**Appendix: Systematics and description of common NPP in sediments**

DOMAIN BACTERIA

Division Cyanophyta/ Cyanobacteria

Class Cyanophyceae

Order Chroococcales

*Microcystis:* Unicells are spherical to hemispherical and are typically ~5 µm in diameter, forming irregular-shaped colonies, with scattered cells that can be densely, or irregular arranged. Colonies can be surrounded by mucilage and often surrounded by amorphous organic matter. Can appear blue green in colour, sometimes brown due to pigments present and gas vesicles. This freshwater ‘blue-green alga’ can be planktonic, benthic, epiphytic, periphytic, and is found in nearly all environments, but most abundant in eutrophic to hypereutrophic waters. Fig. 3a

Order Nostocales

*Anabaena*: chains, usually curved or irregularly coiled, comprised of vegetative cells (~5 µm), ranging from spherical to ellipsoidal, occasionally reniform. Heterocysts are spherical to ovoid and ~5 µm in diameter, and thus rarely seen in palynological preparations that almost invariably involve sieving with mesh sizes larger than this. Akinetes that are more ovoid, typically ~6-10 µm, and can be pale to bright blue-green and even yellow in colour. This cosmopolitan genus is mostly benthic, can also be epiphytic and epiphytic, and known to produce harmful toxins. Akinetes preserve better than other cells and are more common in slides, commonly found separated from the filamentous chain, either individually or grouped in a cluster. Fig. 3d

*Aphanizomenon*: bundled filaments (fascicles) up to 2cm in length, colonies of cylindrical, slightly curved and or coiled trichomes. Vegetative cells and heterocysts are rarely spherical, generally barrel to cylindrical in shape, akinetes are similar shape with an elongated structure and rounded ends. Trichomes with akinetes are commonly preserved, typically ~5-10 µm in diameter with varying length. Most species are planktonic, some benthic, and they are typically found in both shallow and deep eutrophic waters. Known to be associated with harmful algal blooms. Fig. 3c

*Nostoc*: chains consisting vegetative unicells (spherical, ~5 µm diameter) that are typically coiled and form dense clusters. Colony typically surrounded by mucilage, and cells can be pale to bright blue, and olive green. Akinetes (spherical, rarely cylindrical, ~8-10 µm) develop under harsh conditions, form large spherical to flat colonies and gelatinous mats that are visible to the human eye. This possibly polyphyletic cosmopolitan genus is mainly benthic and can grow on most substrates and is known to be endophytic with some fungal and plant taxa.

DOMAIN EUKARYOTA

Division Charophyta

Class Chlorophyceae

Order [Sphaeropleales](https://www.bing.com/search?q=Sphaeropleales&filters=ufn%3a%22Sphaeropleales%22+sid%3a%220a69ab4d-15e4-05d9-09b9-28a6762d09e4%22&FORM=SNAPST)

*Coelastrum*: colonial, spherical-ovoid algae, with unicells arranged in a 4-8-16-32-(64) celled pattern. Unicells can be spherical, flower-like to polygonal in shape, and interconnected with mucilaginous protuberances. Coenobia range from 20-100 µm in size and can exhibit ornamentation but lack processes or sharp spines. This planktonic, cosmopolitan genus is usually found in eutrophic – hypereutrophic fresh water (Jankovská and Komárek 2000). Fig. 3g

*Pediastrum*: colonial green algae composed of unicells that are arranged in a plate-like layer and radiating from the centre, often forming a distinctive “star-like” shape. A coenobium contains at least 4 unicells, increasing by a multiple of 2 to a maximum of 128 unicells, and coenobia range in size from ~15 to 400 µm. Differences in morphology (shape, size and ornamentation of individual cells and coenobium) allow identification to species. *Pediastrum* is a cosmopolitan planktonic, non-motile genus, commonly found in nutrient-rich waters, but some species (e.g., *P. integrum*) are characteristic of oligotrophic environments. Fig. 3f

*Scenedesmus*: flattened and linear coenobia, with unicells arranged in 2-4-8-16-32 cell pattern joined to each other in a “chain-like” manner. Unicells can be ovoid, ellipsoidal, or crescent shape and coenobia can exceed 50 µm in length. This freshwater genus is planktonic and cosmopolitan, and one of the most reported green algae worldwide. Fig. 3h

Tetraëdron; solitary cells typically ~10-15 µm in size and triangular or pyramidal in shape. Cells are symmetrical and have three to five (usually four) angles and have a “nipple-like” process on the end of each point. This planktonic and cosmopolitan genus is common in temperate freshwater lakes and ponds. Fig. 3i,j

Class Trebouxiaceae

Order [Chlorellalesales](https://www.bing.com/search?q=Trebouxiales&filters=ufn%3a%22Trebouxiales%22+sid%3a%22ccd4895a-9c81-0663-634e-034b94972392%22&FORM=SNAPST)

*Acanthosphaera* spp.: solitary, spherical unicells typically ~10–15 µm in size with long slender spines that have a thickened basal section and narrow end, giving the cells a “star-like” shape. Spines can range from ~20–70 µm in length but tend to break off, so long spines are rarely observed in palynological preparations. This planktonic and found mostly in temperate freshwater environments Fig. 3k

Order [Trebouxiales](https://www.bing.com/search?q=Trebouxiales&filters=ufn%3a%22Trebouxiales%22+sid%3a%22ccd4895a-9c81-0663-634e-034b94972392%22&FORM=SNAPST)

*Botryococcus*: colonial genus with unicells that are densely packed and basic and arranged more-or-less radially. Colonies can reach up to 1mm in diameter and have indistinct “blob-like” shapes but high relief due to high lipid content. Unicells are ovoid to spherical in shape but are conically tapered toward the center of the colony. Colonies can be attached to each other via mucilaginous strands. This cosmopolitan planktonic species can be found in a range of freshwater habitats. Fig. 3e

Division Charophyta

Class Zygnematophyceae

Order Desmidiales

*Cosmarium:* conjugate polygonal to elliptical half-cells with moderate to deep sutures and ornamentation consisting of pores, spines, granules, verrucae, scrobiculations, and crenulations. This cosmopolitan genus can be found in nearly all aquatic and sub-aerial habitats, with species inhabits both benthic and planktonic settings in oligotrophic to eutrophic environments. Fig. 3o

*Euastrum* spp. conjugate subrectangular to trapeziform half-cells that can appear nearly rectangular in apical view. The half-cells often have an apical incision, which results in two or more lateral lobes (commonly with spines) differentiating them from the superficially similar *Cosmarium* half-cells, as does a typically lesser degree of ornamentation (e.g., pores, granules, spines, or verrucae). Broadly distributed across North America, commonly found in acidic, oligotrophic waters. Fig. 3n

*Staurastrum:* conjugate spheroidal, ellipsoidal, or polygonal half-cells, most with long “arm”-like processes that can end in two to four spines. Processes can contain various forms of ornamentation, which combined with cell shape, size, and chloroplast shape can be used to distinguish to species level. This genus can be planktonic, benthic, and periphytic and can be found in most freshwater environments. Fig. 3p

Order Zygnematales

*Mougeotia*: vegetative filaments that are cylindrical and longer than they are wide. Filament diameter ranges between ~5 to 30 µm and can appear purple to brown under certain conditions. Fig. 3m

*Zygnema*: cylindrical cells that range ~20-30 µm in diameter, forming chains that can appear rectangular, smooth walls with no ornamentation. The thick-walled zygospores formed by conjugation and the asexualaplanospores are the most common charophyte palynomorphs. Fig. 3l

Division Dinoflagellata

Class Peridiniaceae

Order Peridiniales

*Parvodinium*: small (20-30 µm) shiny, smooth-walled proximate/ acavate cysts, i.e. with no uneven separation between the inner and outer wall. Shape ranges from spherical to conical, and colour from clear to dark reddish brown. The position of the pericingulum can be marked by indentation, in conical cysts clearly separating the larger epicyst from the smaller hypocyst where the antapical archeopyle can be found. Fig. 4a, 5m

*Peridinium*: medium to large (35 – 80 µm) shiny, smooth-walled proximate to proximocavate cysts, with position of the pericingulum marked by very fine ornamentation (e.g., Fig. 4e) or by constriction of the outer wall, appressed to the inner wall (e.g., Fig. 4g); degree of separation of the outer wall from the inner wall and reflection of the apical horn and two antapical horns of thecate cell allows identification to species- cysts of *P. willei* (Fig. 4a) show little/no separation between walls, whereas separation is marked in *P. gatunense* (Fig. 4f), and intermediate in cysts attributed to *P. cinctum* (Fig. 4g), and the horns are clearly reflected in cysts produced by P. limbatum (Fig. 4c), but are much less pronounced in cysts attributed to P. bipes (Fig. 4h), It is noteworthy that molecular phylogenies identify these species as very closely related, as the clade *Peridinium* sensu stricto. Archeopyles are rarely observed but appear to be restricted to the epicyst (e.g., Fig. 4a)

Order Thoracosphaerales

*Fusiperidinium*: proximocavate cysts with a smooth, ellipsoidal inner layer and variable degree of ornamentation on the outer wall, generally scabrate. An apical horn and a single prominent antapical are developed in the other wall, reflecting the shape of the theca; ca. 62 x 45 µm. Apical archeopyles are rarely seen in palynological preparations. Fig. 4b

Phylum Ciliophora

Class Spirotrichia

Order Tintinnida

*Codonella:* Short, urn-shaped lorica, divided by nuchal constriction into distinct posterior “bowl” and anterior collar-like structure. Single-layered lorica formed from agglutinated particles, non-biogenic materials. The genus *Codonella* has been used as a proxy of eutrophication and anoxic, muddy bottom waters (Barbieri and Orlandi, 1989; Danesh et al., 2013; Drljepan et al., 2014; Volik et al., 2016). Fig. 4.9

Phylum Euglenophyta

Class Euglenoidea

*Strombomonas*: Rounded lorica tapered to apical pore, lorica lacks ornamentation, collar

*Trachelomonas*: Spherical or ovoid, porous lorica, may possess ornamentation such as hollow spines, presence of collar structure at anterior end.

Phylum Amoebozoa

Class Tubulinea

Order Arcellinida

*Centropyxis*: Flattened beret-shaped test with an invaginated subterminal aperture. It is most common genus in palynological preparations because of its organic-rich, loosely agglutinated walls. Fig. 4n, o

*Difflugia*: The largest and most diverse arcellinid genus, but coarsely and densely agglutinated and thus less resistant to maceration; aperture not invaginated. Fig. 4m

Phylum Rotifera

Class Monogononta

Order Flosculariaceae

*Filinia*: Genus lacks preservable loricae but eggs (oocytes) are often found in lake sediment; they are large, roughly elliptical in shape and ornamented with lobes of differing sizes. Fig. 5f

Order Ploima

*Kellicottia:* Elongated, thin triangular lorica composed of two fused plates ornamented with spines; four or six anterior spines, two or three being markedly longer than the others, one extremely elongated posterior spine. Planktonic, limnetic, found in many freshwater environments. Fig. 5e

*Keratella:* Shorter, rounded U-shaped lorica, patterned with polygonal plates/facets. Single, double, or absent posterior spine, and six shorter anterior spines which may vary in length. Differences in plate patterning, presence and length of spines differentiate species. Planktonic, limnetic, extremely common in freshwater environments. Fig. 5a-d

Phylum Platyhelminthes

Class Turbellaria

**Order Rhabdocoela**

*Gyratrix*, one of the most cosmopolitan taxa, produces dark brown oocytes with an operculum that is frequently detached and a basal stalk that is normally truncated, leaving a pointed aboral terminus. Fig. 5h

Phylum Nematoda

Class Enoplea

*Trichuris*, the highly infections parasitic whipworm, produces resistant eggs shaped like an American football that are reddish-brown in colour and measure *c.* 79 by 38 μm.

Phylum Arthropoda

Class Crustacea, Subclass Cladocera

Order Branchiopoda, suborder Anomopoda

*Daphnia:* Small (1-5mm), planktonic segmented organism, typically covered by a translucent, double-walled chitinous carapace with ventral gap containing five pairs of legs and a slightly elongated apical spine. Multiple other appendages are present, including prominent forward-facing antennae. Commonly used as proxies of eutrophication (Frisch, et al., 2014; Frisch, et al., 2017). Fig. 5i, j

*Bosmina:* Generally smaller than *Daphnia* (0.3mm to 1.5mm), with an oval translucent carapace covering five to six leg pairs and a shorter, squat body. Similar appendages to *Daphnia*, but primary antennae are more rigid, curved with the appearance of tusks, with greatly reduced sensory hairs. Apical spine is absent in some species, and many have pronounced post-abdominal claws. Fig. 5k

Class Insecta

Order Diptera

Family Chironomidae

*Chaoborus:* Larvae have long, thin, segmented, generally translucent bodies containing two pairs of darker, pigmented gas sacs located near the head and anal fan. Chitinous head capsule with antenna, paired mandibles with longer spikes.

Family Chironomidae

*Chironomus:* Long, segmented bodies, generally bright red in color; anterior and posterior parapods present, multiple paired anal tubules. Head capsule with triangular, paired mandibles with multiple teeth. Fig. 5l

*Tanytarus:* One of the most diverse chronomid genera, whose mandibles are common in palynological preparations from temperate freshwater lakes. Fig. 5m