Chapter 62
Nitella hyalina

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Scientific name: *Nitella hyalina* (DC.) C. Agardh, Syst. Alg: 126. 1824

≡ *Chara hyalina* DC. in Lam. & DC. Fl. Franç. (Lamarck) 5 & 6, ed. 3: 247. 1815
Lectotype (Wood, 1965: 660): Lac de grand lieu/1805/Hectot (G-DC)

= *Nitella hyalina* (DC. in Lam. & DC.) C. Agardh f. *maxima* A. Braun in Migula, Charac. Deutschl.: 196. 1890
Lectotype (Wood, 1965: 664): Dans les eaux de l'étang de Soustons près Bayonne/15. Mai 1877/L. Motelay (NY); Braun, Rabenhorst & Stizenberger, Characeen Eur. 107

= *Chara condensata* Rupr., Beitr. Pflanzenk. Russ. Reiches: 10. 1845

≡ *Nitella condensata* (Rupr.) Kütz., Sp. Alg.: 515. 1849
Lectotype (Romanov, 2021: 2): [Kazakhstan, East Kazakhstan Region, formerly Dzhungaria] [near Narym River] на берегу реки [at river bank] [illegible words] тучной земли [rich soil]/Августа [August] 18[illegible characters] [18.VIII.1838]/no collector (LE A0000403)

= *Chara interrupta* Rupr., Beitr. Pflanzenk. Russ. Reiches: 11. 1845

≡ *Nitella interrupta* (Rupr.) Kütz., Sp. Alg.: 516. 1849
Lectotype (Romanov, 2021: 2): [Kazakhstan, Karagandy Oblast], Dshilantschik [River]/25 Jul[i] [18]42/Schrenk (LE A0000413)

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Local names: DUTCH: Klein glanswier; ENGLISH: Many-branched stonewort; FINNISH: Kalvassiloparta; FRENCH: Nitelle hyaline; GERMAN: Vielästige Glanzleuchteralge; LITHUANIAN: Žalsvasis menturdumblis; RUSSIAN: Нителла гиалиновая; SWEDISH: Glas-slinke (Sweden), blekslinke (Finland); UKRAINIAN: Нітела гіалінова.

62.1 Morphology

Habitus: Plants of *Nitella hyalina* are rather delicate, consisting of strings of isolated heads with a thick mucus layer around the gametangia. Branchlets are arranged, at each axial node, in two distinctly different series (heteroclemous), comprising a primary whorl of branchlets and accessory whorls (see Figs. 62.1, 62.2c and 62.3a, b), in two rows, one above and one below each primary branchlet. The habitus has the appearance of a string of beads (moniliform), see Figs. 62.1a and 62.2a. The species is relatively resistant to deformation out of the water (Fig. 62.2b). *Nitella hyalina* is bright- to dark or brownish green and shiny. The plants can be encrusted with lime, according to Baumann (1911) even heavily encrusted. Under these circumstances the species has a grey-green appearance.

Size: *Nitella hyalina* is small to medium-sized (5–20[40] cm) but usually below 15 cm. In the Bodensee (Germany), France: Landes, Soustons près Bayonne and some deep pits in Portugal a form exists that can be 1 m in size (van Raam, 1998). In depths between 2 and 4 m in clear quarry ponds in northern Germany specimens are up to 35 cm long (R. Becker unpubl.).

Main axis: The main axis diameter is up to 0.8 mm but is mostly around 0.3 mm. The internodes are 2–4(5) times as long as the branchlets and have a size between 0.3 and 4.5 cm, but rarely exceed 1.5 cm (Becker, 2016b).

Cortex, spine-cells, stipulodes: Absent (but see Chap. 3 for stipulodes).

Branchlets: Whorls consist of 6–8(9) primary and 6–12(16) secondary (accessory) branchlets. The secondary branchlets are often curved downwards. The primary branchlets are between 0.3 and 1.1 cm in size, 2–3(4) times furcate, the accessories are much shorter and less furcate ([0]1–2 times). The dactyls are 2-celled (bicellulate), the end-cell is short and pointed/acute, see Figs. 62.1d, e and 62.2a. Young fertile branchlets are enveloped in mucus which is sometimes difficult to see. These plants attach to herbarium paper, and they glitter in direct sunlight.

Bract-cells, bracteoles, **bractlets**: Absent.

Sexuality: The species is monoecious and richly fertile, see Fig. 62.3a, c. Gametangia are conjoined at the second and the third (occasionally at the first) nodes of the primary branchlets and sometimes on the accessory branchlets. Usually the gametangia are enveloped in mucus (Fig. 62.3b).

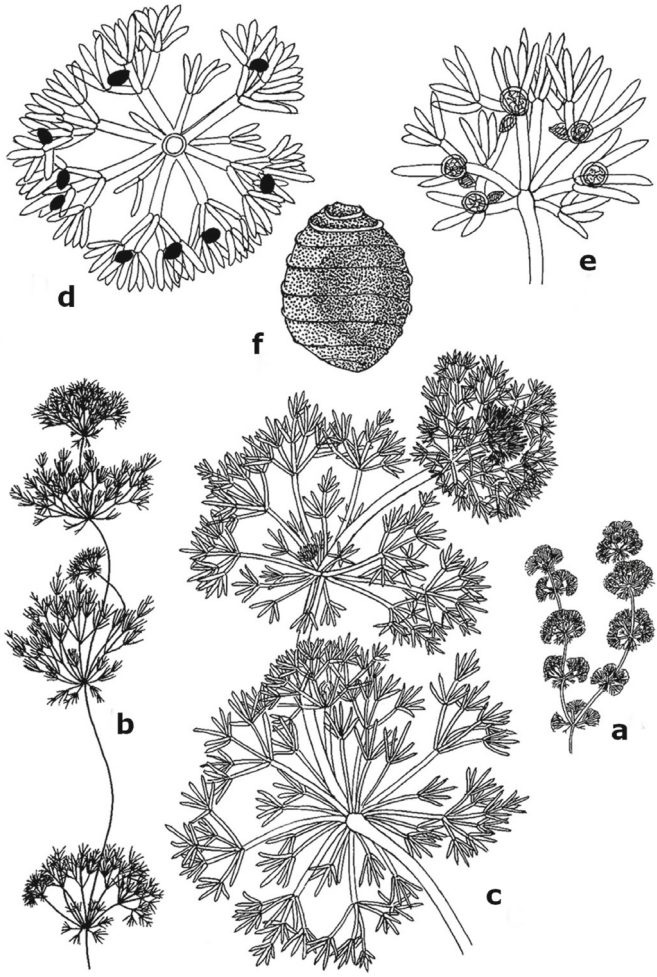

Fig. 62.1 *Nitella hyalina*. **a** Habitus appearance of young plant; **b** Habitus appearance of mature plant; **c** Top of plant; **d** Whorl with primary and secondary branchlets; **e** Fertile top; **f** Oospore. Drawings: Werner Krause

Oogonia: The length of the oogonia are very different among authors. Morphometric data of the oogonia are listed in Table 62.1.

Oospores: The oospore ornamentation is mostly described as fibrous, with fibrous flanges or finely granulate (see Fig. 62.2d, e). The striae are inconspicuous. Table 62.2 gives an overview of the morphometry and colour of the oospores.

Antheridia: The antheridia of *Nitella hyalina* are relatively small and the colour is orange to red. Table 62.3 gives an overview of the literature data on antheridia diameter.

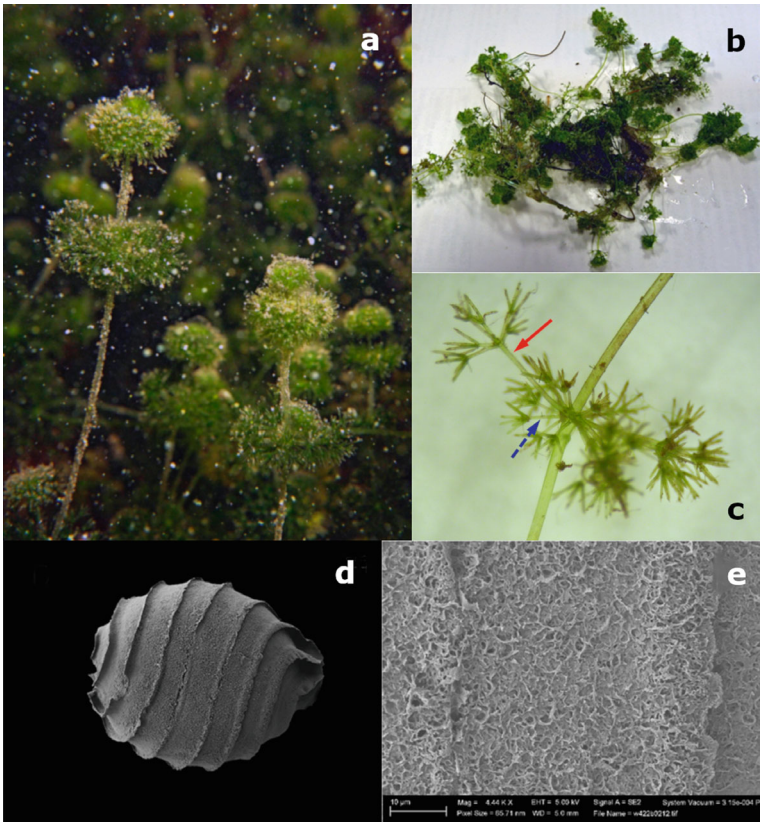

Fig. 62.2 *Nitella hyalina*, details. **a** Habitus appearance; **b** Shape retention when taken out of the water; **c** Node with branchlets (red arrow) and accessory branchlets (blue arrow); **d** SEM of oospore; **e** SEM of oospore-membrane showing fibrous oospore-membrane ornamentation. Photographs: **a**—Klaus van de Weyer; **b**—Emile Nat, **c**—János Csiky; **d**, **e**—Michelle T. Casanova

Bulbils: There are no reports about bulbil formation of *Nitella hyalina*.

62.2 Phenology and Reproduction

Nitella hyalina is predominantly an annual species both in north-western Europe and the Mediterranean region (M. Azzella pers. comm.). The oospores germinate in late Spring (April–May) and fructification is in the summer (August–September). Plants of *Nitella hyalina* can be found in north-west Europe until December and they disappear quickly in winter (van Raam, 1998). In Germany it is seems to be a perennial species in deeper lakes (Becker, 2016b) and can survive a frost period of several weeks (Becker, 2011).

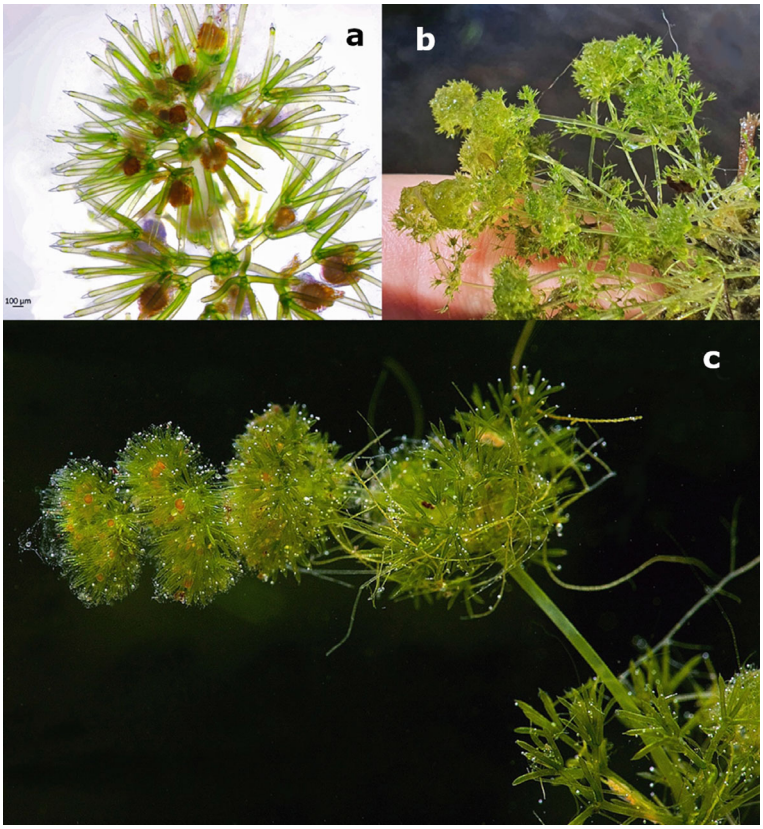

Fig. 62.3 *Nitella hyalina*, gametangia. **a** Branchlets with gametangia and end-cells; **b** Fertile heads enveloped in mucus; **c** Fertile whorls. Photographs: **a**—Dario J. Cavaliere; **b**—Wim Langbroek; **c**—Wil Leurs

62.3 Habitat Conditions and Ecology

Habitat type: *Nitella hyalina* can be found in ponds, pools, brooks, swamps, pits, lakes, oxbow lakes and in Germany and the Netherlands often in quarry ponds. Moreover, a large population was recently recorded in a shallow stormwater pond in north-west Germany (Becker et al., 2022). It can grow in freshwater as well as in brackish waterbodies, estuaries, groundwater wells and in the Finnish part of the Baltic (Corillion, 1957; Krause, 1997; Espinar et al., 2002; Koistinen, 2004; Cirujano et al., 2008; Herbarium specimens Naturalis, Leiden). This species can grow on bare substrates in sheltered openings of reed and bulrush stands, along the shorelines and even in exposed areas of lakes.

Table 62.1 Oogonia morphometry

Author	Length	Width	Coronula length	Coronula width	Number of helical stripes
Migula (1889–1897)	–	–	50–60	–	–
Groves and Bullock-Webster (1920)	500–625	375–400	45	–	9–10
Corillion (1957)	500–625	375–400	45	–	9–10
Wood (1965)	380–625*	260–400	(20)45–70	60–70	8–10
Moore (1986)	up to 400	up to 400	–	–	–
Krause (1997)	500–650	375–400	45–60	60	8–10
van Raam (1998)	up to 500	up to 400	–	–	–
Cirujano et al., (2008)	340–550	260–400	30–70	–	–
Bailly and Schaefer (2010)	350–400	350–400	–	–	–
Becker unpubl	(350)475–625*	(275)350–425	40–75	(45)60–80	8–10
Total range	**340–650**	**260–400(425)**	**(20)45–75**	**(45)60–70(80)**	**8–10**

*Including 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

Sediment: *Nitella hyalina* occurs on sandy or gritty substrates as well as on mud and sand with a (thin) peat layer (van Raam and Maier, 1995). Other substrates: lime mud (Krause, 1997) and clay, gyttja, silt and coarse sand (Koistinen, 2004).

Nutrient conditions: *Nitella hyalina* has a preference for mesotrophic to moderately nutrient-rich conditions (Schmidt et al., 1996). van Raam (1998) and van Raam and Maier (1992) consider this species as occurring in waterbodies low in nitrogen and phosphorus. There are only few data available for nutrient concentrations of waterbodies with *Nitella hyalina*. The records of total phosphorus range from 0.011 to 0.014 mg/l whereas values for ortho-phosphate are <0.015 mg/l in northern Germany (Doege et al., 2016). Data from Versener Heidesee near Meppen (with a huge population of *N. hyalina*) 2016/2017–2020 (4 samplings/year): TN 0.54–0.98 mg/l; NH4 0.03–0.27 mg/l; TP predominantly 0.016–0.031 mg/l but two single samples 0.5 respectively 0.67 mg/l (Böckermann et al., 2022). Data from six water bodies with *N. hyalina*-populations in north-western Germany have shown the following results between 2014 and 2020: TP 0.012–0.067 mg/l, TN 0.048–1.23 mg/l. (Becker et al., 2022). In the Netherlands the measured range for total phosphorus is 0.02–0.2 mg/l (Simons and Nat, 1996) and Azzella (2014) recorded in five Italian lakes the range 0.011–0.022 mg/l. The measured range for total nitrogen is 1.23–1.4 mg/l in Lower Saxonian waters (Becker, 2016b), 0.6–3.2 mg/l in the Netherlands (Nat et al., 1994;

Table 62.2 Oospore morphometry

Author	Length	Width	Number of striae	Colour
Migula (1889–1897)	300–350	280–320	6–7(8)	Reddish to black brown
Groves and Bullock-Webster (1920)	350	300	7–8	Reddish-brown
Corillion (1957)	350	300	7–8	Maroon to black brown
Wood (1965)	(250)300–350	(210) 280–320	6–7(8)	Light- to dark- to reddish-brown
Krause (1997)	300–350	300	6–8	Brown to black brown
van Raam (1998)	Up to 300	Up to 300	–	–
Cirujano et al., (2008)	300–350	260–320	–	Reddish to black brown
Bailly and Schaefer (2010)	Up to 300	Up to 300	7–9	Reddish-brown
Dilger (2010)	(330)338–380(390)	(250)270–320(330)	6–8(9)	Light brown to black
Becker (2016b), unpubl	325–375(400)	(225)275–325(350)	(6)7–8	Brown black
Total range	**(250)300–380(400)**	**(210)260–325(350)**	**6–8(9)**	

All values for length and width in μm

Table 62.3 Antheridia morphometry

Author	Diameter (μm)
Migula (1889–1897)	Up to 300
Groves and Bullock-Webster (1920)	350–425
Corillion (1957)	350–420
Wood (1965)	300–425
Moore (1986)	up to 400
Krause (1997)	350–400
van Raam (1998)	up to 400
Cirujano et al., (2008)	350–425
Bailly and Schaefer (2010)	Up to 400
R.Becker unpubl	(175)325–450(500)
Total range	**(<300)300–450(500)**

Simons and Nat, 1996) and in Italy 0.2–0.4 mg/l (Azzella, 2014). For ammonia the range is 0.067–0.077 mg/l and for nitrate 0.85–0.98 mg/l in northern Germany (Becker, 2016b). The range for ammonia in the Netherlands is 0.1–0.3 mg/l (Nat et al., 1994; Simons and Nat, 1996). In France and Portugal *Nitella hyalina* only grows in nutrient poor conditions (van Raam and Maier, 1995).

Water chemistry: *Nitella hyalina* prefers water with circumneutral to basic acidity. The recorded pH values range between 6.3 and 9.3. The species can be found in freshwater and also in brackish waterbodies (Moore, 1986; van Raam, 1998; Koistinen, 2004; Becker, 2019). The recorded conductivity values range between 28 and 1100 µS/cm. In north-western Germany conductivity ranges are 128–255 µS/cm, pH range from 7.1 to 9.3 and total hardness from 2,4 to 2,9 (Becker et al., 2022). In the Netherlands *Nitella hyalina* prefers calcareous conditions (van Raam, 1998) but it can be found in waters low in calcium as well (Doege et al., 2016). The species can be encrusted, total hardness ranges in between 2.0° dH and 3.2° dH, carbonate hardness varies between 1.5° dH and 3.0°dH. The maximum calcium concentration reported is 95.8 mg/l and maximum chloride concentration is 226 mg/l.

Depth range: *Nitella hyalina* prefers shallow water habitats and is usually found in locations with a water depth between 0.3 and 4 m. In lakes this species can be found at a depth of 8–11 m (Becker, 2016b). According to Corillion (1957) *Nitella hyalina* can withstand some dehydration when water levels drop in the summer. The thick mucus layer protects the gametangia in these conditions.

Associated species: *Nitella hyalina* is the character species of the *Nitellopsidetum obtusae* Sauer ex Dąmbska 1961. In most of the Dutch vegetation recordings *Nitella hyalina* is accompanied by *Nitellopsis obtusa* (van Raam, 1998). Other accompanying species are: *Nitella flexilis, Chara aspera*, *C. virgata, Eleocharis acicularis, Potamogeton berchtoldii, Utricularia vulgaris, U. minor, Elodea nuttallii* and *Ranunculus circinatus*. In NW Germany currently it occurs with: *Nitella opaca, N. translucens, Baldellia ranunculoides, Pilularia globulifera, Potamogeton alpinus* and *Myriophyllum alterniflorum.* In France and Portugal *Nitella hyalina* is accompanied by species of the *Littorelletea, Potametea or Phragmitetea*, e.g. *Chara braunii, C. fragifera, C. aspera, Nitella gracilis, N. confervacea* and *N. translucens* (Corillion, 1957; Krause, 1983b). Espinar et al. (2002) report for salt marshes in South-Spain the accompanying species *Chara connivens, C. canescens* and *C. galioides*. In Spain *Nitella hyalina* often grows in rice fields. This species is also the character species of the *Nitelletum hyalinae* Corillion, 1957 (Corillion, 1957; Csiky et al., 2014) and is characteristic as part of the *Nitelletum syncarpo-tenuissimae* W. Krause, 1969 (Krause, 1969). *Nitella hyalina* can also grow in monospecific stands of a few hundred square metres.

62.4 Variability

Nitella hyalina is hardly varying with respect to its habitus, except for its size. In lakes in France, the German Bodensee and deep pits in Portugal a large form is known: *Nitella hyalina* f. *maxima.* In these waters the plants can reach a height of 1 m.

62.5 Identification and Risk of Confusion

Nitella hyalina can be quite small and develop dense whorls. With this appearance it will resemble the following species: *Nitella tenuissima, N. confervacea* and *N. wahlbergiana*. The arrangement of branchlets in two distinctly different (heteroclemous) whorls consisting of a bigger primary whorl of branchlets and two smaller secondary (accessory) whorls of branchlets is a characteristic of *Nitella hyalina* that separates this species from *N. tenuissima, N. confervacea* and *N. wahlbergiana*. *Nitella congesta* is the dioecious counterpart of *Nitella hyalina* but it is rare and endemic in Australia.

62.6 Distribution

Nitella hyalina has a cosmopolitan distribution (Korsch, 2018). It roughly can be found between 65° north latitude and 50° south latitude and a number of oceanic islands like New Caledonia, New Zealand, Madagascar, Japan and Gran Canarias. The species is missing around the equator. In Europe the centre of distribution of *Nitella hyalina* is located in the western Mediterranean area and in France (Fig. 62.4). In southern Finland in the Baltic area there are some isolated habitats. Although the distribution area is large, *Nitella hyalina* is (very) rare at most sites.

62.7 Status and Threats

The disappearance of *Nitella hyalina* at many sites in Europe is quite attributable to the destruction of its habitats. Especially the loss of small waterbodies is a major threat for the species. Apart from this, for the area of Zürich (Switzerland) Schwarzer (2019) mentioned eutrophication, increase in water turbidity, anthropogenic interference, strong predation by non-domestic herbivorous fish and waterfowl and competition from vascular plants as the main risk factors. *Nitella hyalina* can disappear and reappear quite suddenly for no apparent reason. That makes water management and the carrying out of species protection programs difficult. The current example of

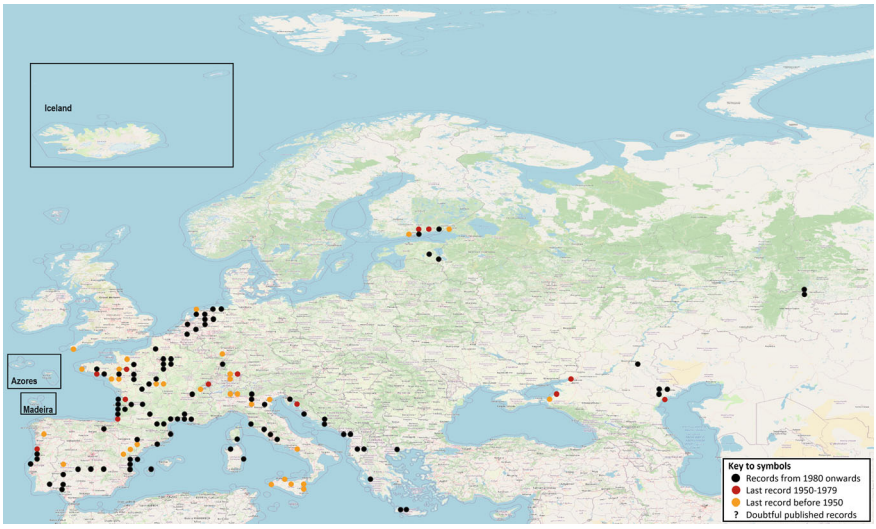

Fig. 62.4 Distribution of *Nitella hyalina* in Europe. For worldwide distribution see Korsch (2018). Black dots are records from 1980 on, red dots from 1950 to 1979 and yellow dots before 1950; unconfirmed/doubtful published records (if applicable) are marked with "?" on top. Map prepared by Heiko Korsch

a mesotrophic lake in north-western Germany with stable and huge stands of *N. hyalina* for more than 15 years, demonstrates, that such a population can almost be destroyed within less than two years by changes in fishery exploitation.

On the other hand this species can tolerate some disturbance: In the Croatian site (on the island of Pag), sheep use the small pond as drinking water, which they use every day in the summer. Therefore the turbidity and eutrophication in the water body is relatively high. Despite these conditions, this species has been found in the pond several times from 2007 to 2017 (July–August). In some cases, the stands were covered by a thin layer of cyanobacteria/filamentous algae (as a result of eutrophication), but they survived. This phenomenon (thin cyanobacteria layer on the thalli) has been reported in other cases with other *Nitella* species, in shallow ponds, puddles (with muddy bottom) in Hungary (J. Csiky pers. comm.).

Nitella hyalina is threatened according to several national European Red Lists (Becker, 2016a). The species is Critically Endangered in the Balkan countries and in Germany (Korsch et al., 2013), Endangered in the Netherlands (van Raam, 2002) and Vulnerable in Finland (Koistinen, 2010) and Spain (Cirujano et al., 2008). *N. hyalina* is Extinct in Great Britain (JNCC 2004) and Regionally Extinct in Switzerland (Auderset Joye and Schwarzer, 2012).

Throughout Europe *N. hyalina* occurs in several habitat types of Community Interest encoded in Annex I of the Habitats Directive 92/43EC (European Commission, 1992). This applies particularly to the oligo- and mesotrophic freshwater habitat types 3110, 3130 and 3140. Moreover, especially in the Mediterranean area, coastal

lagoons, encoded as priority habitat type *1150 are in some regions the habitat of *N. hyalina* (e.g., Becker, 2019). From the national point of view various waterbodies are protected as nature reserves or have a related status of conservation.

N. hyalina is not a pioneer species and requires particularly stable oligo- and mesotrophic freshwater habitats.

With regard to the conservation of *Nitella hyalina* appropriate actions are needed. The main actions for protection and conservation are:

- prevention from damage of habitats,
- prevention/reduction of input of nutrient and pollutants,
- prevention/reduction of use-related impairments,
- preservation of the hydrological regimes,
- removal of cyprinids, predominantly carp and bream
- establishment of protected areas
- implementation of valid Action Plans.

In Switzerland an Action Plan focusing on *Nitella hyalina* is already in the process of implementation (Schwarzer, 2019), for Germany and Sardinia national or regional Action Plans are postulated (Becker, 2016b, 2019).

References

Agardh, C. A. (1824). *Systema Algarum.* Berling. [in Latin].

Auderset Joye, D., & Schwarzer, A. (2012). *Rote Liste Armleuchteralgen. Gefährdete Arten der Schweiz, Stand 2010.* Bundesamt für Umwelt BAFU & Laboratoire d'Ecologie et de Biologie Aquatique der Universität Genf (p. 72) [in German].

Azzella, M. M. (2014). Italian Volcanic lakes: A diversity hotspot and refuge for European charophytes. *Journal of Limnology, 73*, 502–510.

Bailly, G., & Schaefer, O. (2010). *Guide illustré des Characées du nord-est de la France* (p. 96). Conservatoire Botanique National de Franche-Comté [in French].

Baumann, E. (1911). Die Vegetation des Untersees (Bodensee). *Archiv für Hydrobiologie, Supplement 1*, I-V, 1–554, Tafeln I-XV [in German].

Becker, R. (2016a). Gefährdung und Schutz von Characeen. In: Arbeitsgruppe Characeen Deutschlands, *Armleuchteralgen: Die Characeen Deutschlands* (pp. 149–191). Springer [in German].

Becker, R. (2016b). *Nitella hyalina.* In: Arbeitsgruppe Characeen Deutschlands, *Armleuchteralgen: Die Characeen Deutschlands* (pp. 443–455). Springer [in German].

Becker, R. (2011). Erstfund der Vielästigen Glanzleuchteralge *Nitella hyalina* (DC.) Agardh in Niedersachsen. *Berichte der Botanischen Arbeitsgemeinschaft Südwestdeutschlands Beiheft, 3*, 5–10. [in German].

Becker, R. (2019). The Characeae (Charales, Charophyceae) of Sardinia (Italy): Habitats, distribution and conservation. *Webbia, 74*, 83–101.

Becker, R., Fuhrmann, K., Meyer-Spethmann, U., Sinkowski, M., & Willen, M. (2022). Verbreitung, Populationsentwicklung und Schutz besonders gefährdeter Arten der Armleuchteralgen (Charales, Characeae) in Nordwestdeutschland. *Drosera, 40*, 81–100. [in German].

Böckermann, T., Becker, R., & Willen, M. (2022). Der Versener Heidesee – vom Baggersee zum fischfreien Hotspot für gefährdete Pflanzenarten in Nordwestdeutschland. *Drosera, 40*, 37–54.

Cirujano, S., Cambra, J., Sánchez Castillo, P. M., Meco, A., & Flor Arnau, N. (2008). *Flora ibérica. Algas continentales. Carófitos (Characeae)* (p. 132). Real Jardín Botánico [in Spanish].

Corillion, R. (1957). Les Charophycées de France et d'Europe Occidentale. *Bulletin de la Société Scientifique de Bretagne, 32* (Hors série I & II), 1–499 [in French].

Csiky, J., Purger, D., & Blaženčić, J. (2014). New occurrence and distribution of *Nitella hyalina* (DC.) Agardh (Characeae) and the first report on *Nitelletum hyalinae Corillion* 1957, in Croatia. *Archiv of Biological Science, 66*, 203–208.

Dilger, M. (2010). Merkmale zur Erkennung von *Nitella*- und *Tolypella*-Arten der Characeaen [sic] über Oosporen aus Sedimenten oder von Pflanzen. *Rostocker Meeresbiologische Beiträge, 23*, 40–59. [in German].

Doege, A., van de Weyer, K., Becker, R., & Schubert, H. (2016). Bioindikation mit Characeen. In Arbeitsgruppe Characeen Deutschlands, *Armleuchteralgen: Die Characeen Deutschlands* (pp. 97–138). Springer [in German].

Espinar, J. L., Garcia, L. V., Garcia Murillo, P., & Toja, J. (2002). Submerged macrophyte zonation in a Mediterranean salt marsh: A facilitation effect from established helophytes? *Journal of Vegetation Science, 13*, 831–840.

European Commission. (1992). Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. *Official Journal of the European Communities L 206*, 7.

Groves, J., & Bullock-Webster, G. R. (1920). *The British Charophyta* (p. 405). Ray Society.

JNCC [Joint Nature Conservation Committee]. (2004). *Conservation Designations for UK Taxa.* http://jncc.defra.gov.uk/page-3408.

Koistinen, M. (2004). *Nitella hyalina.* In H. Schubert, & I. Blindow (Eds.), *Charophytes of the Baltic Sea* (pp. 186–192). A. R. G. Gantner.

Koistinen, M. (2010). *Näkinpartaislevät*. In P. Rassi, E. Hyvärinen, A. Juslén, & I. Mannerkoski (Eds.), *Suomen lajien uhanalaisuus: Punainen kirja 2010* (pp. 204–207). Ympäristöministeriö & Suomen ympäristökeskus.

Korsch, H. (2018). The worldwide range of the Charophyte species native to Germany. *Rostocker Meeresbiologische Beiträge, 28*, 45–96.

Korsch, H., Doege, A., Raabe, U., & van de Weyer, K. (2013). Rote Liste der Armleuchteralgen (Charophyceae) Deutschlands. 3. Fassung, Stand: Dezember 2012. *Hausskechtia Beiheft, 17*, 1–32. [in German].

Krause, W. (1969). Zur Characeenvegetation der Oberrheinebene (Characeae in the upper plain of the Rhine). *Archiv Für Hydrobiologie, Supplement, 35*, 202–253. [in German].

Krause, W. (1983). Characeen-Standorte in Portugal mit besonderer Rücksicht auf den Einfluß des Menschen. *Tuexenia, 3*, 289–296. [in German].

Krause, W. (1997). Charales (Charophyceae) Süßwasserflora von Mitteleuropa. In H. Ettl, G. Gärtner, H. Heynig, & D. Mollenhauer (Eds.), *Süßwasserflora von Mitteleuropa BD 18.* Fischer [in German].

Migula, W. (1889–1897). Fünfter Band: Die Characeen. In A. Fischer, E. Fischer, F. Hauck, G. Limpricht, C. Luerssen, W. Migula, H. Rehm, P. Richter, & G. Winter (Eds.) *Dr. L. Rabenhorst's Kryptogamenflora von Deutschland, Oesterreich und der Schweiz* (2nd ed.). Eduard Kummer [in German].

Moore, J. A. (1986). *Charophytes of Great Britain and Ireland*. BSBI Handbook 5. Botanical Society of the British Isles.

Nat, E., Simons, J., de la Haye, M. A. A., & Coops, H. (1994). *Historisch en actueel verspreidingsbeeld van kranswieren in Nederland in samenhang met waterkwaliteitsfactoren.* RIZA werkdocument 94.148X (p. 77). Lelystad [in Dutch].

van Raam, J. C. (1998). *Handboek Kranswieren.* Chara boek [in Dutch].

Romanov, R. E. (2021). Typification of *Chara* (Charales, Charophyceae) species described by C.F. Lessing, F.J. Ruprecht and M.M. Hollerbach. *Notulae Algarum, 213*, 1–7.

Schmidt, D., van de Weyer, K., Krause, W., Kies, L., Garniel, A., Geissler, U., Gutowski, A., Samietz, R., Schütz, W., Vahle, H.-C., Vöge, M., Wolff, P., & Melzer, A. (1996). Rote

Liste der Armleuchteralgen (Charophyceae) Deutschlands. 2. Fassung, Stand: Februar 1995. *Schriftenreihe Für Vegetationskunde, 28*, 547–576. [in German].

Schwarzer, A. (2019). Aktionsplan Vielästige Glanzleuchteralge (*Nitella hyalina* (DC.) C. Agardh). AP ZH 1–53. *Artenschutzmassnahmen für gefährdete Farn- und Blütenpflanzen im Kanton Zürich* (p. 30). Fachstelle Naturschutz Zürich [in German].

Simons, J., & Nat, E. (1996). Past and present distribution of stoneworts (Characeae) in The Netherlands. *Hydrobiologia, 340*, 127–135.

van Raam, J. C. (2002). Rode lijst 2000 voor de Nederlandse kranswieren. *Nieuwsbrief Kranswieren, 6*(11), 7–8.

van Raam, J. C., & Maier, E. X. (1992). Overzicht van de Nederlandse kranswieren. *Gorteria, 18*, 111–116. [in Dutch].

van Raam, J. C., & Maier, E. X. (1995). Nederlandse kranswieren. 5. Klein glanswier [*Nitella hyalina* (DC.) Agardh]. *Gorteria, 21*, 101–106. [in Dutch].

Wood, R. D. (1965). *Monograph of the Characeae.* J. Cramer.