Chapter 24
Chara connivens

Kaire Torn and Emile Nat

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Scientific name: *Chara connivens* Salzm. ex A. Braun, Flora 18: 73. 1835

Neotype (Wood, 1965: 177): Tanger/[no date]/Salzmann (PC 577722).

= *Chara arcuatifolia* Vilh. in Spisy Prír. Fak. Karlovy Univ. 80: 23. 1928 "arcuatofolia"
Lectotype: (Wood, 1965: 179): Czelkar, in fl. Kauldzhur/[no date]/N. Androssow 77 (LE).

Local names: DANISH: Glat Kransnål; DUTCH: Gebogen kransblad; ENGLISH: Convergent stonewort; ESTONIAN: Sile mändvetikas; FINNISH: Suppunäkinparta; GERMAN: Gebogene Armleuchteralge; LITHUANIAN: Glaustašakis maurabragis; POLISH: Ramienica zagięta, RUSSIAN: Хара сходящаяся; SWEDISH: Tuvsträfse; UKRAINIAN: Хара збігаюча.

24.1 Morphology

Habitus: Plants are bright green, sometimes yellowish or dark green and usually not encrusted (Fig. 24.1). Branchlets of male plants are often curved inward (Fig. 24.2a). Plants can be compact and stiff (shallow water, Fig. 24.3a) or slender with long internodes (deeper water, Fig. 24.3b, c).

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Fig. 24.1 Habitus appearance of *Chara connivens*. *Chara connivens* in the Baltic Sea. Photograph: Kaire Kaljurand, Kõiguste Bay, 2013

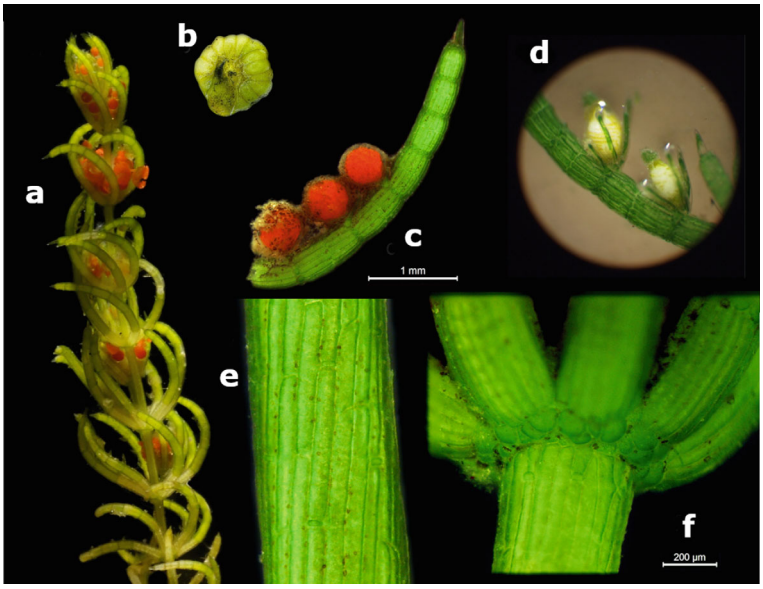

Fig. 24.2 Details of *Chara connivens*, photos. **a** Incurved branchlets of male *C. connivens*, **b** Bulbils, **c** Branchlet with antheridia, **d** Branchlet with oogonia, **e** Cortex without spine-cells (nodal cells of cortex are visible), **f** Stipulode rows. Photographs: **a—**Heiko Korsch; **b—**Klaus van de Weyer; **c**, **e**, **f—**Anastasiia Kovtun-Kante; **d—**Kaire Torn

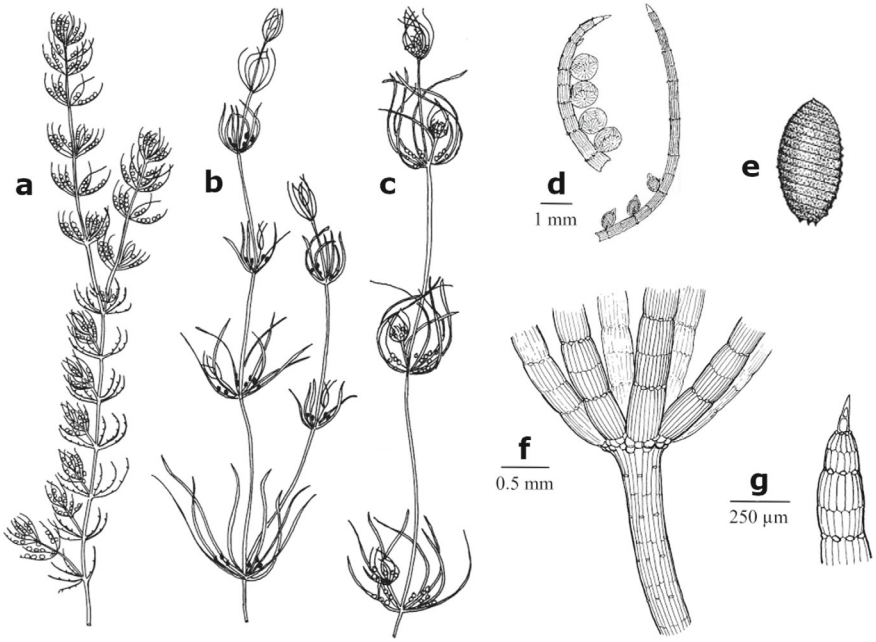

Fig. 24.3 Details of *Chara connivens*, drawings. **a** Habitus of male plant from shallow conditions, **b** Female plant from deep water, **c** Male plant from deep water, **d** Fertile branchlets of male (left) and female (right) plants, **e** Oospore, **f** Cortex with node and stipulodes, **g** Tip of branchlet. Drawings: **a—**Klaus van de Weyer; **b–e—**Werner Krause; **f**, **g—**Mindaugas Ryla

Size: The plants are small to medium-sized (5–20 cm) but may reach up to 50 cm if growing in deeper water.

Main axis: The shoot diameter is 0.3–0.6 (1.2) mm, but based on Urbaniak and Gąbka (2014) can reach up to 1.4 mm. The internodes are generally longer than the branches, 0.3–2 (5.3) cm in length, in the upper whorls mainly shorter or of equal length.

Cortex: The cortex is triplostichous and isostichous, the surface smooth and finely striped. The cortex can be slightly twisted (Figs. 24.2e and 24.3f).

Spine-cells: Spine-cells are lacking or rudimentary. Cortex nodal cells are visible or solitary rudimentary cells are present (Fig. 24.2e).

Stipulodes: Stipulodes are small and globular, arranged in two rows, but often rudimentary and form irregular rows (Figs. 24.2f and 24.3f).

Branchlets: Predominantly 6–9 (up to 10) branchlets are arranged in one whorl. Each branchlet has 8–10 segments of which the upper 1–2 short segments are ecorticated. The end cell is narrow, short and pointed. The branchlets of the male plants are mainly curved inward (Figs. 24.2c–d and 24.3d–f).

Bract-cells: Rudimentary papillous cells are present.

Bracteoles: Elongated and slender. On male plants bracteoles are mainly shorter than ripe antheridia, rarely of the same length. On female plants they are shorter than or as long as the oogonia.

Bractlets: Elongate, shorter than or as long as the oogonia (Fig. 24.2d).

Sexuality: The species is dioecious. Gametangia solitary, only developed on the lowest 1–4 (rarely 5) segments of the branchlets (Figs. 24.2c, d and 24.3d).

Oogonia: Solitary, coronula strongly convergent. Table 24.1 gives an overview about morphometrical data available (see also Fig. 24.2d).

Oospores: Oospores are slender, dark brown to black when mature (Fig. 24.3e). Membrane of the oospore is granular (Corillion, 1957; Groves and Bullock-Webster, 1924; Urbaniak and Blaženčić, 2012). Table 24.2 gives an overview about morphometrical data.

Antheridia: Antheridia are inconspicuous; maximum diameter 1100 μm. Colour is orange red to brownish red, located relatively close to each other (Figs. 24.2c and 24.3d). Table 24.2 gives an overview about morphometrical data available Table 24.3.

Bulbils: According to most authors bulbils are missing. Based on German, Danish and Swedish material multicellular bulbils may be present (Becker, 2016; Blindow, 2008; Schou et al., 2017; see Fig. 24.2b).

24.2 Phenology and Reproduction

Chara connivens is mostly annual, data about germination are limited. Fertile plants were found from June to September (Becker, 2016; Mouronval et al., 2015; Torn and Martin, 2004). The plants in the Mediterranean Basin can begin to fructify in March (R. Becker own data), then die off in temporary waters as they dehydrate in summer and germinate again after the rainfall (Becker, 2016).

24.3 Habitat Conditions and Ecology

Habitat type: *Chara connivens* has been found in lakes, ditches, temporary ponds, swamps, artificial irrigation systems, as well as in the brackish Baltic Sea and its associated lagoons and coastal lakes and in the Mediterranean area up to Israel especially along the coast.

Sediment: Grows on sand, mud, silty sand, muddy sand, muddy clay, loamy conditions, peat bogs and in the Baltic Sea also on mixtures of sand with pebbles.

Table 24.1 Oogonia morphometry

Author	Length	Width	Coronula length	Coronula width	Number of helical stripes
Migula (1889–1897)	850–1150*	320–550	–	–	–
Groves and Bullock-Webster (1924)	750	400	200	185	13–14
Corillion (1957)	650–900	320–550	200	185	13–14
Wood (1965)	675–750	330–400	200–240	150–180	13–15
Moore (1986)	–	< 500	–	–	–
Compère (1992)	600–750	300–400	–	–	–
Krause (1997)	650–750	330–400	200–240	160	14–15
Torn and Martin (2003)	650–1100*	320–550	–	–	13–15
Langangen (2007)	< 1100*	–	–	–	–
Cirujano et al. (2008)	675–800	330–400	150–240	–	–
Ahmadi et al. (2012)	850–930**	450–520	130–200	180–200	14–15
Urbaniak and Gąbka (2014)	605–775	330–410	–	–	–
Mouronval et al. (2015)	–	–	200–240	–	–
Becker (2016)	625–800	375–400	125–200	–	11
Schou et al., (2017)	500–1150*	150–550	–	–	–
Total range	**600–900(1150*)**	**(150)300–550**	**125–240**	**150–200**	**11–15**

* Uncertain whether length is without coronula, ** with coronula
Length in the first column excludes the coronula except for values marked by asterisks; coronula length and width are given separately, all values for length and width in μm.

Nutrient conditions: *Chara connivens* is found from oligotrophic to eutrophic conditions. It is reported to tolerate high concentrations of nutrients (Becker, 2016). It is found at total phosphorus concentrations up to 6.9 mg/l, at total nitrogen concentrations up to 4.7 mg/l and showed positive correlation with orthophosphates (Del Pozo et al., 2011).

Water chemistry: *Chara connivens* can occur in fresh calcareous and brackish water. In the Netherlands, *C. connivens* was detected at chloride concentrations between 0 and 1070 mg/l (Simons and Nat, 1996), the optimum growth of the species is at a chloride concentration of 124 mg/l (Simons et al., 1994). In the Baltic Sea the species is more frequent at salinity 2–6 psu, but can be found in salinity conditions up to

Table 24.2 Oospore morphometry

Author	Length	Width	Number of striae	Colour
Migula (1889–1897), Corillion (1957)	580–700	240–350	12–13	Black
Groves and Bullock-Webster (1924)	500–600	250–300	12–13	Dark brown to black
Wood (1965)	500–700	240–350	11–13	Dark brown to black
Krause (1997)	500–700	250–350	12–14	Dark brown to black
van Raam (1998)	< 650	< 300	–	–
Torn and Martin (2004)	500–700	240–350	11–14	Dark brown to black
Cirujano et al. (2008)	500–650	250–350	–	Dark brown to black
Ahmadi et al. (2012)	630–700	350–430	12–13	Brown to black
Urbaniak and Gąbka (2014)	485–595	205–325	–	Dark brown to black
Becker (2016)	500–550	300–350	–	Black
Schou et al. (2017)	490–700	210–350	12–14	Dark brown
Total range	**485–700**	**205–430**	**11–14**	

All values for length and width in μm

Table 24.3 Antheridia morphometry

Author	Diameter (μm)
Migula (1889–1897)	800–1100
Groves and Bullock-Webster (1924), Compère (1992)	600–700
Corillion (1957)	600–1100
Wood (1965)	500–1100
Moore (1986), van Raam (1998), Langangen (2007)	< 1000
Krause (1997)	600–1000
Torn and Martin (2004)	600–1100
Cirujano et al. (2008)	700–1000
Ahmadi et al. (2012)	720–930
Urbaniak and Gąbka (2014)	650–1000
Becker (2016)	(450)500–1000
Schou et al. (2017)	(450)500–1100
Total range	**(450)500–1100**

9 psu (Langangen, 2007; Mouronval et al., 2015). Based on the overview in Doege et al. (2016), the range of water chemistry is: pH value 7–9, electrical conductivity 34–3070 µS/cm, carbonate hardness 4 °dH, general hardness 4.5 °dH, Ca^{2+} 16.8–180 mg/l, and Cl^- 50–1070 mg/l.

Depth range: The species is more often found below 2 m water depth but may be present up to 4 m depth (Torn and Martin, 2004). In Germany, the Netherlands and in Sardinia *Chara connivens* is often found at depths below 1 m.

Associated species: A large range of associated species is listed in literature. As accompanying species are among others mentioned: *Chara aspera*, *C. globularis*, *C. hispida*, *C. tomentosa*, *C. vulgaris*, *C. virgata*, *Myriophyllum spicatum*, *Stuckenia pectinata*, *Najas marina* (Becker, 2016 and references therein). *Chara connivens* also occurs in monospecific stands.

24.4 Variability

Variability of the species is minor. Plants from deeper water or more dense communities are thin and slender with relatively long internodes and do not hold shape. Branchlets of sterile specimens do not curve inward, also some fertile specimens may have straight branchlets.

24.5 Identification and Risk of Confusion

Chara connivens cannot be differentiated from *C. globularis* when sterile. The differences are also minor with *C. virgata* if it is sterile and when the stipulodes of *C. virgata* are undeveloped. The spine-cells of *C. virgata* are larger compared to missing or rudimentary spine-cells of *C. connivens*. From spineless *C. aspera* or *C. aspera* with papilliformous spine-cells it can be differentiated by acute tips of stipulodes of *C. aspera* (Nielsen, 2004a). Dioecious *C. fragifera* can be distinguished from *C. connivens* by the characteristic multicellular bulbils of C. *fragifera* (Nielsen, 2004b).

24.6 Distribution

See Fig. 24.4.

The main distribution of *Chara connivens* in Europe is in Spain. Outside Europe, it has been detected along the Southern Mediterranean coast (Morocco, Algeria, Tunisia, Egypt, Syria, Israel), and Asia (e.g., Iran, Russia, India) (Ahmadi et al., 2012; Becker, 2016; Krause, 1997; Rybak and Woyda-Ploszczyca, 2019).

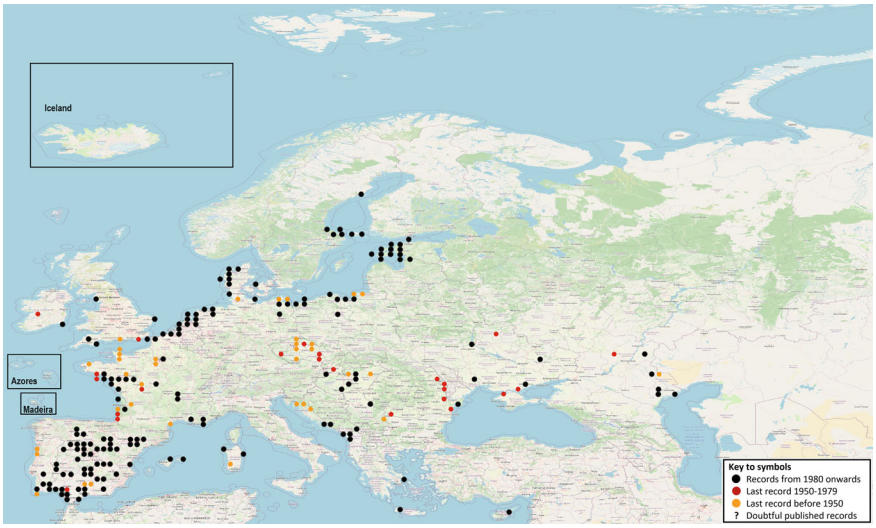

Fig. 24.4 Distribution of *Chara connivens* in Europe. For worldwide distribution see Korsch (2018). Black dots are records from 1980 on, red dots from 1950 to 1979 and yellow dots before 1950; unconfirmed/doubtful published records are marked with "?" on top. Map prepared by Heiko Korsch

24.7 Status and Threats

The species is extinct in several localities (Becker, 2016) where it had been described by Migula (1889–1897). *Chara connivens* was included in the previous HELCOM list of threatened and/or declining species. The species is not considered threatened in the Baltic Sea at the moment. In the Estonian waters *C. connivens* has become more common in recent decades and the species is rather frequent also along the Uppland coast in Sweden (HELCOM, 2013) with probably stable occurrence. One of the *Chara* collections in the Linnaean herbarium is *Chara connivens* (Gregor et al., 2019). In Germany it is a rare species in the past and at present. In the Netherlands it is rare at the Wadden Islands and the dune area of the North Sea and has more or less stable vegetations in peat puddles. *Chara connivens* is very rare in Italy and in other parts of the Mediterranean area (Becker, 2019) except the Iberian Peninsula, where it is regarded as rather common (Cirujano et al., 2008).

24.8 Remarks

The distribution vector of the species into the Baltic Sea is considered controversial. The species is assumed to have been introduced into the Baltic Sea by shipping (Leppäkoski and Olenin, 2000; Luther, 1979; Paavola et al., 2005). However, a natural

dispersal by waterfowl is rather probable (Blindow, 2009). In Finland, the species has been considered unsuitable for IUCN Red List assessment as an introduced species (Hyvärinen et al., 2019). Although, HELCOM (HELCOM, 2013), Sweden (SLU Artdatabanken, 2020) and Estonia (eElurikkus, 2021) have assessed the threats to the species. Trbojević et al. (2020) reported *Chara connivens* from Serbia, but it did not cluster with other *C. connivens*, but more closely with *C. globularis*.

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