteles separated by allotubes and microlaminae. Microstructure obscurely microreticulate. Lower Devonian (?Lochkovian), Middle Devonian (Eifelian)–Upper Devonian (Frasnian, ?Famennian).

Stachyodes Bargatzky, 1881b, p. 688, non Wright & Studer, 1889, p. 55, an alyconarian according to Mistaen (1985, p. 192) and non oblitum [*S. ramosa Bargatzky, 1881b, p. 691; OD; holotype specimen lost; synonymized by Nicholson, 1886a, p. 107, with Sromatopora verticillata McCoy, 1850, p. 377, type specimen at Cambridge University, apparently lost] [*Sphaerostroma Gürich, 1896, p. 127 (type. S. exiguum Gürich, 1896, p. 128, OD); =Stachyodella Delage & Hérouard, 1901, p. 162, see Mistaen, 1985, p. 192 for discussion of synonymy; =Keega Wright, 1901, p. 18 (type, K. austale, OD), see Riding, 1974b, for discussion of synonymy.] Growth form in most species dendroid, rarely laminar or combination of laminar growing into erect branches: with axial canal, or canals, crossed by tabulae. Smaller canals and pachysteles separated by allotubes radiating upward and outward to periphery in dendroid forms. Structure defined by canals, allotubes, and autotubes cut in axial parts of transverse sections as round and irregular voids and at periphery as irregular radial canals opening at margin (and covered in best-preserved specimens by an enveloping, thin, skeletal sheath). Peripheral allotubes separating irregular, radial pachysteles. Structure traversed by dark microlaminae parallel to successive growth surfaces, forming concentric rings only in peripheral zone of transverse sections, and parabolas in longitudinal sections. Structural elements thick, occupying most of the skeleton, microreticulate in well-preserved specimens, and more commonly appearing striated, with vacuoles in some species, commonly recrystallized to diagenetic fibrous microstructures. [Stachyodes differs from most stromatoporoid genera in the consistency of its dendroid growth form, its central canal exiting at the top, its lack of stromhizae, the peripheral membrane in well-preserved specimens, and the obscure but striated nature of its microstructure. The last of these suggests that it may be a non-stromatoporoid sponge with poorly preserved spicules. Further study of the specimen described by da Silva and others (2014) should determine whether it could be assigned to Stachyodes. In the absence of both possible type specimens, most research workers have accepted Nicholson’s interpretation that S. ramosa and S. verticillata are the same species and have recognized the genus on the basis of his descriptions and illustrations.] Lower Devonian (?Lochkovian), Middle Devonian (Eifelian)–Upper Devonian (Frasnian, ?Famennian): Australia (New South Wales), ?Lochkovian; Afghanistan, Kara-Kalpak, China (Guangxi, Sichuan, Hunan), England (Devon), Germany (Eifel), Russia (Kuznetsk Basin, Pechora Basin, Urals, Pre-Urals), Uzbekistan, Middle Devonian; Belgium (Ardennes), Tien Shan, China (Qinghai), Germany (Sauerland), Russia (Kuznetsk Basin), Vietnam, Eifelian; Afghanistan, Australia (Canning Basin, Queensland), Belgium (Ardennes), Canada (Alberta, British Columbia, Manitoba), China (Guangxi, Guizhou, southern Qinghai), Czech Republic (Moravia), Germany (Eifel), Russia (Kuznetsk Basin), Thailand, USA (Missouri), Givetian; Afghanistan, Australia (Canning Basin, Queensland), Belgium (Ardennes), Canada (Alberta, Saskatchewan), Tien Shan, Zeravshan Ridge, China (Guangxi, Guizhou, Yunnan), Czech Republic (Bohemia), France (Bouloannais), Germany (Rhineland), Iran (Kerman), Poland (Holy Cross Mountains), Russia (northeastern Siberia, Pechora Basin, Timan), USA (Iowa, Missouri), Vietnam, Famennian; Russia (western Pre-Urals), Famennian.——

Order AMPHIPORIDA

Rukhin, 1938

Stromatoporoids of dominantly dendroid form composed of compact to fibrous, single layered skeletal elements, commonly arranged in irregular amalgamate networks but also in pillars radiating upward and outward from growth axis, with or without axial canals, obscure laminae, and peripheral sheaths enclosing skeleton. ?middle Silurian, upper Silurian (Ludlow)–Upper Devonian (upper Famennian).

Family AMPHIPORIDAE Rukhin, 1938
[Amphiporidae Rukhin, 1938, p. 90]

Diagnosis as for order. ?middle Silurian, upper Silurian (Ludlow)–Upper Devonian (upper Famennian).

Amphipora Schultz, 1883, p. 245 [*Caunopora ramosa Phillips, 1841, p. 19, SD Stearn, 1997c, p. 839; holotype lost, neotype, NHM. P0308, sections A1 to A6] [*Haraamphipora Rukhin, 1938, p. 93 (type, H. pachyroides, OD); =Vicinostachyodes Yavorsky, 1961, p. 56 (type, V. mirabilis, OD); =Vicinostachyodes
genera listed above.] Skeleton dendroid, branching dichotomously, with axial canal locally absent, locally with well-defined wall, locally poorly defined, opening into interskeletal network of voids and irregular canals by pores. Skeletal network formed by pillars radiating upward and outward obliquely from axis, and short elements extending from and joining them to form an irregular structure that may, in transverse sections, define open or closed spaces. Peripheral sheaths sporadically developed in most species, as an imperforate, thin, skeletal wall supported beyond skeletal network by extensions of skeletal elements. Microstructure compact, fibrous. [The plethora of Middle and Upper Devonian occurrences and published species make the listing of their distribution impractical here.]

*Clathrodictyella* Bogo Yavlen Sk a Ya, 1965a, p. 42 [*Amphipora turkestanica Lessovaia, 1962, p. 117; OD; holotype, GMU 46/489]. Similar to *Amphipora* in axial canal and peripheral sheaths, but in axial section, structural elements are gently arched, crumpled laminae or cysts, arranged in parabolic series transverse to axial canal. *Silurian* (Ludlow): Russia (eastern Urals), Uzbekistan (Tien Shan).——Fig. 476a–b. *A. ramosa* (Phillips), neotype, NHM. P0308, Chercombe Bridge Limestone, near Newton Abbott, Devon, England; a–b, two sections through neotype suite, ×2.5; c–d, two transverse sections across neotype stem showing variations in skeletal network and central canal, ×10 (Stearn, 2011b).——Fig. 476a–b. *A. ramosa* (Phillips), neotype, NHM. P0308, Chercombe Bridge Limestone, near Newton Abbott, Devon, England; a, longitudinal section from neotype suite showing axial canal, pillars, and peripheral sheath on only one side, ×10; b, axial to tangential section of stem from neoparatype, NHM. P0310, showing peripheral sheaths and well-developed pillars, ×10 (Stearn, 2011b).

*Clathrodictyella* Bogo Yavlen Sk a Ya, 1965a, p. 42 [*Amphipora turkestanica Lessovaia, 1962, p. 117; OD; holotype, GMU 46/489]. Similar to *Amphipora* in axial canal and peripheral sheaths, but in axial section, structural elements are gently arched, crumpled laminae or cysts, arranged in parabolic series transverse to axial canal. *Silurian* (Ludlow): Russia (eastern Urals), Uzbekistan (Tien Shan).——Fig. 477a–b. *C. turkestanica* (Lessovaia), holotype, GMU 46/489, Bankovy horizon, eastern slope of Urals, axial and transverse sections, ×10 (Stearn, 2011b).

*Euryamphipora* Klovan, 1966, p. 14 [*E. platyformis; OD; holotype, GSC 19834] [=*Solidostroma* KhromYKh, 1974a, p. 30 (type, *S. congesta*, OD)]. Growth form tabular, plate like; structure amalgamate in longitudinal section, with peripheral sheaths, may have long pillars evident in sections parallel to plate axes. [Klovan (1966) and Mistaen
Amphiporida—Amphiporidae

(1985) described the genus as growing as a horizontal plate; Cockbain (1984) reconstructed the skeleton as a vertical plate. Middle Devonian (Givetian)—Upper Devonian (Frasnian): Australia (Queensland), France (Boulonnais), Givetian; Afghanistan, Australia (West Australia), Canada (Alberta, Saskatchewan), Frasnian.—Fig. 478a–b. *E. platyformis*, holotype, GSC 19834, Leduc Formation, Redwater Field, Alberta, Canada; a, longitudinal section showing laminar growth form, ×5; b, longitudinal section showing amalgamate appearance and flexing of skeleton, ×10 (Stearn, 2011b).—Fig. 479a–b. *E. platyformis*, holotype, GSC 19834, Leduc Formation, Redwater Field, Alberta, Canada; a, longitudinal section showing peripheral sheaths, ×10; b, tangential section showing pillars at edge of skeleton and amalgamate structure, ×10 (Stearn, 2011b).

Novitella Bogoyavlenskaya in Bogoyavlenskaya & Dan’Shina, 1984, p. 22 [*Paramphipora tchussovensis* Yavorsky, 1955, p. 159; OD; holotype, CNIGR 7351/136]. Similar to Amphipora but with prominent, gently arched laminae in axial sections. Upper Devonian (Frasnian): Russia (Tsaritsin, now Volgograd region, eastern and western Urals).—Fig. 480a–b. *N. tchussovensis*
Porifera—Hypercalcified Sponges

**Fig. 478. Amphiporidae (p. 826–827).**

*Euryamphipora*
Order & Family Uncertain

**Paramphipora** Yavorsky, 1955, p. 154 [*P. mirabilis*; OD; holotype, CNIGR 7351/236] [=Vacuustroma Nguyen Hung & Mistiaen, 1997, p. 193 (type, V. michelini Nguyen Hung & Mistiaen, 1997, p. 198, OD)]. Similar to *Amphipora* in structure but with skeletal elements of vacuolate microstructure without central axis. [Although several writers (Klovan, 1966; Stearn, 1966, 1997c; Flügel & Flügel-Kahler, 1968; Cockbain, 1984; Mistiaen, 1988) have questioned the validity of Yavorsky’s genus because it was based on the absence of an axial dark line in the skeletal elements that they considered subject to diagenesis, Yavorsky insisted (1968, 1969a, 1971) that it was equally distinguished by vacuolate microstructure. Since the only characters separating both *Paramphipora* and *Vacuustroma* from *Amphipora* are the lack of the axial line and the presence of vacuoles, the latter (Vacuustroma) is listed as a junior synonym here. Nearly all the more than 60 species that have been ascribed to *Paramphipora* are found in Russia and China only. Because the diagnoses and types of these species have not been individually examined to see whether they conform to Yavorsky’s definition, the list of occurrences is based on the original generic assignments and should be regarded as tentative.]

**ORDER AND FAMILY UNCERTAIN**

**Clavidictyon** SugiYama, 1939, p. 441 [*C. columnare*; OD; holotype, Tôhoku University, Sendai, 60,813]. Columnar, without axial canal, amalgamate in axial zone but with well-defined laminae and short pillars confined to interlaminar space in peripheral zone. Compact microstructure. [Some characteristics suggest affinity to the clathrodictyids, others to the amphiporids.] middle Silurian–Upper Devonian (upper Famennian): Japan, middle Silurian; USA
Porifera—Hypercalcified Sponges

(Michigan), **Middle Devonian**; China (Guangxi), **upper Famennian**.——**Fig. 482a–c.** C. columnare, holotype, 60,813, middle Silurian, Hikoro-it-mura, Japan; a, longitudinal sections, from type slide, ×6; b, transverse section, showing few laminae, ×10; c, transverse section showing well-defined laminae, ×10 (Stearn, 2011b).

**Eostachyodes** Dong & Wang, 1982, p. 28 [*E. compacta; OD; holotype, NIGP 61351–61352*]. Columnar growth form, without axial canal, structural elements in axial zone completely amalgamate, peripheral zone with pachyiste-like elements; microstructure fibrous or melanospheric. [Dong and Wang (1982) placed the genus in the Idiostromatidae. Dong (1988) placed it in the Stachydi-tidae. It differs from *Stachyodes* in lacking an axial canal, the extreme difference between axial and peripheral parts of the skeleton, and in its microstructure.] **Middle Devonian:** China (Yunnan).——**Fig. 483, 1a–b.** *E. compacta*, holotype, NIGP61351-52, Gumu Formation, Wenshan, longitudinal and transverse sections, ×5 (Dong, 2001).

**Lamellistroma** BogoyavlenSKaYa, 1977b, p. 17 [*L. lamelliferum* BogoyavlenSKaYa, 1977b, p. 18; OD; holotype, SOAN 1089/101]. Thin, compact pillars and laminae forming regular, closely spaced grid. Pillars round in tangential section. [BogoyavlenSKaYa (1977b) placed this genus in the family Densastromatidae, but Stearn (1980) placed it in synonymy with *Actinostroma*. Other possibilities are *Coenostroma*, *Gerronostroma*, or *Densastroma*.] **Lower Devonian (Lochkovian)–Middle Devonian (Eifelian)**: Russia (eastern Urals), Lochkovian; Russia (eastern trans-Urals), Pragian–Emsian; Russia (eastern Urals), Eifelian.——**Fig. 483, 2a–h.** *L. lamelliferum*, holotype, 1089/101, Tal’tiskii horizon, Eifelian, River Saumy, eastern slope of Urals, Russia, longitudinal and tangential sections, ×10 (Stearn, 2011b).

**Paschkoviella** Kosareva, 1979, p. 43 [*P. aequicrassa; OD; holotype, location of type specimen uncertain*. Spool-shaped pillars, superposed, and extensive laminae, locally with axial light zone. Microstructure finely porous. **Middle Devonian** (Eifelian):
Russia (River Zolotukha).——Fig. 483.3a–b. *P. aequicrassa*; holotype, longitudinal and tangential sections, ×10 (Kosareva, 1979).

**Perplexostroma** BOGOVLENSKAYA, 1981, p. 32 [*Stromatopora dvenigorodensis* RIABININ, 1953, p. 51; OD; VNIIGRI 153]. Pillars long, sinuous, anastomosing; tangential elements largely dissepiments. [This genus is probably synonymous with *Vikingia* on the basis that the type species *S. dvenigorodensis* RIABININ is a species of *Vikingia* comparable to *V. tenuis* (NESTOR), and the specimens illustrated by BOGOVLENSKAYA (1981, pl. 23.2, pl. 24.1) are not conspecific with the designated type species.] Silurian (Ludlow–Pridoli): Ukraine (Podolia).——Fig. 484.1a–b. *P. dvenigorodense* (RIABININ), holotype, VNIIGRI 153, lower Ludlow, River Dnieper, longitudinal and tangential sections, ×10 (Riabinin, 1953).

**Praeidiostroma** BOGOVLENSKAYA, 1971a, p. 108 [*P. praecox*; OD; holotype, SOAN 38a/982]. Dendroid growth form with axial canal branching into smaller canals. Pillars and laminae thin, long, apparently compact. [The type species appears to be a dendroid form of *Gerronostroma* with an axial canal.] Silurian (Ludlow–Pridoli): Russia (eastern slope of Urals).——Fig. 485.1a–b. *P. praecox*, holotype, 38a/982, axial and transverse sections, ×10 (Stearn, 2011b).

**Pseudoactinostroma** LESCOVAJ, 1970, p. 81 [*P. hamidulense* LESCOVAJ, 1970, p. 82; OD; holotype, GMU 13/493]. Pillars confined to interlaminar space, compact, branching and joining, locally forming intermediate laminae; laminae extensive, widely spaced, formed of collocluli from pillars, making hexactinellid network in tangential section. [The laminae are much like those of an actinostomatid.] Middle Devonian (Eifelian); Central Asia (Zeravshan Mountains).——Fig. 484.2a–b. *P. hamidulense*, holotype, 38a/982, longitudinal and tangential sections, ×10 (Stearn, 2011b).

**?Pseudostromatopora** DONG, 1991, p. 70 [*P. yushuensis* DONG, 1991, p. 71; OD; holotype, NIGP 91933]. Structure irregular of dominant pachystele, locally forming amalgamate network, cut as isolated masses of irregular outline in tangential section, separated by allotubes, cellular to diffuse in microstructure; tangential elements largely dissepiments. [The genus is a homonym of *Pseudostromatopora* SIMIONESCU, 1926, a bryozoan, and requires a new name.] Middle Devonian–Upper Devonian: China (Qinghai, Tibet).——Fig.
Porifera—Hypercalcified Sponges

Fig. 482. Uncertain (p. 829–830).
Figu 483. Uncertain (p. 830–831).
Fig. 484. Uncertain (p. 831).
Order & Family Uncertain

Fig. 485. Uncertain (p. 831–836).
485,2a–b. *P. yushuensis*, holotype, 91933ab, Xiongqin Formation, southern Qinghai, China, longitudinal and tangential sections, ×10 (Dong, 2001).

**Taymyrostroma** Khromykh, 2001, p. 13 [*T. taymyrensis*; OD; holotype, TsGM 2022/4]. Laminae thin, compact, single layer, extensive; longitudinal structural elements (possibly pillars) highly irregular, confined to interlaminar space, rarely extending directly across interlaminar space, forming a tangled mass in longitudinal section; thin, compact, in tangential section forming an irregular, fine meshwork enclosing rounded galleries; astrorhizae well developed, superposed.

[Although placed in the Lophiostromatidae by Khromykh (2001), this genus is unlike the other genera in the family or any other late Ordovician stromatoporoid in its complex pillar structure between extensive thin laminae. In these features, it shows convergence with such younger genera such as *Intexodictyides* and *Atelodictyon.*]

Upper Ordovician (Katian): Russia (Taimyr Peninsula).——Fig. 485,3a–b. *T. taymyrensis*, holotype, CSGM 2022/4, left bank of Parnaya River, Siberia, Burskii horizon, Nyun’skaya Subformation; a, longitudinal section, ×10; b, tangential section, ×10 (Khromykh, 2001).
CLASS UNCERTAIN, ORDER PULCHRILAMINIDA: SYSTEMATIC DESCRIPTIONS

B. D. Webby

Class UNCERTAIN
Order PULCHRILAMINIDA
Webby, 2012

Large, laminar, domical to columnar skeleton represented by thin latilaminae of mainly calcite spar–replaced skeletal elements that intercalate with mudrock layers; internally main skeletal elements preserved as erect, slender, upwardly tapering, spinose rods (walled but with spar-replaced centers); typically extending from tops of latilaminae into overlying mudrock layers; weakly developed meshworks also preserved in localized areas where rods combine with undulating rows of long, low cysts, or sometimes latilaminae exhibit intermingling wispy, threadlike elements; no astrorhizae known. Lower Ordovician (upper Tremadocian)–Middle Ordovician (lower Darriwilian).

This small group of large, hypercalcified, frame-building organisms occupies an important place in the development of Lower Ordovician–Middle Ordovician reefs in North America, the Argentinian Precordillera, and southern China (Webby, 2002; Adachi, Liu, & Ezaki, 2011), but its affinities remain to be fully evaluated. The group has no apparent links with Cambrian hypercalcified sponges, but in exhibiting skeletons of large size, frayed lateral margins, and well-developed latilaminae, it shares certain resemblances with the nonspiculate Ordovician–Devonian labechiid stromatoporoids (and other stromatoporoids). The pulchrilaminids, however, differ morphologically in having a more loosely aggregated meshwork of skeletal elements, including slender, upwardly tapering, spinose rods that are spiculelike and may represent diagenetically altered styles. They therefore seem best regarded as a separate, independent group of hypercalcified sponges. Relationships with known spiculate sponge groups remain uncertain. Previously the family Pulchrilaminidae Webby, 1993, was doubtfully incorporated in the order Labchiida (Webby, 1993, 1994, 2004b; Webby in Stearn & others, 1999) but is excluded herein.

Bogoyavlenskaya (2001a, p. 46), adopted a different approach in introducing the order Protolabchiida to accommodate members of three families: the Lophiostomatidae Nestor, 1966a, Stratodictyidae Bogoyavlenskaya, 1977a, and Pulchrilaminidae Webby, 1993. But this is a heterogeneous grouping that bears little relation to the key morphological features of both pulchrilaminids and the other families. In this Treatise volume, the families Lophiostomatidae and Stratodictyidae are maintained as parts of the order Labchiida (see p. 709–754). Bogoyavlenskaya’s family Stratodictyidae is recognized as a part of the family Labchiidae Nicholson, 1879b (based on genus Stratodictyon Webby, 1969), and a part of the family Rosenellidae Yavorsky in Khablina & Yavorsky, 1973 (based on genus Pseudostylodictyon Ozaki, 1938, and its junior synonym Parksodictyon Bogoyavlenskaya in Bogoyavlenskaya & Lobanov, 1990), of the Labchiida. None of the characters used by Bogoyavlenskaya (2001a) to define the order Protolabchiida is diagnostic specifically of that order (for English translation of Bogoyavlenskaya’s [2001a] diagnosis of order Protolabchiida, provided by Heldur Nestor, see p. 710). All listed morphological characters are present also in representatives of the order Labchiida. Consequently, the Protolabchiida is regarded in part as a junior
WeBBy, 1993

synonym of the Labechiida. However, the family Pulchrilaminidae has fundamentally different diagnostic characters and must be separated from labechiids, including Bogoyavlenskaya’s two other protolabechiid families. The uniquely pulchrilaminid features are: (1) long, slender, spinose, spiculelike rods (usually erect but sometimes tilted) that characteristically protrude above tops of latilaminae into overlying mudrock, or more randomly spaced, oblique-to-erect threadlike elements; and (2) may, in localized areas (usually upper parts of latilaminae), combine in loosely aggregated meshworks with rows of finer, undulating cyst plates.

Family PULCHRILAMINIDAE

Webby, 1993

[ Pulchrilaminidae Wozni, 1993, p. 58 

Characters as for order. [The pulchrilaminid skeleton is distinguished by its large size (commonly up to 300 mm in width and 500 mm in height), thin latilaminae, and mainly erect (in a few places tilted), slender, upwardly tapering, spinose (spiculelike) rods. The latilaminae vary from 0.1 to 3.0 mm in thickness and are characteristically bounded by growth interruptions, probably mainly caused by regular, episodic sedimentation events, resulting in the intercalated mudrock layers. The latilaminae are commonly frayed at lateral margins to give a markedly ragged appearance to the skeleton. Even the thinnest latilaminae (0.1–0.2 mm thick) were able to support the bases of long, slender, tapering, spinose rods in upright orientations, and they extend into overlying layers of mudrock (maintaining their orientation in the mud to a height of at least 0.5 mm) without much evidence of visible support (apart from a few wispy films of broken or incomplete cyst plates). Cyst plates generally are not well preserved in the Pulchrilamina skeleton, mainly occurring in localized areas near tops of latilaminae as rows of fine, closely spaced, undulating, platelike elements forming meshworks with the slender, upright, spinose rods. Only a few examples of rods tilted out of parallel alignments suggest that the overall structural meshwork of rods and cysts was rather weakly developed, with the cyst plates providing very limited support, unlike the larger, more compact and rigid skeletal frameworks of labechiid stromatoporoids. The intermingling, threadlike elements in some growth layers of Zondarella resemble the slender threads of a possible unnamed cyanobacterium (or possibly alga) that intergrew with the labechiid stromatoporoid Cystostroma in the Upper Ordovician Gordon Group, Tasmania (Webby, 1991, fig. 10a–c), which raises the possibility that Zondarella may have sometimes developed as an intergrowth of pulchrilaminid and cyanobacterial crusts. Ianilamina is another problematic genus that exhibits slender threadlike strands but differs in developing porous laminae. Lower Ordovician (upper Tremadocian–Middle Ordovician (lower Darriwilian).

Pulchrilamina Toomey & Ham, 1967, p. 983 [*P. spinosa Toomey & Ham, 1967, p. 983, pl. 128,1–4; M; holotype, thin section, U.S. National Museum, Washington, no. USNM 155300, remains unfigured; three paratypes, USNM no. 155303, 155304, 155315, all longitudinal sections, have been figured (Toomey & Ham, 1967, pl. 128,1–4). Large, strongly latilaminate, laminar, domical-to-columnar skeleton; latilaminae commonly frayed or frayed toward lateral margins, bounded top and bottom by growth interruptions, and alternating between wedges of mudrock; internally exhibit upwardly tapering long, slender, spinose (spiculelike) rods, characteristically protruding beyond tops of latilaminae into overlying mudrock; a few may be tilted out of an orderly, subparallel alignment; also, more localized rows of long, thin, low, undulating cyst plates may be preserved, forming meshworks in combination with the rodlike elements, but these appear, in a few places, to be rather loosely aggregated with some cyst plates not entirely fused to rods; in most areas, latilaminae are mainly replaced by spar, including crystalline calcite mosaics; no astrophizate have been confirmed. Lower Ordovician (upper Tremadocian–Floian); Canada (Newfoundland), United States (Texas, Oklahoma), southern China (Guizhou, Hubei, Anhui).—Fig. 486a–c. *P. spinosa; El Paso Group, McKelligon Canyon Formation, southern Franklin Mountains, western Texas, and Arbuckle Group, Kindblade Formation, Oklahoma; field photographs of outcrops showing growth form of skeletons; a, photograph of part of a reef mound, Kindblade Formation, dipping at 45° N, with exposure of individually
large *Pulchrilamina* skeletal mounds that exhibit a columnar shape and lateral margins that sometimes have a ragged appearance, but in other places have apparently been cut by narrow erosion channels and infilled by calcarenite deposits; structures exposed along Interstate Highway 35, southern Arbuckle Mountains, Oklahoma, ×0.24 (Webby, 2012a); *b*, more detailed characteristics of domical *Pulchrilamina* skeleton showing distinctive, slightly undulating laminae that appear to individually taper toward lateral margins of specimen (see area at lower left); exposed in reef mound, main biohermal interval, McKelligon Canyon Formation, southern Franklin Mountains, ×0.46 (Webby, 2012a); *c*, part...
Fig. 487. Pulchrilaminidae (p. 838–841).
of domical *Pulchrilamina* skeleton, laminae (see area at lower left) on lateral margin appearing to be sharply truncated by an erosion channel; main biothermal interval, McKelligon Canyon Formation, southern Franklin Mountains, 10x0.33 (for additional locality details, see TOOMEY & BARCOCK, 1983, p. 51–91, Stop 2) (Webby, 2012a).—Fig. 487a–h. *P. spinosa*, thin sections of type and other specimens; a, paratype, USNM 155315, ~137 m above base of Kindblade Formation, Mill Creek section, Arbuckle Mountains, Murray County, Oklahoma, thin, lowermost, spar-filled latilamina and vertical spinose rods, continuous through a dark, mudrock inclusion into much thicker, overlying latilamina (completely replaced by mosaic calcite), x20 (TOOMEY & Ham, 1967, pl. 128,4); b, paratype, USNM 155304, main mound section, lower part, McKelligon Canyon Formation, southern Franklin Mountains, western Texas, completely recrystallized main latilamina, and irregularly distributed, vertical, slightly tapering—completely recrystallized main latilamina, and vertical spinose rods, continuous through a dark, mudrock inclusion into much thicker, overlying latilamina, (right center of photo), and a second mudrock inclusion into mudrock, x30 (TOOMEY & Ham, 1967, pl. 128,3); c, longitudinal section of specimen, MC-38-MB, D. V. LeMone collection, University of Texas, El Paso, McKelligon Canyon Formation, southern Franklin Mountains, divergent spinose rods, suggesting they formed in a loosely aggregated skeleton of weakly developed, very fine horizontal elements, unlike labechiid structures, x20 (Webby, 1986, fig. 4B; reproduced with the permission of Oxford University Press: “Problematic Fossil Taxa,” 1986, edited by A. Hoffman & M. H. Nitecki, p. 153, fig. 3E); e, longitudinal section of unnumbered specimen, mound horizon and locality as view b, enlarged longitudinal section of unnumbered specimen from same locality and horizon as view e, showing greater detail of meshwork of vertical rods (spar-replaced but not wall-less vertical structures) and undulating horizontal rows of variably sized cyst plates, from tiny vesicles to more moderately sized, elongate, low-convexity structures, x80 (TOOMEY & NITECKI, 1979, fig. 13a; reproduced with permission of the Managing Editor of Fieldiana, Harold Voris, Field Museum of Natural History, Chicago).—Fig. 488a–h. *I. kirkupensis* PICKETT & ZHEN in ZHEN & PICKETT, 2008, p. 63 [*I. kirkupensis* PICKETT & ZHEN in ZHEN & PICKETT, 2008, p. 64, fig. 5A–11]; h, longitudinal section of specimen, MMF44876, and MMF 44879; eight thin sections]. Skeleton laminar to broadly domical in shape, and composed of successive, comparatively thin latilaminae (incremental units) that are discontinuous laterally and subdivided into a lower part of thicker, poorly differentiated, vaguely meshwork-like areas of threadlike strands, flocculent structures and calcite spar replacement textures, and an upper part defined by a very thin, darker, densely porous lamina. In addition, succession of latilaminae may be interrupted by darker mudrock layers, lighter-colored spar-filled cavities and encrustations of organisms like cyanobacteria, sponges, and bryozoans. [The presence of porous laminae is not characteristic of other pulchrilaminid genera; therefore, the genus is only doubtfully referred to the group. Other features of *Ianilamina* are similar to *Zondarella*; however, *Zondarella* shows a few traces of very fine, rounded, dotlike shapes suggestive of spinose rods, but these still require to be positively confirmed; see further discussion of *Ianilamina* in PICKETT and ZHEN (in ZHEN & PICKETT, 2008, p. 64, 66)]. Middle Ordovician (lower Darriwilian): Australia (New South Wales).—Fig. 488a–f. *I. kirkupensis*; limestone lens from base of Goonumbla Volcanics, Kirkup property, near Gunningbland, central New South Wales; a–c, paratype MMF 44875a, longitudinal section showing different enlargements of the same thin section; a, general view of domical skeleton with extensive, thin latilaminae that encrusts an anaspispidellid sponge (lower right). x1.2 (ZHEN & Pickett, 2008, fig. 5B); b, enlarged view of upper right part of view a showing successive latilaminae with a mainly dark flocculent appearance, except where capped by even darker, crustlike laminae and in an area near the middle where latilaminae have been largely replaced by lighter sparry calcite infills, x6.8 (ZHEN & Pickett, 2008, fig. 5E); c, detailed view of small area in upper left part of view b showing regular latilaminar elements but may
have only limited lateral continuity, as shown by a number of terminations where an upper lamina curves downward to meet an underlying lamina abruptly; each crustlike lamina commonly exhibits a row of very small disruptions that represent pores; vaguely threadlike strands are only shown in a few small areas within latilaminae, whereas irregular, elongated areas with sparry calcite replacements are more common, ×16.7 (Webby, 2012a); d, oblique-tangential section of paratype MMF 44875b through a latilamina showing porous laminae along latilaminae boundaries and threadlike to vaguely cellular elements within the body of central latilaminar unit, ×8 (Zhen & Pickett, 2008, fig. 5F); e, tangential section of holotype MMF 29887b, illustrating details of the pores within a
single lamina, ×40 (Zhen & Pickett, 2008, fig. 5); f, longitudinal view of paratype MMF 44876 showing two small encrusting, rounded to irregular possible bryozoan colonies that grew above a dark mudrock sliver between underlying and overlying latilaminae of Ianilamina, ×10 (Zhen & Pickett, 2008, fig. 5G).

**Zondarella** Keller & Flügel, 1996, p. 188 [*Z. communis* Keller & Flügel, 1996, p. 188, pl. 47,1,7,9; pl. 48,1–3; M; Institute of Paleontology, University of Erlangen, Germany, no. RA 641; no illustrations of types or other material have yet been illustrated in tangential section].

Large, mainly domical to laminar skeleton characteristically composed of stacked, sheetlike growth layers, in places simulating latilaminae; both irregularly undulating, horizontal dark laminae, sometimes recognizable as less continuous discrete, elongated low convexity cyst plates or less continuous horizontal, spaced-out rows of colliculi-like rods, and more localized, randomly spaced, intermingling, oblique-to-vertical, thread-like elements (possibly rods) may occur and may alternate with bands filled with calcite spar and/or darker mudrock matrix. [Photos of tangential sections of specimens of *Z. communis* from the type locality (kindly provided courtesy of Marcelo Carrera, Córdoba, Argentina in 1999, 2008) show a pattern of very fine, rounded, dotlike shapes representing probable rods. Compared with the dotlike appearance of spinose rods in *Pulchrilamina spinosa* (see tangential section; Fig. 2f), these are much finer (about half the diameter), and they are more closely spaced]. *Middle*
**Porifera—Hypercalcified Sponges**

Ordovician (Dapingian): Argentina (Precordillera), Canada (?Newfoundland).——Fig. 489a–d.

*Z. communis;* upper San Juan Formation, Las Lajas section, 24 km southwest of San Juan, Argentine Precordillera; a, holotype, longitudinal section, showing nature of latilaminate growth layers and a number of intercalations of dark layers composed of sedimentary matrix, ×3.5 (Keller & Flügel, 1996, pl. 47, 7); b, holotype, longitudinal section, contrasting zones of horizontal laminar and intermingling, oblique-to-vertical skeletal features in lower to middle parts, and zones of largely coarse, recrystallized sparite and fine matrix in the upper part, ×8.5 (Keller & Flügel, 1996, pl. 47, 9); c, holotype, longitudinal section, showing more continuous dark lines bounding latilaminae, and incomplete, slightly undulating laminae that are interrupted by a few short vertical elements (small arrowheads) within the latilaminae, ×16 (Keller & Flügel, 1996, pl. 48, 1); d, longitudinal section, specimen no. RA 542, *Z. communis*, Los Berros section, San Juan Formation; darker bands showing well-defined, elongated, low-convexity cyst plates, ×16 (Keller & Flügel, 1996, pl. 47, 2).

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