

## 7.5 Appendix E – Arcellinida Systematics

**Domain:** EUKARYOTA Chatton 1925

**Kingdom:** PROTOZOA Goldfuss 1818

**Phylum:** AMOEBOZOA (Lühe 1913) Corliss 1984

**Subphylum:** LOBOSA Carpenter 1861

**Class:** TUBULINEA Smirnov et al., 2005

**Subclass:** RHIZOPODA Dujardin, 1861

**Order:** ARCELLINIDA Kent 1880

**Family:** ARCELLIDAE Ehrenberg 1830

**Genus:** ARCELLA Ehrenberg 1832

***Arcella vulgaris* Ehrenberg 1830**

(Plate 1, Figure 1; Plate 3, Figure 1)

*Arcella vulgaris* Ehrenberg 1830, p. 40, pl 1, fig. 6

**Diagnosis:** Test hemispherical, dome-shaped, convex, with a distinct basal rim; yellow or light brown, height of test about one-half the diameter; test surface is either smooth or with regular undulations; aperture circular, invaginated.

**Family:** *Centropyxidae* Jung 1942

**Genus:** *Centropyxis* Stein, 1859

***Centropyxis aculeata* (Ehrenberg, 1832) strain "aculeata"**

(Plate 1, Figures 2–3; Plate 3, Figures 2–3; Plate 5, Figures 1–2)

*Arcella aculeata* Ehrenberg 1830, p. 60 (nomen nudum)

*Arcella aculeata* Ehrenberg 1832a, p. 40 (nomen nudum)

*Arcella aculeata* EHRENBURG 1832, p. 91

*Arcella aculeata* Ehrenberg, EHRENBURG 1843, p. 133, pl. 9, figs. 6a–c.

*Centropyxis aculeata* (Ehrenberg) MEDIOLI & SCOTT 1983, p. 39, pl. 7, figs. 10–19.

*Centropyxis aculeata* (Ehrenberg) strain “aculeata” REINHARDT, DALBY, KUMAR & PATTERSON 1998, p. 140, pl. 1, fig. 1a–c.

**Diagnosis:** Test compressed, circular or ovoid, cap-shaped, with 1–8 lateral spines; test surface often rough and covered with quartz grains and/or diatoms frustules; aperture invaginated, circular or hemi-spherical; sub-terminal.

***Centropyxis aculeata* (Ehrenberg, 1832) strain “discoides”**

(Plate 1, Figures 4–5; Plate 3, Figures 4–5; Plate 5, Figures 3–4)

*Arcella discoides* EHRENBURG 1843, p. 139

*Arcella discoides* Ehrenberg, EHRENBURG 1872, p. 259, pl. 3, fig. 1

*Arcella discoides* Ehrenberg, LEIDY 1879, p. 173, pl. 28, fig. 14–38

*Centropyxis discoides* var. *discoides* PENARD 1890, p. 150, pl. 5, figs 38–41

*Centropyxis discoides* PENARD [sic], OGDEN and HEDLEY 1980, p. 54, pl. 16, figs A–E

*Centropyxis aculeata* (Ehrenberg) strain “discoides” REINHARDT, DALBY, KUMAR, PATTERSON 1998, p. 140, pl. 1, fig. 2

**Diagnosis:** Test compressed, often circular, doughnut-shaped, without lateral spines; test surface often rough and covered with quartz grains and/or diatoms frustules; aperture invaginated, circular or hemi-spherical; sub-terminal.

***Centropyxis constricta* (Ehrenberg 1843) strain “aerophila”**

(Plate 1, Figures 6–7; Plate 3, Figures 6–7; Plate 5, Figures 5–6)

*Centropyxis constricta* (Ehrenberg) SCOTT & MEDIOLI 1983, p. 41, pl. 7, fig. 5 (not figs 1–4, 6–9).

*Centropyxis constricta* (Ehrenberg) strain “aerophila” PATTERSON & KUMAR

2000, p. 317, pl. 2, fig. 4

*Centropyxis constricta* (Ehrenberg) strain “aerophila” PRENTICE, ROE, BENNION, SAYER, SALGADO 2018, p. 195, fig. 2d

**Diagnosis:** Test variable in shape, elliptical or broad ovoid; no spines on the fundus unlike strains “constricta” and “spinosa”; test surface often rough and covered with quartz grains, fundus often covered with large grains; aperture terminal and eccentric, deeply invaginated.

***Centropyxis constricta* (Ehrenberg 1843) strain “constricta”**

(Plate 1, Figures 8–10; Plate 3, Figures 8–10; Plate 5, Figures 7–8)

*Arcella constricta* EHRENBERG 1843, p. 410, pl 4, fig. 35, pl. 5, fig. 1

*Centropyxis constricta* (Ehrenberg) SCOTT & MEDIOLI 1983, p. 41, pl. 7, figs 1–4, 6–9 (not fig. 5).

*Centropyxis constricta* (Ehrenberg) strain “constricta” REINHARDT, DALBY, KUMAR, PATTERSON 1998, p. 140, pl. 1, figs. 4a–b.

**Diagnosis:** Test variable in shape, elliptical or broad ovoid; no spines on the fundus unlike strains “constricta” and “spinosa”; test surface often rough and covered with quartz grains, fundus often covered with large grains; aperture terminal and eccentric, deeply invaginated.

***Centropyxis constricta* (Ehrenberg 1843) strain “spinosa”**

(Plate 1, Figure 11; Plate 3, Figures 11)

*Arcella constricta* EHRENBERG 1843, p. 410, pl 4, fig. 35, pl. 5, fig. 1

*Centropyxis spinosa* (Ehrenberg) CASH in CASH and HOPKINSON 1905, p. 135, text figs. 26 a–c, pl 16, fig. 15

*Centropyxis spinosa* Cash, OGDEN and HEDLEY 1980, p. 62, pl 20, figs. a–d  
*Centropyxis constricta* (Ehrenberg) strain “spinosa” REINHARDT, DALBY,  
KUMAR, PATTERSON 1998, p. 140, pl. 1, fig. 5

**Diagnosis:** Test variable in shape, elliptical or broad ovoid; more flattened compared to stains “aerophile” and “constricta”; three or more long spines on the fundus; spines are half the length of the test; test surface often rough and covered with quartz grains; aperture terminal and eccentric, deeply invaginated.

***Coniocassis pontigulasiformis* (Beyens, Chardez & De Bock 1986)**

(Plate 3, Figures 12–17; Plate 5, Figures 11–12)

*Centropyxis pontigulasiformis* BEYENS, CHARDEZ, & DE BOCK 1986, p. 84, pl. III, figs. 1–5

*Coniocassis pontigulasiformis* (Beyens, chardez, & De Bock 1986) NASSER & PATTERSON, 2015, p. 7, pl. 1, figs. 1–6

**Diagnosis:** Test ovoid or subspherical to spherical; subcircular in cross section; test dorsoventrally symmetrical in most cases; test wall comprised of agglutinated particles derived from mineral or biologic sources bound together with an organic cement; aperture circular; proportionately very large conical to funnel-shaped and typically asymmetrically oriented flange extends from aperture; broad apertural rim recurved inward and comprised of fine agglutinated grains.

**Family:** *Diffflugidae* Stein 1859  
**Genus:** *Diffflugia* Leclerc in Lamarck 1816

***Diffflugia bidens* Penard 1902**

(Plate 3, Figure 6)

*Diffflugia bidens* PENARD 1902, p. 264, text figs. 1–8.

**Diagnosis:** Test ovoid, compressed in cross-section, relatively smooth; fundus usually with 2–3 small spines; aperture large, circular, without collar.

***Diffflugia globulosa* (Dujardin 1837)**

(Plate 3, Figure 6)

*Diffflugia globulosa* DUJARDIN 1837, pl.9, figs. 1a.b

*Diffflugia globulosa* (Dujardin 1837) PENARD 1902, p. 258

**Diagnosis:** Test spherical or hemispherical, often made of large quartz particles, sometimes consists of diatom frustules; test generally rough, but can be smooth in some specimens; aperture circular and surrounded by smaller particles

***Diffflugia urens* Patterson, McKinnon, Scott, and Mediolli 1985**

(Plate 2, Figure 5; Plate 4, Figure 9)

*Diffflugia urens* Patterson, Mckinnon, Scott, & Mediolli 1985, p. 132, pl. 3, figs 5–14

*Diffflugia urens* Patterson, Mackinnon, Scott, & Mediolli ESCOBAR, BRENNER, WHITMORE, KENNEY, CURTIS 2008, p. 729, fig. 3k.

**Diagnosis:** Test spherical, often small; test surface relatively smooth; aperture very small with expanded flanged collar of variable width.

***Diffugia glans* Penard 1902 strain “glans”**

(Plate 2, Figure 6; Plate 4, Figure 10; Plate 6, Figures 3–4)

*Diffugia glans* PENARD 1902 p.247

*Diffugia glans* Penard strain “glans” PATTERSON, ROE, SWINDLES 2012, p. 39, fig. 4.28

*Diffugia glans* Penard strain “glans” PRENTICE, ROE, BENNION, SAYER, SALGADO 2018, p. 195, fig. 2m.

**Diagnosis:** Test oval to ovoid, slightly elongated, fundus rounded, neck absent, aperture circular with smooth lip, test made of fine sand particles; test tapers from the center towards both ends

***Diffugia glans* Penard 1902 strain “distenda”**

(Plate 2, Figure 7; Plate 4, Figure 11; Plate 6, Figures 6–7)

*Diffugia distenda* OGDEN 1983 p. 31, fi. 21a–d.

*Diffugia glans* Penard strain “distenda” PATTERSON, ROE, SWINDLES 2012, p. 39, fig. 4.30

*Diffugia glans* Penard strain “distenda” NASSER, PATTERSON, ROE, GALLOWAY, FALCK, PALMER, SPENCE, SANEI, MACUMBER, NEVILLE 2016, p. 136, fig. 3.11

**Diagnosis:** Similar to “glans” in addition to a small curved spine on the fundus.

***Difflugia glans* Penard 1902 strain "magna"**

(Plate 2, Figure 8)

*Difflugia glans* Penard strain "magna" PATTERSON, ROE, SWINDLES 2012, p. 39, fig. 4.29

**Diagnosis:** Similar to "glans" but larger in size.

***Difflugia elegans* Penard 1890**

(Plate 2, Figure 2; Plate 4, Figures 7–8; Plate 6, Figures 15–16)

*Difflugia elegans* PENARD 1890, pl. 4, figs. 4–11

**Diagnosis:** Test rough, pyriform, short neck; spine present on fundus, often curved; tests composed of small to large pieces of angular quartz and sometimes diatom frustules.

***Difflugia bicornis* Penard 1890**

(Plate 2, Figure 2; Plate 4, Figures 7–8; Plate 6, Figures 15–16)

*Difflugia bicornis* PENARD 1890, pl. 4, figs. 12–14

**Diagnosis:** similar to *Difflugia elegans* but with two spines present on fundus.

***Diffflugia urceolata* Carter 1864 strain “urceolata”**

(Plate 2, Figure 4)

*Diffflugia urceolata* Carter 1864, p. 27, pl. 1. fig. 7.

*Diffflugia urceolata* Carter strain “urceolata” REINHARDT, DALBY, KUMAR, PATTERSON 1998, pl. 2, fig. 2b

*Diffflugia urceolata* Carter strain “urceolata” NASSER, PATTERSON, ROE, GALLOWAY, FALCK, PALMER, SPENCE, SANEI, MACUMBER, NEVILLE 2016, p. 136, fig. 3.9

**Diagnosis:** Test spheroid to ovate; cauldron-like; fundus rounded; neck short, sometimes noticeably curved or straight collar of different shape and size. Aperture wide, circular, terminal; test often composed of sand grains of variable coarseness.

***Diffflugia oblonga* Ehrenberg 1832 strain “oblonga”**

(Plate 2, Figures 9–10; Plate 4, Figures 12–13; Plate 6, Figures 15–16)

*Diffflugia oblonga* EHRENBURG 1832, p. 90.

*Diffflugia oblonga* Ehrenberg, OGDEN and HEDLEY 1980, p. 148, pl. 63, figs. a–c.

*Diffflugia oblonga* Ehrenberg strain “oblonga” REINHARDT, DALBY, KUMAR, PATTERSON 1998, p. 140, pl. 2, figs. 10a,b.

*Diffflugia oblonga* Ehrenberg strain “oblonga” NASSER, PATTERSON, ROE, GALLOWAY, FALCK, PALMER, SPENCE, SANEI, MACUMBER, NEVILLE 2016, p. 136, fig. 3.12

**Diagnosis:** Shell ovoid-elongate, laterally circular, with a smooth surface; neck long; aperture small, circular.



***Diffflugia oblonga* Ehrenberg 1832 strain “spinosa”**

(Plate 2, Figures 11–12; Plate 4, Figure 14)

*Diffflugia oblonga* Ehrenberg strain “spinosa” REINHARDT, DALBY, KUMAR, PATTERSON 1998, p. 140, pl. 2, figs. 10a,b.

*Diffflugia oblonga* Ehrenberg strain “oblonga” NASSER, PATTERSON, ROE, GALLOWAY, FALCK, PALMER, SPENCE, SANEI, MACUMBER, NEVILLE 2016, p. 136, fig. 3.13

**Diagnosis:** Similar to “oblonga” in addition to a thick curved spine on fundus.

***Diffflugia oblonga* Ehrenberg 1832 strain “tenuis”**

(Plate 2, Figures 13–14; Plate 4, Figure 15; Plate 6, Figures 12–13)

*Diffflugia pyriformis* var. *tenuis* PENARD 1890, p. 138, pl. 3, figs. 47–49

*Diffflugia oblonga* Ehrenberg strain “oblonga” NASSER, PATTERSON, ROE, GALLOWAY, FALCK, PALMER, SPENCE, SANEI, MACUMBER, NEVILLE 2016, p. 136, fig. 3.14

**Diagnosis:** Similar to “oblonga” except having smaller test with shorter a neck.

***Diffflugia oblonga* Ehrenberg 1832 strain “lanceolata”**

(Plate 2, Figures 16; Plate 6, Figure 14)

*Diffflugia lanceolata* PENARD 1890, p. 145, pl. 4, figs. 59–60

*Diffflugia lanceolata* Penard, OGDEN and HEDLEY 1980, p. 140, pl. 59, figs. a–d

*Diffflugia oblonga* “lanceolata” REINHARDT, DALBY, KUMAR, PATTERSON

1998, pl. 2, fig. 6

**Diagnosis:** Test elongate, tapering at both ends, made of siliceous angular particles; test is usually polished and smooth; aperture circular and surrounded by a collar

***Diffugia protaeiformis* Lamarck 1816 strain “*protaeiformis*”**

(Plate 4, Figure 16)

*Diffugia protaeiformis* Lamarck 1816, p. 95 (with reference to material in a manuscript in Leclerc)

*Diffugia protaeiformis* Lamarck 1816 strain “*protaeiformis*” ASIOLI, MEDIOLI, PATTERSON 1996, p. 254, pl. 2, fig. 1a,b

*Diffugia oblonga* Ehrenberg strain “*oblonga*” NASSER, PATTERSON, ROE, GALLOWAY, FALCK, PALMER, SPENCE, SANEI, MACUMBER, NEVILLE 2016, p. 136, fig. 3.16

**Diagnosis:** Test cylindrical to subcylindrical, widest at aboral end, tapering to the apertural end; aboral end may be pointed or more gently rounded, with or without a spine; aperture circular, small, no apertural rim; test surface usually rough

***Diffugia protaeiformis* Lamarck 1816 strain “*acuminata*”**

(Plate 2, Figures 16–17; Plate 4, Figure 17; Plate 6, Figures 17–18)

*Diffugia protaeiformis* Lamarck 1816, p. 95 (with reference to material in a manuscript in Leclerc)

*Diffugia acuminata* EHRENBURG 1830, p. 95

*Diffugia acuminata* Ehrenberg 1830 OGDEN & HEDLEY 1980, p. 118, pl. 4, figs.

A–C

*Diffflugia oblonga* Ehrenberg strain “oblonga” NASSER, PATTERSON, ROE, GALLOWAY, FALCK, PALMER, SPENCE, SANEI, MACUMBER, NEVILLE 2016, p. 136, fig. 3.17

**Diagnosis:** Test elongated almost cylindroconical, fundus acuminate, tapering to form a blunt spine, neck absent, aperture circular, narrow without lip, test smooth.

***Diffflugia protaeiformis* Lamarck 1816 strain “claviformis”**

(Plate 2, Figure 18; Plate 4, Figure 18; Plate 6, Figures 19)

*Diffflugia protaeiformis* Lamarck 1816, p. 95 (with reference to material in a manuscript in Leclerc)

*Diffflugia pyrifomis* var. *claviformis* PENARD 1899, p. 25, pl. 2, figs. 12–14

*Diffflugia claviformis* OGDEN and HEDLEY 1980, p. 126, pl. 52, figs. a–d

**Diagnosis:** Test similar to “acuminata” except that is made of medium to coarse size particles.

***Diffflugia protaeiformis* Lamarck 1816 strain “scalpellum”**

(Plate 2, Figure 20; Plate 4, Figure 20)

*Diffflugia scalpellum* PENARD 1899

*Diffflugia protaeiformis* Lamarck 1816 strain “scalpellum” MACUMBER, PATTERSON, REINHARDT, NEVILLE, SWINDLES 2014, p. 311.

*Diffflugia oblonga* Ehrenberg strain “oblonga” NASSER, PATTERSON, ROE, GALLOWAY, FALCK, PALMER, SPENCE, SANEI, MACUMBER, NEVILLE 2016, p. 136, fig. 3.20

**Diagnosis:** Test cylindrical; asymmetrically shaped apex; test composed of quartz particles and diatom frustules, giving it the appearance of a regular smooth surface. Aperture usually circular.

***Diffugia curvicaulis* Penard 1899**

(Plate 2, Figure 19; Plate 4, Figure 19; Plate 6, Figures 19)

*Diffugia curvicaulis* Penard 1899.

**Diagnosis:** Test tubular, narrowing from the fundus to the aperture, usually transparent, colorless or brown, with a distinct aboral horn, often curved and sometimes perforated at the apex; test usually with smooth outline, composed of small and medium sized pieces of flat quartz and fragments of diatoms; aperture circular, surrounded by regular arrangement of small particles.

**Genus:** *Pontigulasia* Rhumbler 1896

***Pontigulasia compressa* (Carter 1864)**

(Plate 2, Figures 16–17; Plate 4, Figure 17; Plate 6, Figures 17–18)

*Diffugia compressa* CARTER, 1864, p. 22, pl. 1, figs. 5, 6.

*Pontigulasia compressa* (Carter) RHUMBLER, 1895, p. 105, pl.4, fig. 13a, b

**Diagnosis:** Test pyriform, in transverse-section round or compressed; aperture round or elliptical; shell commonly with a constriction between the neck and the main body; v-shaped constriction.

**Genus:** *Lagenodiffugia* Medioli and Scott, 1983

***Lagenodiffugia vas* (Leidy, 1874)**

(Figure 3.5)

*Diffflugia vas* LEIDY, 1874, p. 155.

*Lagenodiffflugia vas* (Leidy) MEDIOLI & SCOTT, 1983, p. 33–34, pl. 2, figs. 18–23, 27, 28.

**Diagnosis:** Test pyriform, often with a well-marked constriction of the neck, frequently circular in cross-section but sometimes slightly compressed, composed mainly of agglutinated mineral particles bound by an organic cement; aperture terminal, circular.

**Genus:** *Mediolus* Patterson 2015

***Mediolus corona* (Wallich 1864)**

(Plate 1, Figures 13–15; Plate 3, Figure 1)

*Diffflugia protaeiformis* [sic] Ehrenberg subspecies *D. globularis* (Du-jardin)  
*var. D. corona* WALLICH 1864, p. 244, pl. 15, fig. 4a–c, pl. 16, figs. 19–20.

*Diffflugia corona* Wallich ARCHER 1866, p. 186

*Mediolus corona* (Wallich) PATTERSON 2015, p. 3, fig. 2.1–2; fig. 3.1–12.

**Diagnosis:** Test spherical to sub-spherical; test is composed of mineral grains, quartz and diatom frustules; test ornamented by conical hollow spines on fundus; aperture circular, surrounded by a variable number of inward-oriented angular crenulations (tooth-like structures).

**Family:** HYALOSPHEENIIDAE Schulze 1877

**Genus:** *Cucurbitella* Penard 1902

***Cucurbitella tricuspis* (Carter 1856)**

(Plate 1, figures 18–21)

*Diffugia tricuspidis* CARTER 1856, p. 221, fig. 80

*Cucurbitella tricuspidis* (Carter 1856) MEDIOLI, SCOTT & ABOBTT, 1987, p. 42, text figs. 1, 4.

**Diagnosis:** Test ovoid; surface smooth, outline regular; body constructed of small to medium, angular mineral grains; aperture with 3–4 lobes.

**Genus:** *Heleopera* Leidy 1879

***Heleopera sphagni* (Leidy 1874)**

(Figure 3.2)

*Diffugia (Nebella) sphagni*, LEIDY, 1874, p. 157.

*Heleopera sphagni* (Leidy) 1874 CASH and HOPKINSON, 1909, p. 143, pl. 30, figs. 4–9

**Diagnosis:** Test broadly ovoid, regular in outline, compressed; chitinous membrane tinted yellowish (rarely brownish), with a surfacing of irregular transparent siliceous plates; fundus with little foreign material, often without.

**Family:** LESQUEREUSIIDAE Jung 1942

**Genus:** *Lesquereusia* Schlumberger 1845

***Lesquereusia spiralis* (Ehrenberg 1840)**

(Figure 3.3)

*Diffugia spiralis* EHRENBURG 1840, p. 199.

*Lesquereusia spiralis* (Ehrenberg) LEIDY 1879, p. 145, 146, pl. 22, 23, figs. 1–7, pl. 24, figs. 11, 12.

**Diagnosis:** Test with an asymmetrical neck, slightly compressed laterally; neck prominent, sharply turned to one side; aperture terminal, circular.