

Typification of *Chara connivens* Salzmänn ex A. Braun f. *brevifolia* Vilhelm, *C. crinita* Wallroth and *C. glomerulifera* Ruprecht and clarification of conflicting species concepts for *C. arcuatifolia* Vilhelm (Charales, Charophyceae)

Roman Evgenevich Romanov, Komarov Botanical Institute of the Russian Academy of Sciences, Professora Popova Str., 2, 197376, St. Petersburg, Russia (correspondence: romanov_r_e@ngs.ru)

The original material for three charophyte species and one form described by Wallroth (1815), Ruprecht (1845) and Vilhelm (1928, 1930) was located in the Herbarium of the Komarov Botanical Institute of the Russian Academy of Sciences (LE) in attempt to clarify their nomenclature and taxonomy. Study of the original material allowed designation of lectotypes here in accordance with ICN Art. 9.3 (Turland & al., 2018) and clarification of conflicting species concepts in case of *C. arcuatifolia* (cf. Wood & Imahori, 1965; Hollerbach & Krassavina 1983; Han & Li, 1994). The specimens are mostly stored in paper envelopes, but the envelope labels are usually not the original ones, and both labels are cited below for cases if they are different. Russian text in labels is reproduced with a translation in brackets. LE barcodes are indicated for each studied specimen.

Chara arcuatifolia Vilhelm 1928: 23 ('*arcuatifolia*')

Lectotype (designated 'as Neotype and probable Lectotype of *C. arcuatifolia*' by Wood in Wood & Imahori 1965: 178, here accepted as lectotype): Prov: Turgai, Челкаръ, река Каульдзуръ [Chelkar, Kauldzhur River] / 24 VI 1910 / N.Androssow / Plantae Turkestanicae / [dioecious plants] (LE A0001543).

Isolectotypes (here designated): Rossia asiatica. Turkestan. Prov. Turgai. Czelkar, fl. Kauldzhur / 24 VI 1910 / N.Androssow (LE A0001539, A0001540, A0001541).

= *C. globularis* Thuillier var. *globularis* R.D.Wood f. *arcuatifolia* (Vilhelm) R.D.Wood in R.D.Wood et Imahori 1965: 178. Lectotype (designated by Wood in Wood & Imahori 1965: 178): Czelkar, in fl. Kauldzhur / 24 VI 1910 / N.Androschow (LE A0001543).

Current name: *Chara connivens* Salzmänn ex A. Braun 1835: 73. Neotype (designated by Wood & Imahori 1965: 177): Tanger / without a date / Salzmänn (PC).

Specimen in the protologue: '*Rossia asiatica. Turkestan. Transcaspia. Prov. Turgai. Syr-Darja. Buchara. Czelkar, fl. Kauldzhur* (4.VI.1910, leg. N.Androschow)'.

Original material (LE!): 1. Authentic label: Prov: Turgai, Челкаръ, река Каульдзуръ [Kazakhstan, Aktobe Region, Chelkar (Shalkar), Kauldzhur River] / 24 VI 1910 / N.Androssow / Plantae Turkestanicae (LE A0001539). Envelope label: Rossia asiatica. Turkestan. Prov. Turgai. Czelkar, fl. Kauldzhur / 24 VI 1910 / N.Androssow. 2. Envelope labels: Rossia asiatica. Turkestan. Prov. Turgai. Czelkar, fl. Kauldzhur / 24 VI 1910 / N.Androssow (LE A0001540, A0001541, A0001543). The authentic labels by collector are missing. – Entangled with less abundant *C. globularis* in nearly all cases, but one envelope contains only *C. connivens* (LE A0001543, see below).

Comments: This species was described under name '*Chara arcuatifolia*' and is here corrected to '*arcuatifolia*' in accordance with ICN Art. 60.10 (Turland & al. 2018). The printed label of original material was reproduced by Vilhelm, although it included all the sites visited by Androschow. The locality '*Czelkar, fl. Kauldzhur*' was specifically underlined, indicating the type locality for *C. arcuatifolia* (Hollerbach, 1950). *Chara arcuatifolia* was described as monoecious in the protologue, although the gametangia were described as 'solitary in different whorls' ('*antheridia et cystocarpia solitaria in verticillis singulis*', Vilhelm, 1928: 23), which could be interpreted as formation of antheridia and oogonia in different whorls of the same plant. The original material of *C. arcuatifolia* is consisted of entangled thalli of two species – more abundant dioecious *C. connivens* and less abundant monoecious *C. globularis* (LE!). The results

of a study of original material could be interpreted as evidence of an opinion of Vilhelm that he had specimens of a single species having oogonia and antheridia at different whorls of the same plant. The entangled male and female thalli of *C. connivens* were interpreted by him as monoecious plants. Such a pattern of gametangial formation is entirely unknown for extant charophytes. The less-abundant material of *C. globularis* was overlooked by Vilhelm. The part of original material received as a loan in 1958 by Wood and Imahori (LE A0001543) consisted of dioecious plants only. Thus, although not all original material was available to Wood, he was closer to correct interpretation by Vilhelm than Hollerbach (see below) and the typification suggested by Wood is correct. Therefore, a neotype of *C. arcuatifolia* selected by Wood (Wood & Imahori 1965: 179) is correctly a lectotype and accepted as such here. *Chara arcuatifolia* differs from *C. connivens* in the smaller number of branchlet segments (Wood & Imahori, 1965), which seems to be insufficient for its maintenance as a separate species. The presence of both conjoined and sejoined gametangia at the same plant was suggested as the most important trait for evaluation of *C. arcuatifolia* as a species by Hollerbach but resulted in erroneous species concept (Hollerbach & Krassavina, 1983). It can be easily explained by presence both dioecious *C. connivens* and monoecious *C. globularis* in original material of *C. arcuatifolia*. The species concept of Hollerbach & Krassavina (1983) cannot be confirmed with thorough morphological studies in many populations as well as with original material (Romanov, unpubl. data). The presence of two similar species in original material resulted in merging of traits of both species (Hollerbach & Krassavina, 1983). A study of plants with the morphology of *C. arcuatifolia* according to the description by Hollerbach & Krassavina (1983) from a wide spectrum of Eurasian regions, i.e., between the Baltics, Central Asia and Baikal Siberia implemented by the author, suggests that the morphotype of *C. globularis* having arcuate branchlets was reported as *C. arcuatifolia* from the territory of the former USSR, mostly occurring at excessive insolation, especially in wave-exposed habitats.

Chara connivens Salzm. ex A. Braun f. *brevifolia* Vilhelm 1930: 593

Lectotype (here designated): Fl. Kaulidžur, distr. Irgis, gov. Turgai / 24 VI 1910 / N. Androssow / [dioecious plants] (LE A0001545).

Isolectotypes: 1. Fl. Kaulidžur, distr. Irgis, gov. Turgai / 24 VI 1910 / N. Androssow (LE A0001546). 2. *Rossia asiatica*. Turkestan. Prov. Turgai. Czelkar, fl. Kauldzhur / 24 VI 1910 / N. Androssow (LE A0001543).

Current name: *Chara connivens* Salzm. ex A. Braun 1835: 73. Neotype (designated by Wood & Imahori 1965: 177): Tanger / without a date / Salzm. (PC).

= *C. globularis* Thuillier f. '*arcuatifolia*' (Vilhelm) R.D. Wood in R.D. Wood & Imahori 1965: 178. Lectotype (designated by Wood in Wood & Imahori 1965: 178): Czelkar, in fl. Kauldzhur / 24 VI 1910 / N. Androssow (LE A0001543).

Specimen in the protologue: '*Rossia: Gouv. Leningrad. Gatschina* (3/VIII 1846, leg. Ruprecht). – *Turkestan. Gouv. Turgai, distr. Irgis. Fl. Kauldzhur* (24/VI 1910, leg. N. Androssow). – [Herb. Acad. Sc. Leningr.]'.

Syntypes (LE!): 1. *Gouv. Petropolis. Gatschina* / 03.08.1846 / Ruprecht (LE A0001547). 2. Envelope label: Fl. Kaulidžur, distr. Irgis, gov. Turgai [Kazakhstan, Aktobe Region, Kauldzhur River] / 24 VI 1910 / N. Androssow. Authentic labels by collector are missing. (LE A0001545, A0001546). – Both specimens from Kazakhstan contain entangled *C. connivens* f. *brevifolia* and *C. globularis*.

Comments: See above for *C. 'arcuatifolia'*, *C. arcuatifolia* and *C. connivens* f. *brevifolia* Vilhelm, described from the same original material (Vilhelm, 1928, 1930), are based on the same species and, therefore, should be recognized as a synonyms. The syntype from Gatchina belongs to *C. globularis*, as indicated by Luther in his *determinavit* slip (Luther, 1979; LE A0001547). The

lectotype was selected among two other syntypes, storing in the envelopes labelled as *C. connivens* f. *brevifolia* by Vilhelm.

Chara crinita Wallroth 1815: 190

Lectotype (here designated): *In stagno Koelmensi pone Halam. cop.* / no date / Wallroth / Hb. Schrader (LE A0001536).

Current name: *Chara canescens* Loiseleur 1810: 139. Lectotype (designated by Wood in Wood & Imahori 1965: 159): *in aquis stag. circa Tolonum* / no date / no collector (PC, herb. Desvaux).

Specimen in the protologue: ‘*In stagno Kölmensi uberrime: passim quoque ad Wansleben*’.

Original material (LE!): Authentic labels: 1. *In stagno Koelmensi pone Halam [In a stagnant water belonging to Koellme behind Halle]. cop[iose]* / no date / d[edit] Wallroth / Hb. Schrader (LE A0001536). 2. *Koelme pr[o]pe Halle* / no date / Wallroth / Hb. Schrader (LE A0001538).

Comments: Wood selected a neotype for *C. crinita* because he had failed to locate original Wallroth material; however, original material for this name has been found thus superseding neotype designation in accordance with ICN Art. 9.19 of the Code. Both specimens of the original material include female plants only belong to this species. The more abundant specimen with the label closer to the protologue was selected as a lectotype.

Chara glomerulifera Ruprecht 1845: 7

Lectotype (here designated): *des. Cumanum* / MB. [Marshall von Bieberstein] / no date (LE 01157113)

Current name: *Tolypella glomerata* (Desvaux) Leonhardi 1863: 129. Lectotype (designated by Wood in Wood & Imahori 1965: 733): *in rivulis* / without a date / Desvaux (PC).

Specimen in the protologue: ‘*In aquis pigris deserti Cumani* (Hb. M. Bieb. [Bieberstein])’.

Original material (LE!): *des[erto] Cumanum* [Russian Federation, south-east of European Russia] / MB. [Marshall von Bieberstein] / no date (LE 01157113).

Comment: Original material was discovered in the personal collection of F.A. Marschall von Bieberstein (1768–1826) stored separately at LE. It contains three small sheets of contemporaneous paper with specimens of *C. glomerulifera*. They are mounted on a single herbarium sheet together with the envelope containing fragments of male and female plants of *Nitella opaca* (Bruzelius) C.Agardh without indication of a species name for the latter. All plants of *C. glomerulifera* were treated with acid and pressed again in 1845 according to Ruprecht’s notes, which allowed for keeping them in excellent condition over time. Handwritten *determinavit* slips are also mounted on this sheet, which the specimens are determined as *Chara flexilis* Thuillier and *C. translucens* Persoon and published by Marschall a Bieberstein (1808: 377). These specimens agree with the description of Ruprecht (1845), but the locality given on the label is briefer than that given in the protologue. It is reasonable to assume that the two species, *C. glomerulifera* and *N. opaca*, were collected from the same freshwater locality. Precise georeferencing is impossible but seems to be located within a drainage basin of the Kuma River, a tributary of the Caspian Sea. *Chara glomerulifera* is a junior synonym for *C. glomerata* Desvaux, the basionym for the current name *Tolypella glomerata*.

I am grateful to Ivan Tatanov for a search of the algal specimens in the herbarium of Marschall von Bieberstein, Eva Haiduk and Norbert Holstein for recognizing and clarification of the text at handwritten label by Wallroth, Thomas Gregor, anonymous reviewer, and Michael D. Guiry for suggestions for improvement of the manuscript. This work was supported partly by the Russian Foundation for Basic Research, project No. 20-04-00280, partly by the project AAAA-A18-118022090078-2 of the Komarov Botanical Institute of the Russian Academy of Sciences.

Han, F.S. & Li, Y.Y. (Eds) (1994). *Flora algarum sinicarum aquae dulcis*. Tomus 3. Charophyta.

- Beijing: Science Press. pp. i–vii, 1–267. [In Chinese]
- Hollerbach, M.M. (1950). Sistematically spisok kravykh vodoroslei, obnaruzhennykh v predelakh SSSR po 1935 g. vkluchitelno [The systematic list of charophytes, found on USSR territory till 1935 inclusively]. *Trudy Botanicheskogo Instituta im. V.L. Komarova AN SSSR. Ser. 2. Sporovye rasteniya* 5: 20–94. [In Russian]
- Hollerbach, M.M. & Krassavina, L.K. (1983). *Opredelitel presnovodnykh vodorosley SSSR. Vyp. 14. Kharovyie vodorosli – Charophyta* [The identification manual of freshwater algae of the USSR. Iss. 14. The charophytes – Charophyta]. pp. 1–190. Leningrad: Nauka. [In Russian]
- Leonhardi, H.F. v[on] (1863). Die bisher bekannten Oesterreichischen Armleuchter-Gewächse besprochen von morphogenetischen Standpuncte. *Sitzungsberichte Verhandlungen des naturforschenden Vereines in Brünn* 2: 122–224.
- Loiseleur Deslongschamps, J.L.A. (1810). *Notice sur les plantes à ajouter à la flore de France (Flora Gallica) avec quelques corrections et observations*. pp. 1–172, 21 pls. Paris: J.B. Sajou.
- Luther, H. (1979). *Chara connivens* in the Baltic Sea area. *Annals of Botany Fennici* 16: 141–150.
- Marschall a Bieberstein, L.B.F. (1808). *Flora taurico-caucasica exhibens stirpes phaenogamas*, in Chersoneso Taurica et regionibus caucasicis sponte crescentes. Tomus 1. pp. [i]–vi, [1]–428 [Errata]; Tomus II. Pp. [1]–477 [+ Errata for tomus I and II]. Charkouiae: Typis Academicis.
- Ruprecht, F.J. (1845). Distributio cryptogamarum vascularium in Imperio Rossico. *Beiträge der Pflanzenkunde des Russischen Reiches*. Dritte Lieferung. pp. [1]–56. Petropoli [St Petersburg]: Buchdruckerei der Kaiserlichen Akademie der Wissensehaften.
- Sakayama, H., Kasai, F., Nozaki, H., Watanabe, M.M., Kawachi, M., Shigyo, M., Nishihiro, J., Washitani, I., Krienitz, L. & Ito, M. (2009). Taxonomic reexamination of *Chara globularis* (Charales, Charophyceae) from Japan based on oospore morphology and *rbcL* gene sequences, and the description of *C. leptospora* sp. nov. *Journal of Phycology* 45(4): 917–927.
- Thuillier, J.L. (Ann VII [1799]). *Flore des environs de Paris*, ou, Distribution méthodique des plantes qui y croissent naturellement, Faite d'après le système de Linnée: avec le nom et la description de chacune et latin et in françoise; l'indications de leur lieu natal, de leur durée, du temps de leur florasion, de la coluleur de leurs fleurs, et al citation de Auteurs qui les ont le mieux décrites ou en ont donées les meilleures figures. Nouvelle édition: revue corrigée et considérablement augmentée [éd. 2]. pp. 1–595. Paris: Chez l'Auteur et H.L. Perronneau.
- Turland, N.J., Wiersema, J.H., Barrie, F.R., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Kusber, W.-H., Li, D.-Z., Marhold, K., May, T.W., McNeill, J., Monro, A.M., Prado, J., Price, M.J. & Smith, G.F., editors (2018). *International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code)* adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. *Regnum Vegetabile*, Vol. 159. pp. [i]–xxxviii, 1–253. Glashütten: Koeltz Botanical Books.
- Vilhelm, J. (1928). Characeae Europae orientalis et Asiae ex herbario instituti cryptogamici horti botanici reipublicae rossicae (ante Petropolitani). *Spisy vydávané Přírodovědeckov Fakultov Karlovy University (Publications de la Faculté des Sciences de l'Université Charles, Praha)* 80: 1–24, 1 pl.
- Vilhelm, J. (1930). Ad Characearum Europae orientalis et Asiae additamentum. *Bulletin Jardin Botanique Principal de l'URSS* 29(5–6): 582–596. [In Russian and Latin]
- Wallroth, K.F.G. (1815). *Annus botanicus, sive supplementum tertium ad Curti Sprengelii floram halensem*. pp. [i]–xxx, [1]–194, pls I–VI. Halae [Halle]: sumptibus Car. Aug. Kümmelii.
- Wood, R.D. & Imahori, K. (1964). *A revision of the Characeae*, 2. Iconograph of the Characeae. Monograph of the Characeae. pp. v–xv, 1–5, icons 1–395. Weinheim: Verlag von J.Cramer.
- Wood, R.D. & Imahori, K. (1965). *A revision of the Characeae*. First Part. Monograph of the Characeae. pp. i–xxiv, 1–904. Weinheim: Verlag von J.Cramer.
- Zaneveld, J.S. (1941). The Charophyta of Malaysia and adjacent countries. *Blumea* 4: 1–223.