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Some Charophytes (Characeae, Charophyta) from central and western of Iran including *Chara kohrangiana species nova*

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Abstract – Stoneworts are a conserved group within green algae which usually inhabit in submerged conditions of slow running and standing water. Charales is a difficult taxonomical group regarding species identification. This paper records 13 species of charophytes within three genera found in about eighty localities from Iran. The taxa *Chara connivens, C. contraria, C. crassicaulis, C. fibrosa, C. grovesii, C. gymnophylla* (two varieties *C. gymnophylla* var. *gymnophylla* and *C. gymnophylla* var. *rohlenae*), *C. kirghisorum, C. pedunculata, C. socotrensioides, C. tomentosa, C. vulgaris* (*C. vulgaris* var. *longibracteata* and *C. vulgaris* var. *vulgaris*), *Nitella hyalina* and *Tolypella glomerata* were studied, including vegetative and oospore characteristics of them. *C. vulgaris* and *C. gymnophylla*, are the most common species. The species *C. kohrangiana* is proposed as a new monoecious species characterized by stipulodes developed in one row, anterior and posterior bract-cells, ecorticate branchlets and diplostichous incomplete axial cortex. *C. kohrangiana* belongs to subgenus *Charopsis* section *Agardhia* subsection *Agardhia*.

Charophytes / *Chara* / *Nitella* / *Tolypella* / *Chara kohrangiana* / determination / taxonomy

Résumé – Les Charales constituent un groupe ancien au sein des algues vertes qui se trouve généralement submergées dans des eaux calmes ou stagnantes. L'identification des espèces de cet ordre est une tache le plus souvent difficile. Dans cette étude couvrant huit localités en Iran, 13 espèces de Charales appartenant à trois genres ont été répertoriées et observées. Les taxa *Chara connivens, C. contraria, C. crassicaulis, C. fibrosa, C. grovesii, C. gymnophylla* (deux variétés *C. gymnophylla* var. *gymnophylla* et *C. gymnophylla* var. *rohlenae*), *C. kirghisorum, C. pedunculata, C. socotrensioides, C. tomentosa, C. vulgaris* (*C. vulgaris* var. *longibracteata* et *C. vulgaris* var. *vulgaris*), *Nitella hyalina* et *Tolypella glomerata* ont été étudiés par le biais d'observations morpho-anatomiques de l'appareil végétatif et de l'observation au MEB des oospores de la plupart des taxa. *C. vulgaris* et *C. gymnophylla*, sont les espèces les plus communes. Une nouvelle espèce, *C. kohrangiana* est proposée ; elle est caractérisée par des individus monoïques ayant des stipulodes développés sur une ligne, des cellules antérieures et postérieures, des ramifications non cortiquées et un cortex axial diplostique et incomplet. *C. kohrangiana* appartient au sous-genre *Charopsis* section *Agardhia* subsection *Agardhia*.

Charophytes / *Chara* / *Nitella* / *Tolypella* / *Chara kohrangiana* / détermination / taxonomie

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Joop Van Raam is died on the 1st October 2011.

INTRODUCTION

The Characeae, variously known as stoneworts, musk grasses, bass weeds, or just *Chara*, constitute a group of freshwater macrophytes (Wood & Imahori, 1964). The morphology of the Charophytes is very distinctive, with a main axis formed by cells of unlimited growth (internodes; each segment unicellular), separated by multicellular nodes. Branchlets arise from the node cells, are of limited growth, and repeat the structure of internodes/nodal structures. The rhizoids, which help the plant to be attached at the sediments, are multicellular and branched (Fritsch, 1935; Wood & Imahori, 1964). Wood & Imahori (1964) divided the order Charales into two tribes and reclassified many taxa from species level to the infraspecific rank (Stewart & Mattox, 1975) separated the Chlorophyta on the basis of morphological similarities and oospore wall ornamentation into two classes; Chlorophyceae and Charophyceae. Life cycle include germination of oospore and produce filaments which developed to rhizoides and a protonema, the shoot grows upward and after meiosis gametangia are borne at the nodes on the shoots and gametes are produced without any meiosis (Wood & Imahori, 1964). The stem of Characeae grows through a process of sub-division of the apical growing cell, a cell which has itself sub-divided and developed to a node that developed to bract-cells, antheridia, sporangia, stipules, cortex and an internodal cell which does not sub-divide but extend to an elongated cell (Allen, 1882).

Diagnostic features

The two tribes of Chareae and Nitelleae are distinguished by the number of the coronula cells at the apex of the oogonium, and construction of the rays in the whorls (Wood & Imahori, 1964). In tribe Chareae the coronula consists of five cells arranged in one tier, and whorls of branchlets are simple and the main axis may be corticated or ecorticated, and stipulodes are usually present. Also the presence of bract-cells and stipulodes and spine cells are typical for many *Chara* species. In tribe Nitelleae two tiers of five cells are typical for the coronula, the branchlets in *Nitella* are furcated 1-4 times (called rays), whereas the branchlets of *Tolypella* are monopodial as in tribe Chareae but with multicellular laterals. The members of this tribe are always ecorticated. Stipulodes, spine cells and bract-cells are also absent.

History of the research in Iran

Braun (1849) and later Braun & Nordstedt (1882) reported *Chara foetida* (*Chara vulgaris*) from Persien Isfahan and Kashan. Leonard (1981) collected *Chara vulgaris*, and *Nitella hyalina* in the Tabas region. Carle & Frey (1977) reported vegetation with *Chara tomentosa* from Lake Maharlo near Shiraz. Sheidai *et al.* (1997) analysed the chromosome number of *C. vulgaris* found in ponds near Tehran in Iran ($2n = 28, 35$). More recently, Hutorowicz (2008), studied the oospore of *C. tomentosa* from Holocene sediments of Lake Zeribar in Iran.

MATERIALS AND METHODS

Samplings were done during August to September of 2008 and 2009 from eighty localities from western and central Iran. Eighty two populations ascribed to

13 species were collected, belonging to three genera of Characeae (details of the localities are given in Table 2). The specimens were homothallic with oogonia and antheridia. Collections were made by hand, as well as with the help of grapnel at various depth of water. Herbaria mounts and preserved material were prepared and deposited in the Herbarium of Shahid Beheshti University (HSBU), Tehran. The voucher numbers are given in the Table 2. Overall morphology of the specimens is examined with a stereoscopic microscope (10X, 15X and 20X magnifications). The specimens were identified according to the descriptions provided by Wood & Imahori, (1964); Wood & Mason, (1977); Van Raam & Stewart (2009) and Casanova (2005) (Table 1).

RESULTS

Chara connivens Salz. *ex* A. Braun 1835 **Figs 1-7**

Synonym: *Chara duriaei* (A. Braun) A. Braun. 1867
Nomina: *Chara globularis* var. *globularis* f. *connives* (Salz. *ex* A. Braun) R.D. Wood. 1962, *pro parte*.
Neotype: [per R.D. Wood, Aug. 28, 1956; ref. Wood 1965, p. 177, spec. c] Herbier Laboratoire de Cryptogamie, Muséum National d'Histoire Naturelle, Paris (PC). Tanger, Salzmann.
Distribution: rare, but widespread in Europe, northern Africa, Ukraine, Russia, and India. Table 2 provides the geographical position of the sites where charophytes were collected in Iran.

Plants dioecious. Stem 30-40 cm high, slender, with short branchlets, incrusted (Figs 1, 2). Axes slender, to 700 µm in diameter, internodes 4-6 times as long as branchlets. Cortex 2-3 corticated; isostichous, spine cells solitary, rudimentary. Stipulodes rudimentary. Branchlets 7-8 in a whorls, incurved, to 1 cm long, segments 7-8 of which 5-6 are 2-corticated; terminal segments 2-celled, ecorticate (Figs 3, 4, 6). Bract-cells 5-6, short, about as long as oogonium length, bracteoles 2, as long as bract-cells. Gametangia solitary, at lowest 3-4 branchlet nodes (Fig. 4). Oogonia 850-930 µm (incl. coronula) long, 450-520 µm wide, convolutions 14-15, coronula 130-200 µm high, 180-200 µm wide. Oospores dark brown to black, 630-700 µm long, 350-430 µm wide, ellipsoidal, striae 12-13, fossa 41-50 µm across, membrane minutely granulate (Fig. 7). Antheridia 720-930 µm diametre.

Chara contraria A. Br. *ex* Kütz., *Phycol. germ.*: 258. 1845. **Figs 8-13**

Nomina: *Chara vulgaris* var. *vulgaris* f. *contraria* (A. Braun *ex* Kütz.) R. D. Wood 1962. *Pro parte Chara vulgaris* var. *contraria* (A. Braun *ex* Ktz.) Moore 1986.
Type: National Herbarium of the Netherlands, Leiden (L), 8 specimens, f. *macroteles* as Lectotype [per R.D. Wood April 7, 1959], ex Herbarium Ktzing, ex Herbarium Weber-Van Bosse. A. Braun, 1839, in der nähe von Carlsruhe gesammelt.
Synonyms: *Chara sabauda* HY, 1913.
Distribution: Northern hemisphere, Europe, Asia, North America, South America, Australia, locations in Iran are given in Table 2.

Plants monoecious. Stem up to 5-30 cm high, axes slender, 300-650 µm in diameter, greyish green to dark green, usually strongly incrusted (Fig. 8). Cortex diplostichous, tylacanthous to isostichous, spine cells solitary short or papilliform,

Table 1: Classification of *Chara* species according to different authors.

Name of the taxa	*Wood 1962* *Wood & Imahori 1965*	*Wood 1965* *microspecies* *appendix*	*Pal et al. 1962* *(India)*	*Gollerbach &* *Krassavina* *1983 (Russia)*	*Han & Li 1994* *(China)*	*Krause (1997)* *(Europe)*
Chara connivens Salzmann ex A. Braun 1835	*Chara globularis* var. *globularis* f. *connivens* (Salzm. ex A. Br.) R.D. Wood 1962, pro parte	*Chara connivens* Salzmann ex A. Braun 1835	*Chara connivens* Salzmann ex A. Braun 1835	*Chara connivens* Salzmann ex A. Braun 1835	*Chara connivens* Salzmann ex A. Braun 1835	*Chara connivens* Salzmann ex A. Braun 1835
Chara contraria A.Braun ex Kutzing 1845	*Chara vulgaris* var. *vulgaris* f. *contraria* (A.Br. ex Kutzing) R.D. Wood 1962	*Chara contraria* A.Braun ex Kutzing 1845	*Chara contraria* A.Braun ex Kutzing 1845	*Chara contraria* A.Braun ex Kutzing 1845	*Chara contraria* A. Braun ex Kutzing 1845 var. *contraria*	*Chara contraria* A.Braun ex Kutzing 1845
Chara crassicaulis Schleicher 1821	*Chara vulgaris* var. *vulgaris* f. *crassicaylis* (Schleicher ex A. Braun) R.D. Wood 1962	*Chara crassicaulis* Schleicher 1821	not	not	not	*Chara crassicaulis* Schleicher 1821
Chara grovesii Pal 1932	*Chara vulgaris* var. *gymnophylla* f. *grovesii* (Pal) R.D.Wood 1962	*Chara grovesii* Pal 1932	*Chara grovesii* Pal 1932	not	not	not
Chara gymnophylla (A.Braun) A. Braun 1835 var. gymnophylla	*Chara vulgaris* var. *gymnophylla* (A.Br.) R.D. Wood 1962 f. *gymnophylla*	*Chara squamosa* Desfontaines 1800	*Chara vulgaris* *subsp. squamosa* (Desfontaines) Zaneveld 1940	*Chara* *gymnophylla* (A.Braun) A. Braun 1835	not	*Chara* *gymnophylla* (A.Braun) A. Braun 1835
Chara gymnophylla (A.Braun) A. Braun 1835 var. *rohlenae* (Vilhelm) Ahmadi 2010	*Chara vulgaris* var. *gymnophylla* (A.Br.) R.D.W. f. *rohlenae* (Vilhelm) R.D. Wood 1962	*Chara rohlenae* Vilhelm 1913	not	*Chara* *gymnophylla* (A.Braun) A. Braun 1835	not	*Chara* *gymnophylla* (A.Braun) A. Braun 1835
Chara kirghisorum Lessing 1835	*Chara vulgaris* var. *kirghisorum* f. *kirghisorum* (Lessing) R.D. Wood 1962	*Chara* *kirghisorum* Lessing 1835	not	*Chara* *kirghisorum* Lessing 1835 em. Hollerbach	not	not
Chara pedunculata Kützing 1834	*Chara hispida* var. *hispida* f. *polyacantha* (A. Braun) R.D. Wood 1962 (nomen illeg.)	*Chara* *pedunculata* Kützing 1834	not	*Chara* *polyacantha* A. Braun 1859	not	*Chara* *polyacantha* A. Braun 1859

Table 1: Classification of *Chara* species according to different authors. *(continued)*

Name of the taxa	*Wood 1962 Wood & Imahori 1965*	*Wood 1965 microspecies appendix*	*Pal et al. 1962 (India)*	*Gollerbach & Krassavina 1983 (Russia)*	*Han & Li 1994 (China)*	*Krause (1997) (Europe)*
Chara socotrensioides (R.D. Wood) R.D. Wood 1965	*Chara vulgaris* var. *denudata* f. *socotrensioides* R.D. Wood 1962	*Chara socotrensioides* (R.D. Wood) R.D. Wood 1965	not	not	*Chara interrupta* Han et Kao 1963 nomen illeg.	not
Chara tomentosa L. 1753	*Chara tomentosa* L. pro parte	*Chara tomentosa* L. 1753	not	*Chara tomentosa* L. 1753	*Chara tomentosa* L. 1753	*Chara tomentosa* L. 1753
Chara vulgaris L. 1753 var. *longibracteata* (Kützing) J. Groves & Bullock-Webster 1924	*C.vulgaris* L. var. *vulgaris* f. *longibracteata* (Kützing in Reichenbach) H. & J. Groves 1880	*Chara longibracteata* Kützing in Reichenbach 1832	not	*Chara vulgaris* L 1753.	*Chara vulgaris* L. 1753 var. *longibracteata* (Kützing) J. Groves & Bullock-Webster 1924	*Chara vulgaris* f. *longibracteata* Kützing 1832
Chara vulgaris L. 1753. var. *vulgaris*	*C.vulgaris* L. var. *vulgaris* f. *vulgaris* pro parte	*Chara vulgaris* L. 1753	*Chara vulgaris* L. 1753. pro parte	*Chara vulgaris* L. 1753.	*Chara vulgaris* L. 1753. var. *vulgaris*	*Chara vulgaris* L. f. *vulgaris*
Nitella hyalina (De Candolle) C. Agardh 1824	*Nitella hyalina* (De Candolle) C. Agardh 1824	*Nitella hyalina* (De Candolle) C. Agardh 1824	*Nitella hyalina* (De Candolle) C. Agardh 1824	*Nitella hyalina* (De Candolle) C. Agardh 1824	*Nitella hyalina* (De Candolle) C. Agardh 1824 var. *hyalina*	*Nitella hyalina* (De Candolle) C. Agardh 1824
Tolypella glomerata (Desvaux) Von Leonhardi 1863	*Tolypella nidifica* (O. Muller) A. Braun var. *glomerata* (Desvaux in Loiseleur) R.D. Wood 1962 pro parte	*Tolypella glomerata* (Desvaux) Von Leonhardi 1863	*Tolypella glomerata* Von Leonhardi 1863	*Tolypella glomerata* (Desvaux) Von Leonhardi 1863	not	*Tolypella glomerata* (Desvaux) Von Leonhardi 1863

Table 2. Details of the localities with their voucher numbers and collection date.

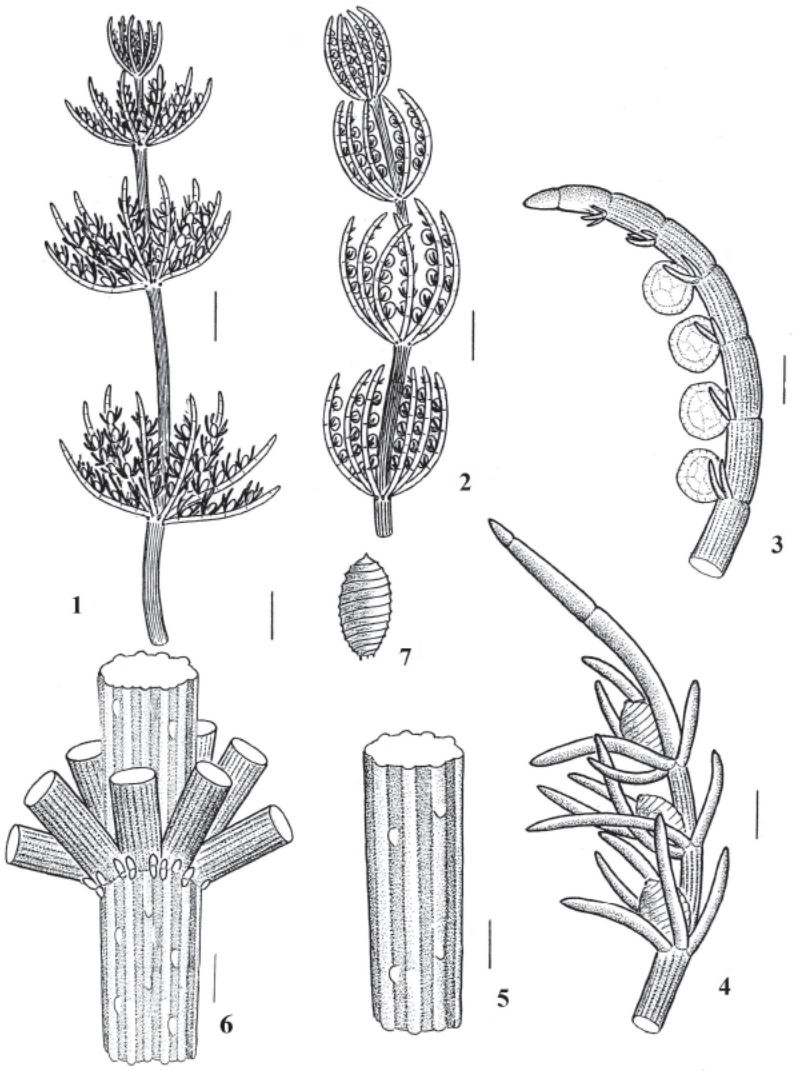
C.gymnophylla var. *gymnophylla*
Fras province
30°27'37" N 51°47'22" E 2143 HSBU-8808719; 25.08.2009
Zanjan Province
36°21'40" N 48°53'42" E 1852 HSBU -8800241; 30.08.2009
36°14'17" N 49°04'06" E 1706 HSBU -8800242; 30.08.2009
Markazi province
39°13'84" N 38°98'15" E 2100 HSBU -8808627; 10.06.2009
34°87'96" N 37°81'28" E 1800 HSBU -8808611; 29.05.2009
34°80'96" N 37°71'76" E 1900 HSBU -8808614; 29.05.2009
Ardebil Province
38°32'07" N 47°53'55" E 1076 HSBU -8800451; 28.08.2009
38°32'15" N 48°08'23" E 1259 HSBU -8800453; 28.08.2009
37°50'47" N 48°20'47" E 1578 HSBU -8800456; 28.08.2009
West Azarbaijan
37°36'58" N 47°09'12" E 1620 HSBU -8800418; 27.08.2009
37°31'56" N 47°20'37" E 1438 HSBU -8800420; 27.08.2009
East Azarbaijan
37°21'13" N 45°09'18" E 1334 HSBU -8800444; 26.08.2009
Kordestan Province
34°47'01" N 46°55'57" E 1427 HSBU -8800871; 24.08.2009
34°55'17" N 46°56'10" E 1598 HSBU -8800872; 24.08.2009
35°17'07" N 46°22'37" E 1111 HSBU -8800874; 24.08.2009
35°36'15" N 46°18'35" E 1432 HSBU -8800876; 25.08.2009
Isfahan Province
32°40'39" N 51°39'01" E 1578 HSBU -8800314; 9.08.2009
31°25'01" N 51°34'21" E 2453 HSBU -8800316; 9.08.2009
Qom Province
34°21'10" N 50°54'19" E 1600 HSBU -8800253; 6.08.2009
24°3342" N 50°09'41" E 1983 HSBU -8800257; 6.08.2009
C. gymnophylla var. *rohlenae*
Fras province
30°37'36" N 53°10'41" E 2313 HSBU -8800711; 25.08.2009
30°37'51" N 53°10'50" E 2319 HSBU -8800712; 25.08.2009
30°31'17" N 53°31'37" E 2332 HSBU -8800713; 25.08.2009
29°42'26" N 52°01'39" E 2026 HSBU -8800717; 25.08.2009
30°22'02" N 51°47'25" E 2105 HSBU -8800718; 25.08.2009
Hamedan Province
34°15'37" N 48°16'15" E 1521 HSBU -8800812; 23.08.2009
34°12'53" N 48°26'04" E 1889 HSBU -8800811; 23.08.2009
Markazi province
34°80'96" N 37°71'76" E 1900 HSBU -8808614; 29.05.2009
Lorestan Province
45°61'60" N 37°72'86" E 1523 HSBU -8800662; 20.08.2009
Ardebil Province
38°32'07" N 47°53'55" E 1076 HSBU -8800451; 28.08.2009
38°30'13" N 48°01'51" E 1124 HSBU -8800452; 28.08.2009
West Azarbaijan
37°56'09" N 47°31'32" E 1675 HSBU-8800416; 27.08.2009
East Azarbaijan
37°07'34" N 45°09'46" E 1767 HSBU-8800443; 26.08.2009
Kermanshah Province
34°24'01" N 47°26'44" E 1290 HSBU-8800834; 24.08.2009
Kordestan Province
36°18'01" N 46°15'12" E 1535 HSBU-88008710; 25.08.2009
Chaharmahal and Bakhtiari Province
32°17'24" N 50°38'52" E 2059 HSBU-8800381; 15.08.2009
Kohkiliyo and Boyerahmad Provice
30°51'56" N 51°20'06" E 1542 HSBU-8800741; 14.08.2009
Isfahan Province
32°47'07" N 51°01'50" E 1979 HSBU-8800313; 9.08.2009
31°22'14" N 51°36'07" E 2244 HSBU-8800315; 9.08.2009
33°20'09" N 50°20'41" E 1996 HSBU-8800318; 15.08.2009
C.gymnophylla var. *gymnophylla*
Fras province
30°27'37" N 51°47'22" E 2143 HSBU-8808719; 25.08.2009
Zanjan Province
36°21'40" N 48°53'42" E 1852 HSBU-8800241; 30.08.2009
36°14'17" N 49°04'06" E 1706 HSBU-8800242; 30.08.2009
Markazi province
39°13'84" N 38°98'15" E 2100 HSBU-8808627; 10.06.2009
34°87'96" N 37°81'28" E 1800 HSBU-8808611; 29.05.2009
34°80'96" N 37°71'76" E 1900 HSBU-8808614; 29.05.2009

Table 2. Details of the localities with their voucher numbers and collection date. *(continued)*

Ardebil Province
38°32'07" N 47°53'55" E 1076 HSBU-8800451; 28.08.2009
38°32'15" N 48°08'23" E 1259 HSBU-8800453; 28.08.2009
37°50'47" N 48°20'47" E 1578 HSBU-8800456; 28.08.2009
West Azarbaijan
37°36'58" N 47°09'12" E 1620 HSBU-8800418; 27.08.2009
37°31'56" N 47°20'37" E 1438 HSBU-8800420; 27.08.2009
East Azarbaijan
37°21'13" N 45°09'18" E 1334 HSBU-8800444; 26.08.2009
Kordestan Province
34°47'01" N 46°55'57" E 1427 HSBU-8800871; 24.08.2009
34°55'17" N 46°56'10" E 1598 HSBU-8800872; 24.08.2009
35°17'07" N 46°22'37" E 1111 HSBU-8800874; 24.08.2009
35°36'15" N 46°18'35" E 1432 HSBU-8800876; 25.08.2009
Isfahan Province
32°40'39" N 51°39'01" E 1578 HSBU-8800314; 9.08.2009
31°25'01" N 51°34'21" E 2453 HSBU-8800316; 9.08.2009
Qom Province
34°21'10" N 50°54'19" E 1600 HSBU-8800253; 6.08.2009
24°3342" N 50°09'41" E 1983 HSBU-8800257; 6.08.2009
C. gymnophylla var. *rohlenae*
Fras province
30°37'36" N 53°10'41" E 2313 HSBU-8800711; 25.08.2009
30°37'51" N 53°10'50" E 2319 HSBU-8800712; 25.08.2009
30°31'17" N 53°31'37" E 2332 HSBU-8800713; 25.08.2009
29°42'26" N 52°01'39" E 2026 HSBU-8800717; 25.08.2009
30°22'02" N 51°47'25" E 2105 HSBU-8800718; 25.08.2009
Hamedan Province
34°15'37" N 48°16'15" E 1521 HSBU-8800812; 23.08.2009
34°12'53" N 48°26'04" E 1889 HSBU-8800811; 23.08.2009
Markazi province
34°80'96" N 37°71'76" E 1900 HSBU-8808614; 29.05.2009
Lorestan Province
45°61'60" N 37°72'86" E 1523 HSBU-8800662; 20.08.2009
Ardebil Province
38°32'07" N 47°53'55" E 1076 HSBU-8800451; 28.08.2009
38°30'13" N 48°01'51" E 1124 HSBU-8800452; 28.08.2009
West Azarbaijan
37°56'09" N 47°31'32" E 1675 HSBU-8800416; 27.08.2009
East Azarbaijan
37°07'34" N 45°09'46" E 1767 HSBU-8800443; 26.08.2009
Kermanshah Province
34°24'01" N 47°26'44" E 1290 HSBU-8800834; 24.08.2009
Kordestan Province
36°18'01" N 46°15'12" E 1535 HSBU-88008710; 25.08.2009
Chaharmahal and Bakhtiari Province
32°17'24" N 50°38'52" E 2059 HSBU-8800381; 15.08.2009
Kohkiliyo and Boyerahmad Provice
30°51'56" N 51°20'06" E 1542 HSBU-8800741; 14.08.2009
Isfahan Province
32°47'07" N 51°01'50" E 1979 HSBU-8800313; 9.08.2009
31°22'14" N 51°36'07" E 2244 HSBU-8800315; 9.08.2009
33°20'09" N 50°20'41" E 1996 HSBU-8800318; 15.08.2009
C. *vulgaris* var. *longibracteata*
Isfahan Province
33°57'56" N 51°15'03" E 1994 HSBU-8800311; 07.06.2009
31°12'36" N 51°45'12" E 2360 HSBU-8800317; 10.06.2009
Chaharmahal and Bakhtiari Province
32°27'16" N 50°18'43" E 2479 HSBU-8800382; 15.06.2009
Fars province
30°20'35" N 53°53'40" E 1891 HSBU-8800714;12.06.2009
30°31'17" N 53°31'37" E 2332 HSBU-8800720;14.06.2009
East Azarbaijan Province
36°55'58" N 45°53'27" E 1287 HSBU-8800441; 27.08.2009
36°59'06" N 45°30'56" E 1289 HSBU-8800442; 26.08.2009
West Azarbaijan Province
38°10'16" N 45°37'19" E 1410 HSBU-8800411; 27.08.2009
38°69'50" N 45°44'13" E 1364 HSBU-8800412; 27.08.2009
37°57'35" N 47°42'55" E 1784 HSBU-8800415; 27.08.2009
37°55'25" N 47°19'26" E 1628 HSBU-8800417; 27.08.2009
Ardebil Province
38°07'37" N 48°27'11" E 1429 HSBU-8800454; 28.08.2009
38°03'04" N 48°28'10" E 1639 HSBU-8800455; 28.08.2009
38°07'37" N 48°27'12" E 1429 HSBU-8800457; 28.08.2009
Markazi province
39°87'23" N 38°28'31" E 2105 HSBU-8800864; 10.06.2009
33°84'34" N 37°99'36" E 1800 HSBU-8808615; 31.07.2009

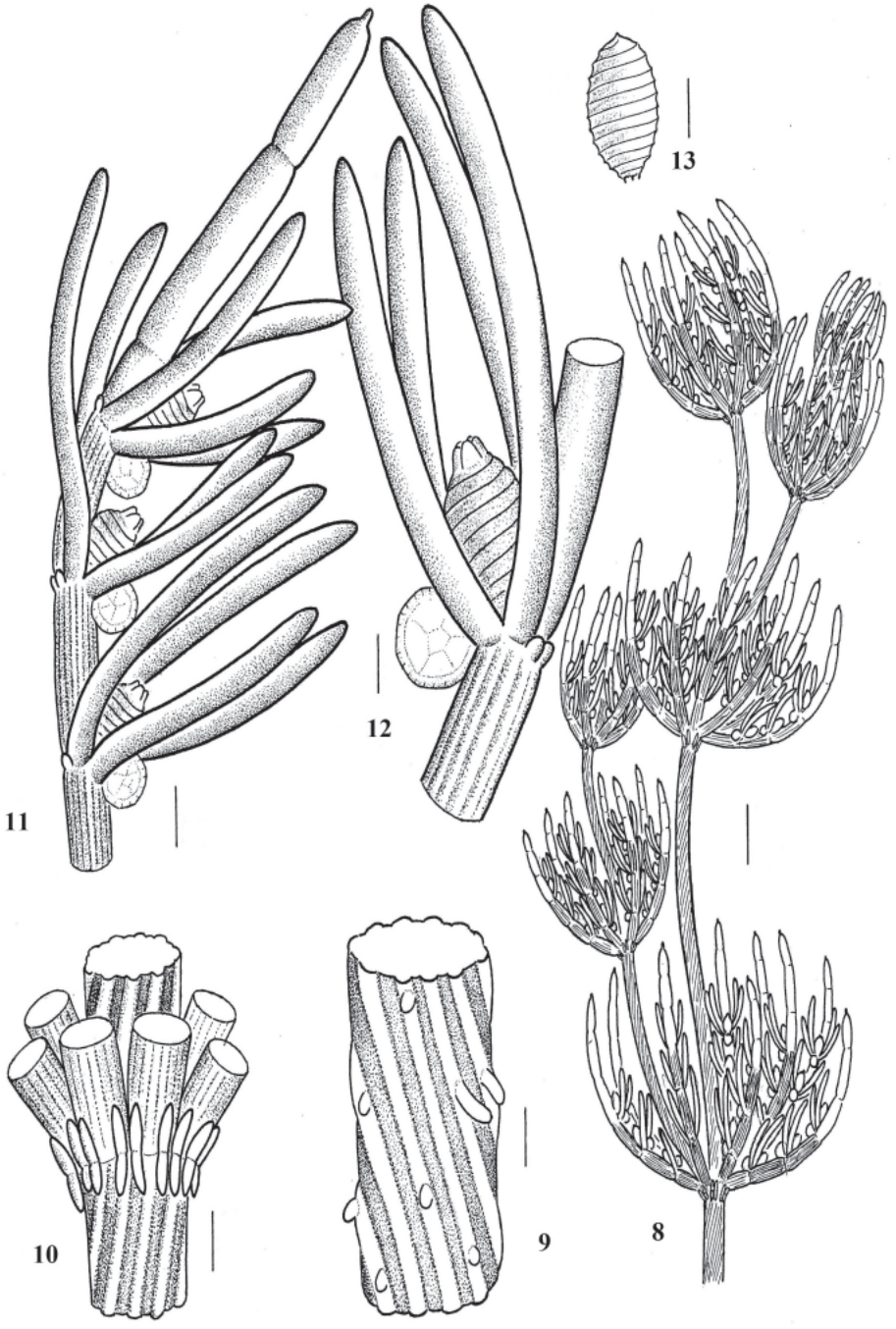
Table 2. Details of the localities with their voucher numbers and collection date. *(continued)*

34°36'20" N 50°21'21" E 1446 HSBU-8808619; 10.06.2009
34°07'56" N 50°50'04" E 2211 HSBU-8808624; 06.06.2009
39°13'84" N 38°98'15" E 2100 HSBU-8808628; 10.06.2009
Zanjan Province
36°08'10" N 49°04'18" E 1694 HSBU-8800243; 30.08.2009
Ghazvin Province
36°10'41" N 49°52'24" E 1244 HSBU-8800281; 30.08.2009
C. *vulgaris* var. *vulgaris*
Qom Province
34°21'10" N 50°54'19" E 1600 HSBU-8800254; 06.08.2009
Kordestan Province
35°21'28" N 46°40'42" E 1525 HSBU-8800873; 24.08.2009
35°31'47" N 46°16'26" E 1327 HSBU-8800875; 25.08.2009
Kermanshah Province
34°27'01" N 47°55'59" E 1442 HSBU-8800831; 24.08.2009
34°44'61" N 46°53'58" E 1367 HSBU-8800833; 24.08.2009
East Azarbaijan Province
37°27'45" N 44°55'32" E 1521 HSBU-8800445; 26.08.2009
36°23'46" N 47°06'20" E 1834 HSBU-8800446; 26.08.2009
37°27'21" N 44°50'03" E 1638 HSBU-8800447; 26.08.2009
West Azarbaijan Province
38°18'05" N 46°52'01" E 1625 HSBU-8800413; 27.08.2009
Ardebil Province
38°63'09" N 48°03'18" E 1560 HSBU-8800458; 28.08.2009
Markazi province
39°05'52" N 38°24'71" E 1943 HSBU-8800865; 10.06.2009
35°30'40" N 37°55'25" E 1995 HSBU-8800869; 20.07.2009
24°33'42" N 50°09'41" E 1983 HSBU-8808620; 10.06.2009
33°88'30" N 37°23'17" E 1857 HSBU-8808623; 29.05.2009
Lorestan province
36°30'91" N 37°49'09" E 2000 HSBU-8800661; 20.08.2009
C. connivens
Esfahan Province
31°12'36" N 51°45'12" E 2360 HSBU-8800319; 10.06.2009
C. contraria
Markazi province
39°48'40" N 37°06'08" E 2275 HSBU-8800863; 03.07.2009
35°30'40" N 37°55'25" E 1995 HSBU-8808610; 20.07.2009
35°36'25" N 37°40'37" E 2200 HSBU-8808613; 29.05.2009
Fars province
30°25'05" N 53°25'46" E 2375 HSBU-8800715; 12.06.2009
East Azarbaijan
36°36'13" N 47°14'06" E 2202 HSBU-8800448; 26.08.2009
C. crassicaulis
Qom Province:
34°23'22" N 50°51'41" E 1468 HSBU-8800251; 06.08.2009
C. fibrosa
Chaharmahal and Bakhtiari Province
32°23'13" N 50°20'02" E 2324 HSBU-8800385; 15.06.2009
C. grovesii
Qom Province
34°23'32" N 50°51'41" E 1468 HSBU-8800252; 06.08.2009
C. kirghisorum
Markazi province
33°62'83" N 37°38'98" E 2034 HSBU-8808616; 31.07.2009
Chara kohrangiana
Chaharmahal and Bakhtiari Province
32°23'13" N 50°20'02" E 2324 HSBU-8800383; 15.06.2009
C. pedunculata
Esfahan Province
31°12'36" N 51°45'12" E 2360 HSBU-8800320; 10.06.2009
C. socotrensioides
Chaharmahal and Bakhtiari Province
30°51'35" N 51°19"59' E 1552 HSBU-8800742;14.06.2009
C. tomentosa
Isfahan Province
32°47'07" N 51°01'50" E 1979 HSBU-8800312; 06.08.2009
31°12'36" N 51°45'12" E 2360 HSBU-8800319; 10.06.2009
T. glomerata
Isfahan Province
31°12'36" N 51°45'12" E 2360 HSBU-8800317; 10.06.2009
N. hyalina
Markazi Province
44°94'66" N 37°52'88" E 1773 HSBU-880868; 31.07.2009



Figs 1-7. *Chara connivens*: **1, 2.** Macroscopic habitus of male and female plant. **3.** Branchlet with the antheridia. **4.** Branchlet node with oogonia. **5.** Spine cells. **6.** Branchlets and stipulodes. **7.** Oospore. Scale bars 2500 µm (Figs 1, 2), 500 µm (Figs 3, 4) and 250 µm (Figs 5-7).

smaller than axis diameter. Stipulodes short, in 2 rows; upper row often somewhat longer (Fig. 10). Internodes 1-4 times the length of the branchlets, branchlets 6-10 in a whorl (Figs 9, 10), 4-7 segments, usually with a few segments completely ecorticated, ecorticated end segment 2-3 celled, end cell conical or slightly reduced (Fig. 11). Interior bract-cells usually longer than the oogonium, posterior absent or rudimentary (Figs 11, 12). Gametangia conjoined, solitary or geminate at 1-4 lower corticated branchlet nodes (Fig. 12), oogonia solitary or geminate, incrusted,



Figs 8-13. *Chara contraria*: **8.** Macroscopic habitus. **9.** Spine cells. **10.** Stipulodes and internode branchlets. **11-12.** Branchlet with oogonia and antheridia. **13.** Oospore. Scale bars, 2500 μm (Fig. 8), 400 μm (Fig. 11), 333 μm (Fig. 33) and 250 μm (Figs 9, 12, 13).

ca 750 µm long (excl. coronula), *ca* 150 µm wide. 13-16 striae, coronula *ca* 150 µm high, *ca* 250 µm wide at the base. Mature oospore dark brown to black, *ca* 600 µm long, *ca* 350 µm wide, with 11-14 low ridges; membrane granulated (Fig. 13).

Chara crassicaulis (Schl. *ex* A. Braun) Kütz. 1857. **Figs 14-18**

Nomina: *Chara foetida* var. *crassicaulis* Schleicher *ex* A. Braun 1834; *Chara vulgaris* var. *crassicaulis* (Schleicher *ex* A. Braun) Kützing 1849; *Chara longibracteata* var. *crassicaulis* (Schleicher *ex* A. Braun) Wallman 1853; *Chara vulgaris* var. *vulgaris* f. *crassicaulis* (Schleicher *ex* A. Braun) R.D. Wood 1962.
Type: Herbarium Musée et Jardins Botanique Cantonaux, Lausanne (LAU), Vevey, J.C. Schleicher.
Distribution: Europe, northern Africa, Asia, locations in Iran are given in Table 2.

Plants monoecious, rather small c. 10 cm high, not much branched, axes moderately stout, c. 650 µm in diameter, green to dark green, moderately to heavily encrusted, cortex diplostichous, clearly aulacanthous. Spine cells solitary, small, and globose. Stipulodes in 2 rows, short, blunt. Internodes 1-4 times the length of the branchlets (Figs 15, 16); branchlets 6-10 in a whorl, very short, strongly incurved, 3-4 corticated segments; end segment 1-2-celled, end cell, short and blunt. Anterior bractcells 2 times as long as oogonium, bracteoles about as long as anterior bract-cells, posteriors rudimentary (Fig. 17). Gametangia conjoined at corticated branchlet segments, oogonia solitary, with limeshell, 560-650 µm long (excl. coronula), 420-450 µm wide, 12-14 convolutions, coronula *ca* 70 µm high, *ca* 180 µm wide at base. Mature oospores light brown, 525-620 µm long, 360-400 µm wide, with 11-13 weak ridges, membrane very finely granulate. Antheridia small and solitary, *ca* 375 µm in diametre (Fig. 18).

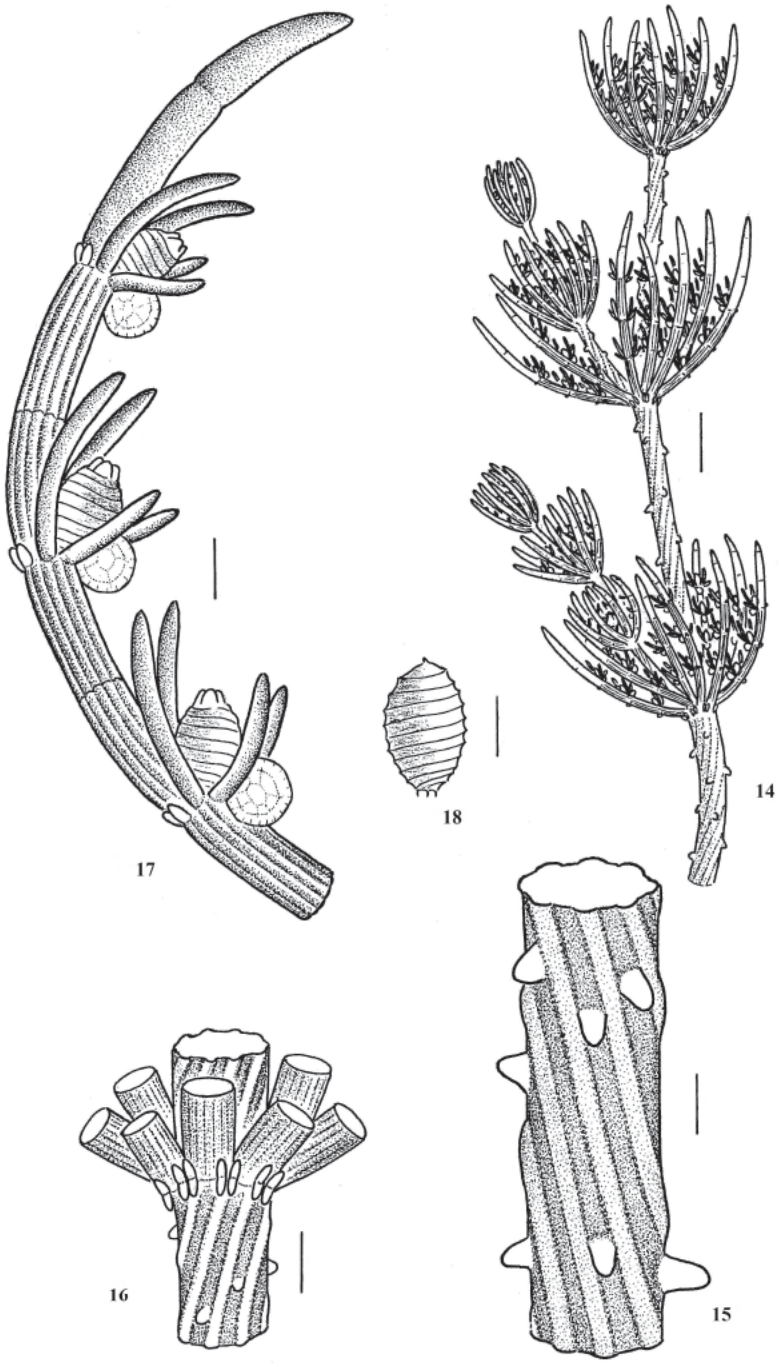
Chara fibrosa C. Aghard *ex* Bruzelius, *Observ. in gen. Chara*: 21. 1824. **Figs 19-23**

Synonyms: *Chara flaccida* A. Braun 1849, *Chara gymnopitys* A. Braun 1852.
Lectotype [per R.D. Wood Dec. 1958, ref. Wood 1965, p. 291 spec. j]: Herbarium Lund (LD), Marianas, Gaudichaud 158.
Distribution: Tropical and subtropical regions, Africa, Asia, Australia, New Zealand, southern Europe, North and South America, sites from Iran are given in table 2.

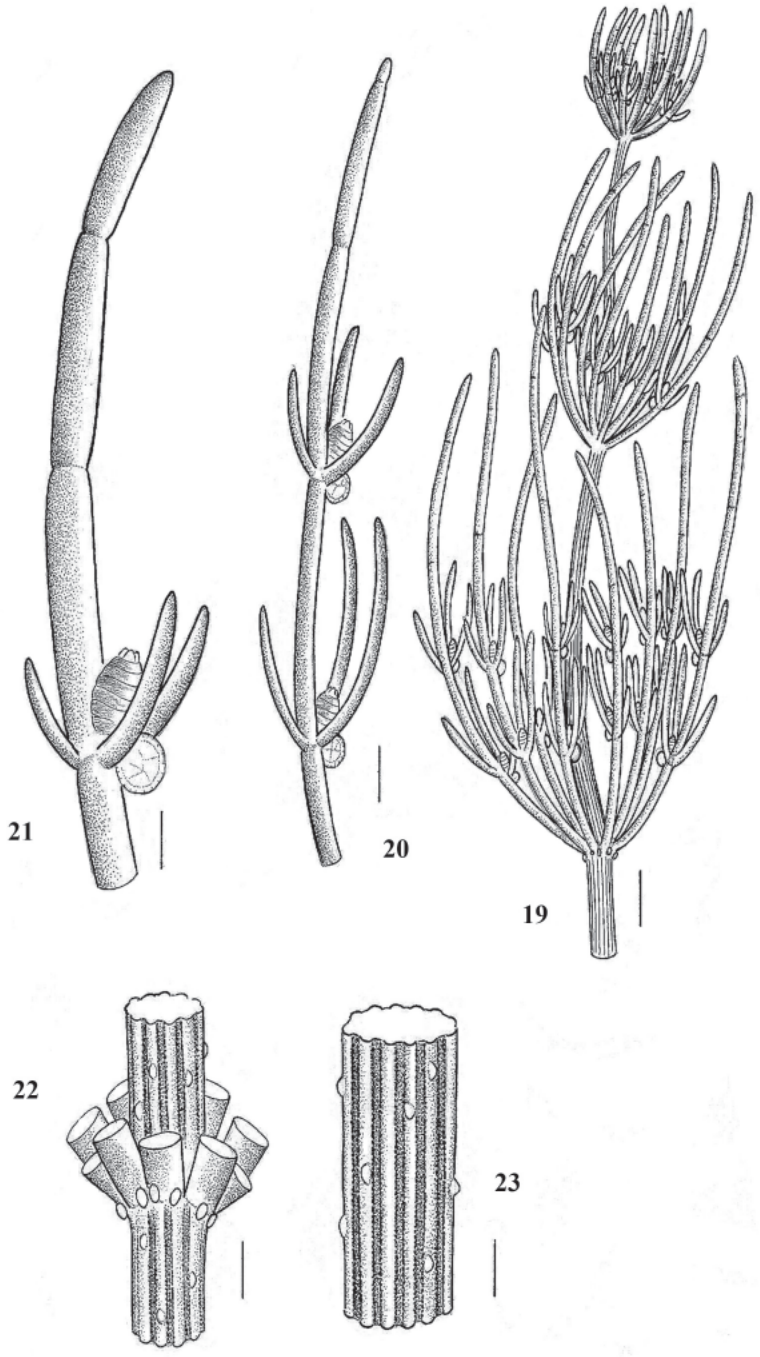
Plants monoecious. Stem up to 5-15 cm high, axes slender 350-450 µm in diameter, green to dark green, incrusted with lime. Cortex diplostichous, tylacanthous. Spine cells solitary, shorter than the axis diameter. Stipulodes long, in 1 row, spreading or acuminate (Fig. 22). Internodes $^1/_2$-3 times as long as the branchlets (Fig. 23); branchlets 8-14 in a whorl (Fig. 19, 22), 4-7 segments, long, ecorticated; end segment 3-5 celled, end cell acuminate (Figs 20, 21). Bract-cells 2-7, usually verticillate, anterior bract-cells longer than oogonium, bracteoles much longer, posterior bract-cells short (Figs 20, 21). Gametangia conjoined at lowest 3 branchlet nodes (Fig. 42), oogonia solitary or geminate, *ca* 450 µm long (excl. Coronula), *ca* 330 µm wide, coronula *ca* 90 µm high, *ca* 140 µm wide at base, *ca* 9 striae. Mature oospores absent. Antheridia *ca* 350 µm in diametre.

Chara grovesii B.P. Pal, *J.Linn. Soc. London, Botany* 49(327): 85. 1932. **Figs 24-27**

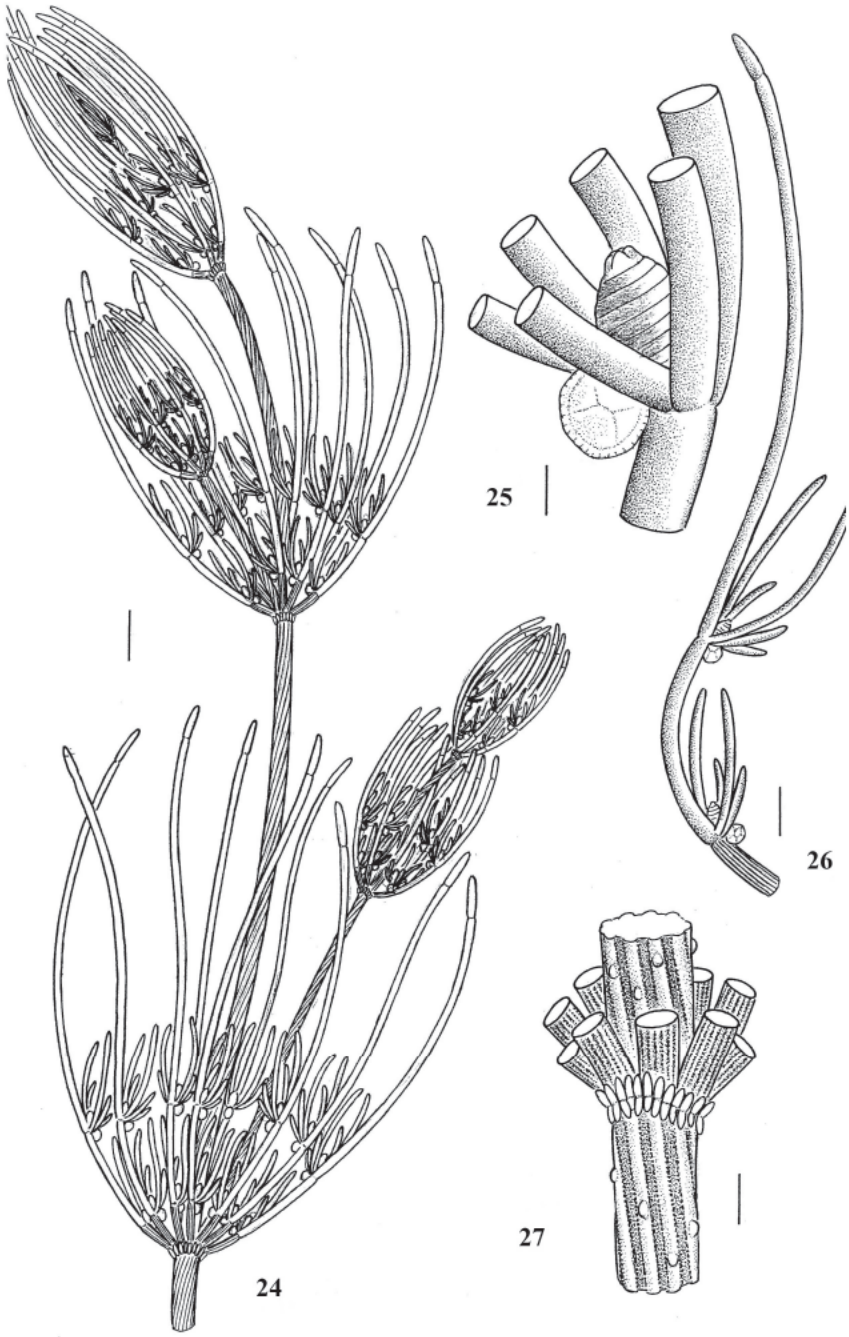
Nomina: *Chara vulgaris* var. *gymnophylla* f. *grovesii* (Pal) R.D. Wood. 1962. "*Chara contraria* subsp. *grovesii* (Pal) Zaneveld 1941" provisional.
Holotype: lost [PAL in litt., ref. Wood 1965, p. 109 spec. a]
Isotype [Lectotype?] [ref. Wood 1965, p. 109 spec. a]: Herbarium New York Botanical Garden, New York (NY), ex herbarium R.D. Wood, ex Herbarium B.P. PAL. In formalin. [Very common in streams and pools, Maymyo, Oct. 1928, B.P. PAL].



Figs 14-18. *Chara crassicaulis*: **14.** Macroscopic habitus. **15.** Spine cells. **16.** Internode with stipulodes. **17.** Branchlet with oogonia and antheridia. **18.** Oospore. Scale bars 2500 µm (Fig. 14), 500 µm (Fig. 16), 400 µm (Fig. 17), 333 µm (Fig. 15) and 250 µm (Fig. 18).



Figs 19-23. *Chara fibrosa*: **19.** Habit. **20.** Branchlet with oogonia and antheridia. **21.** End segment and branchlet tip. **22.** Internode and stipoludes. **23.** Rudimentary spine cells. Scale bars: 2500 µm (Fig. 19), 1250 µm (Fig. 20), 715 µm (Fig. 21), 400 (Fig. 22) and 250 µm (Fig. 23).



Figs 24-27. *Chara grovesii*: **24.** Macroscopic habit. **25.** Antheridium and oogonium. **26.** Tip of the branchlets. **27.** Stipulodes and internode. Scale bars 2500 µm (Fig. 24), 1250 µm (Fig. 26), 500 µm (Fig. 26), 250 µm (Fig. 25).

Distribution: rare, Asia: Burma, India, China. The sites for this species in Iran are given in Table 2.

Plants monoecious, 10-20 cm high, 10-20 cm high, slender, green to dark green, heavily or moderately incrusted; axes diplostichous, tylacanthous or isostichous, 450-550 µm in diameter. Spine cells solitary, rudimentary or short. Stipulodes in 2 rows, short, blunt and usually reduced (Fig. 27). Internodes 1-5 times the length of the branchlets (Fig. 24), branchlets 9-10 in a whorl (Figs 24, 27); basal segment very short, 2-corticated, 2-3 ecorticated segments, endsegment 2-celled, endcell rather long, blunt (Fig. 26). Bract-cells 5-6; anterior bract-cells 2 times as long as oogonium, bracteoles much longer, posterior bract-cells short (Fig. 26). Gametangia conjoined at lowest branchlet nodes, oogonia solitary or geminate, incrusted, *ca* 500 µm long (excl. Coronula), c. 400 µm wide, *ca* 12 striae, coronula *ca* 200 µm high, *ca* 300 µm wide at base. Mature oospores brown to black *ca* 350 µm long, c. 250 µm wide, *ca* 9 low ridges; membrane smooth or granulated. Antheridia *ca* 400 µm in diametre.

Chara gymnophylla A. Braun, *Flora* 18: 62. 1835. **Figs 28-38**

Synonyms: *Chara squamosa* Desfontaines 1799.

Nomina: *Chara foetida* f. *gymnophylla* A. Braun 1834; *Chara vulgaris* var. *gymnophylla* f. *gymnophylla* (A. Braun) R.D. Wood 1962; *Chara vulgaris* subsp. *squamosa* (Desfontaines) Zaneveled 1940.

Syntype, Lectotype [per R.D. Wood, Jan. 4, 1960, ref. Wood 1965, p. 108 spec. b]: Herbier Laboratoire de Cryptogamie, Muséum National d'Histoire Naturelle, Paris (PC). Algier, W. Schimper, March 1832.

Syntype: National Herbarium Nederland, Leiden (L). Algiers, tantum in fontibus admare, W. Schimper, Martio 1832, Unio iteneraria. Annotated by A. Braun as: *Ch. foetida* var. *gymnophylla*.

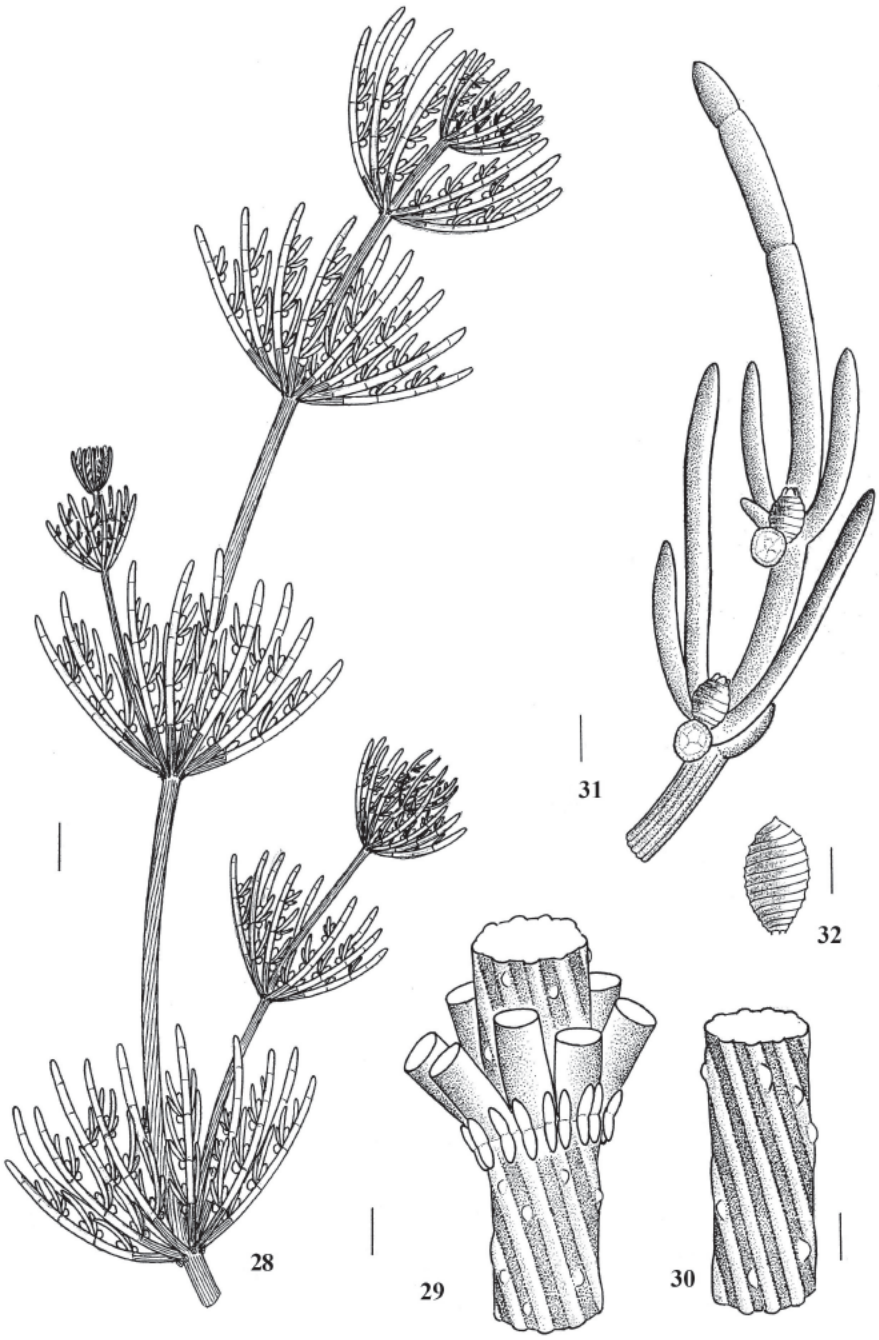
Distribution: Records from Africa, Asia and Europe. The sites from Iran are given in Table 2.

Plants monoecious, 3-30 cm high, upper parts much compacted ("fox-tails"). Axes slender, brown to dark green, generally moderately incrusted, diplostichous, aulacanthous or sometimes isostichous, 600-750 µm in diameter. Spine cells globular, shorter than axis diametre (Fig. 30). Stipulodes in 2 rows, short, oval and usually reduced (Fig. 29). Internodes sterile branchlets, upper internodes much shortened, branchlets 6-11 in a whorl, ecorticated or with 1-3 corticated segments (Figs 28, 29), end segment 2-3 celled, end cell short or rather long, blunt (Fig. 31). Anterior bract-cells 1-2 times as long as the oogonium, bracteole often much longer, posterior bract-cells very short or rudimentary (Fig. 31). Gametangia conjoined at lowest 1-3 corticated and ecorticated branchlet nodes (Fig. 31). Oogonia solitary or geminate, 400-650 µm long (excl. coronula), 350-500 µm wide, 9-12 convolutions, coronula 75-100 µm high, 130-180 µm broad at base. Mature oospores brown to black , 350-550 µm long, 250-350 µm wide, 9-11 low ridges ending in small claws, membrane nearly smooth or finely granulated (Fig. 32). Antheridia solitary, 300-450 µm in diametre.

Chara gymnophylla A. Braun **var. *gymnophylla*** **Figs 28-32**

Nomina: *Chara gymnophylla* A. Braun var. *gymnophylla* f. *gymnophylla; Chara gymnophylla* var. *gymnophylla* f. *condensata* Nordestedt.

Most branchlets with at least 1 corticated segment. 15-30 cm long, lower internodes elongated (f. *gymnophylla*) or less than 10 cm high, bushy, compacted (f. *condensata*) (Figs 28, 31).



Figs 28-32. *Chara gymnophylla* var. *gymnophylla*: **28.** Macroscopic habitus. **29.** Internodes with stipulodes and spine cells. **30.** Spine cells. **31.** Branchlet with oogonia and antheridia and end segment. **32.** Oospore. Scale bars 2500 µm (Fig. 28), 625 µm (Fig. 31), 400 (Figs 29, 30) and 250 µm (Fig. 32).

***Chara gymnophylla* var. *rohlenae* (Vilhelm) Ahmadi stat. nov.** **Figs 33-38**

Nomina: *Chara gymnophylla* var. *rohlenae* f. *rohlenae*; *Chara gymnophylla* var. *rohlenae* f. *elongata* Ahmadi n.f.

Branchlets completely ecorticated, rarely fertile branchlets with 1 corticated segment. Plants small, less than 10 cm high, bushy, very compacted (f. *rohlenae*) or up to 20 cm high with lower internodes elongated (f. *elongata*), (Figs 33, 34, 37).

Chara kirghisorum C.F. Lessing, *Linnaea* 9: 212-213. 1835. **Figs 39-43**

Synonyms: *Chara tatarica* Lessing, *ined. in* herbarium (LE, B destroyed), *Chara contraria* f. *jubataeformis* Vilhelm 1930.

Nomina: *Chara vulgaris* var. *kirghisorum* f. *kirghisorum* (Lessing) R.D. Wood 1962.

Holotype: Herbarium Komarov Botanical Institute, Petersburg (LE), *In lacu quodam salsugineo ad fl. Bolsche Mandlibai non procul ab Orsk*, C.F. Lessing.

Distribution: rare- Asia; it has been reported from Russia, Uzbekistan, Kazachestan. The sites from Iran are given in Table 2.

Plants dioecious, 10-30 cm high, slender and grass like, unincrusted or moderately incrusted. Cortex diplostichous, tylacanthous. Spine cells solitary, varying from small and globose to as long as axis diameter, obtuse or acute (Fig. 40). Stipulodes in 2 rows, 2 sets per branchlet swollen, blunt, adpressed, upper row rather long, lower row shorter (Fig. 41). Internode elongate, much longer than branchlets, 0.6-10 cm long (Fig. 39), branchlets 7-8 in a whorl, ecorticated or with lowest 1-2 segments corticated, strongly incurved and spirally arranged, segments swollen and constricted at the nodes, end segment 2-3(-4)-celled, endcell long, acuminate (Figs 39, 41). Bract-cells 3-6, unilateral; anteriors and bracteoles about as long as oogonium, posteriors short, globular (Figs 42, 43). Gametangia on separate plants, solitary at lowest 1(-3) branchlet nodes, oogonia 540-640 µm long (excl. coronula) 335-480 µm wide, *ca* 12 convolutions, coronula *ca* 120 µm high, *ca* 180 µm wide at base. Mature oospores dark brown to black, *ca* 450 µm long, *ca* 270 µm wide, *ca* 10 low ridges, membrane slightly tuberculate. Antheridia solitary, *ca* 400 µm in diametre.

Chara pedunculata Kötz. 1834, *Flora* 17: 706. **Figs 44-50**

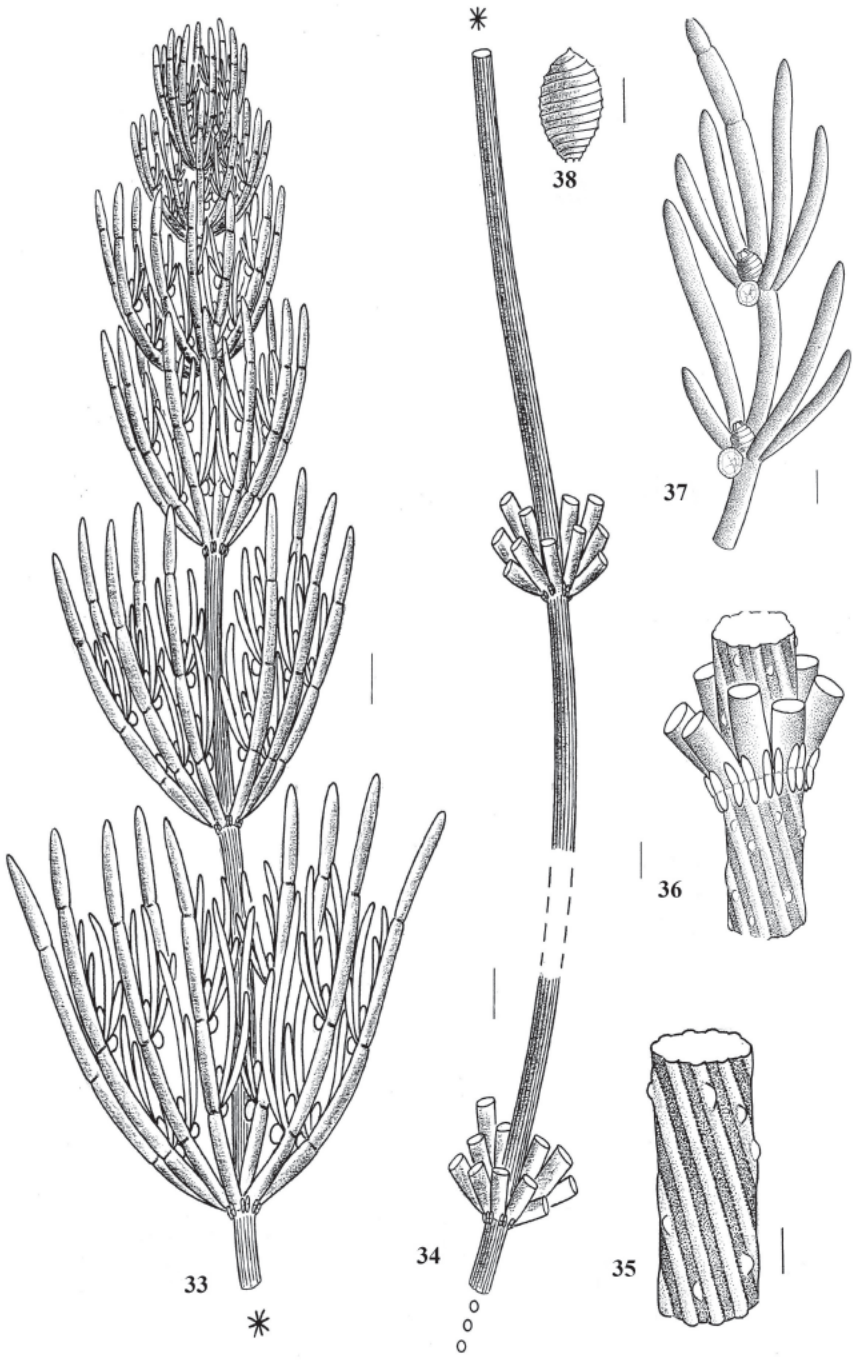
Synonyms: *Chara hispida* var. *pseudocrinita* A. Braun 1834; *Chara spondylophylla* Ktzing 1843, *nomen illeg.* new name for *Chara pedunculata*; *Chara polyacantha* A. Braun 1859.

Nomina: *Chara hispida* var. *hispida* f. *polyacantha* (A. Braun) R.D. Wood 1962

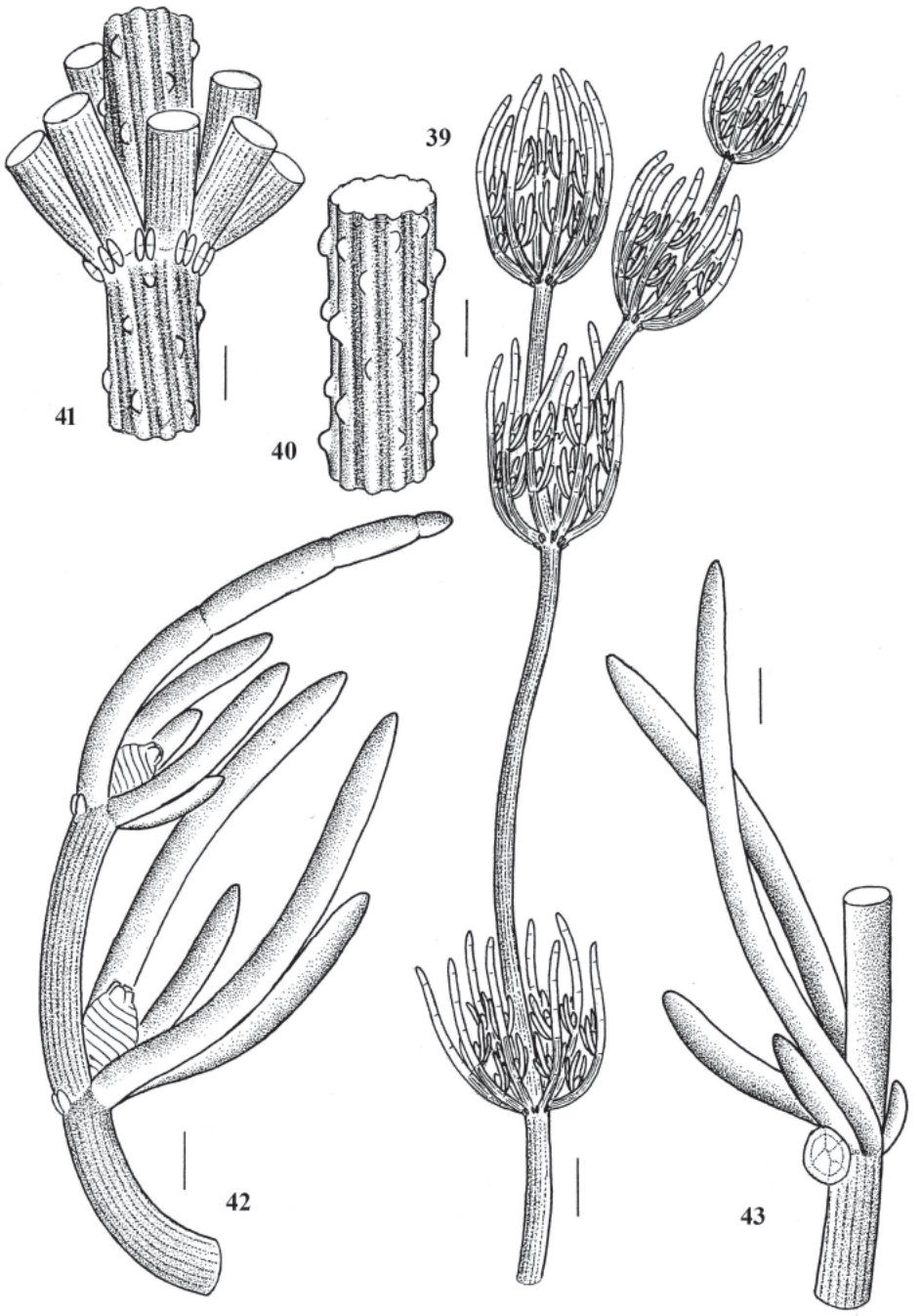
Isotype, Lectotype: Nationaal Herbarium Nederland, Leiden (L), ex Herbarium Kützing, ex Herbarium Weber-Van Bosse. Bei Halle.

Distribution: rare, Europe, Russia, Ukraine.

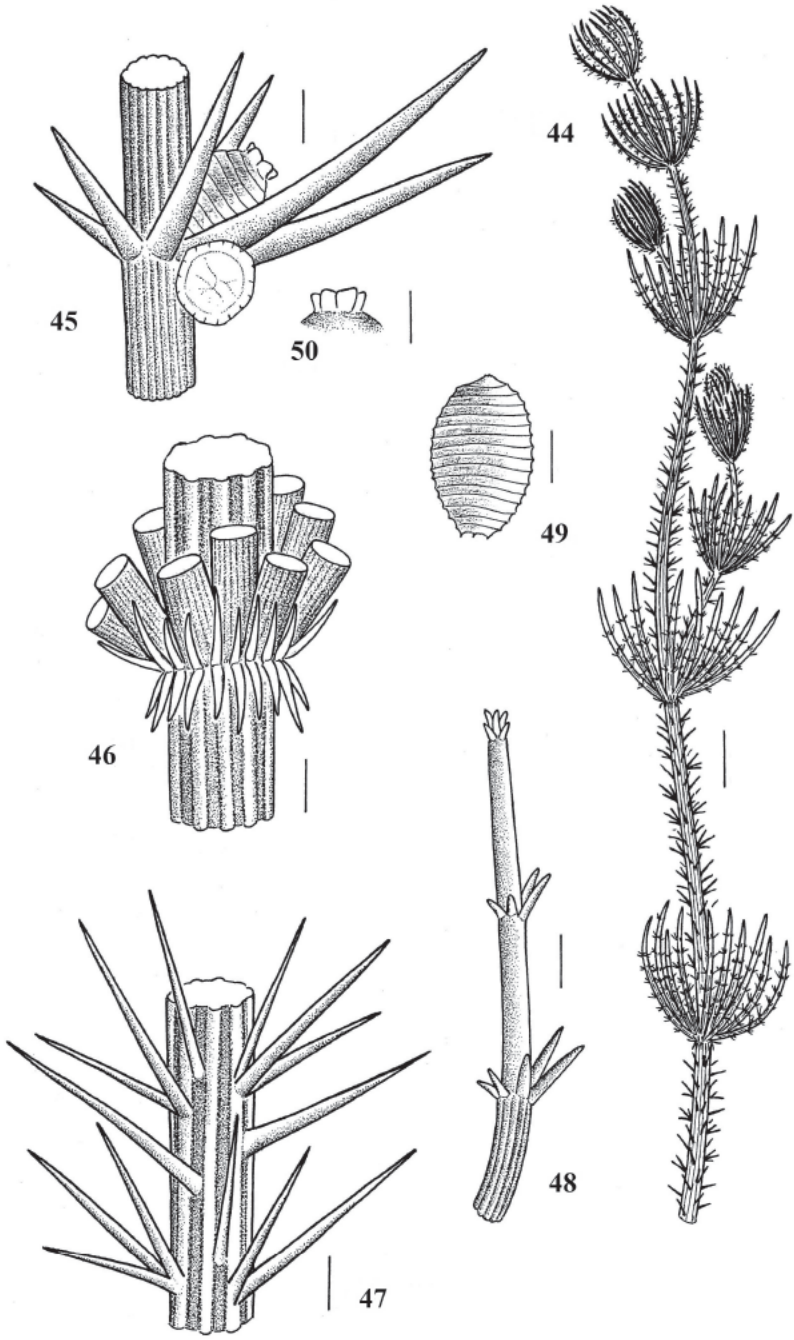
Plants monoecious, 30-60 cm high, slightly incrusted. Axes 800-1000 µm in diameter, internodes 1-2 times as long as branchlets, cortex 2- corticated, isostichous, spine cells, solitary, geminate (2 spines) and fasciculate (3 or more spines), 1-2 times as long as axis diameter (Figs 44, 47). Stipulodes in 2 tiers, 2 sets per branchlets, as long as axis diameter, uppers similar to lowers (Fig. 46). Branchlets 9-10 in a whorl, 1-3 cm long, segments 6-8 of which 5-6 are 2-corticated; end segment 3-celled, naked (Fig. 48). Bract-cells 4-6, verticillate, 2-3 times as long as the branchlets diameter, to 3 mm. long, bracteoles 2, to 2 mm. long, 3 times as long as the mature oogonium (Fig. 45). Gametangia conjoined at lowest 2-3 branchlet nodes, oogonia 950- 1040 µm long, 650-710 µm wide, convolutions 13 to 14, coronula 120-170 µm high, 250-340 µm wide (Fig. 50). Oospores are dark brown to black, fossa 45-60 µm across, striae of 14-15, membrane is irregularly granulate (Fig. 49). Antheridia ca 480-660 in diametre.



Figs 33-38. *Chara gymnophylla* var. *rohlenae*: **33-34.** Macroscopic habitus. **35.** Spine cells. **36.** Internodes with stipulodes and spine cells. **37.** Branchlet with oogonia and antheridia and end segment. **38.** Oopore. Scale bars 2500 µm (Fig. 33, 34), 625 µm (Fig. 37), 400 µm (Figs 35, 36) and 250 µm (Fig. 38).



Figs 39-43. *Chara kirghisorum*: **39.** Habit. **40.** Spine cells. **41.** Internode with stipulodes. **42.** Female branchlet and end segment. **43.** Male branchlet. Scale bars 2500 µm (Fig. 39), 500 µm (Figs 41, 43), 400 µm (Figs 40, 42).



Figs 44-50. *Chara pedunculata*: **44.** Habit. **45.** Gametangia and bract-cells. **46.** Whorls of stipulodes and branchlets. **47.** Spine cells. **48.** Tip of the branchlet. **49.** Oospore. **50.** Coronula cells. Scale bars 2500 μm (Fig. 44), 1000 μm (Fig. 48), 625 μm (Fig. 47), 500 μm (Fig. 46), 250 μm (Figs 49, 50).

Chara socotrensioides R.D. Wood 1965, *in* Wood & Imahori. *Monogr. Characeae* 1: 765. **Figs 51-56**

Basionym: *Chara vulgaris* var. *denudata* f. *socotrensioides* R.D. Wood, *Taxon* 11: 9. 1962.
Synonym: *Chara nuda* Pal., *ined. in herb.*; *Chara interrupta* Han *et* Kao 1963, *nomen illeg. non Chara interrupta* Ruprecht 1845 (is: *Nitella hyalina*).
Holotype: Herbarium New York Botanical Garden, New York (NY) ex Herbarium R.D. Wood; Lower Burma, Tavoy, L.P. Khanna, April 1934.
Distribution: Asia: Burma, China.

Plants monoecious, 10-20 cm high, not much branched, axes moderately stout, c. 500 µm in diameter, greyish green, heavily encrusted and very brittle when dry. Cortex rudimentary, essentially diplostichous, secondary cortex cells nearly absent, primary cortex cells absent on lower internodes, a few small cells developed on upper internodes. Spine cells absent. Stipulodes in 1 row, short and blunt (Fig. 53). Internodes 1-2 times the length of the branchlets; branchlets swollen and stiff, c. 8 in a whorl, incurved, 0.6-1 cm long, without cortex, 3-5 segments; end segment 2-3-celled, end cell short and blunt (Figs 51, 55), anterior bract-cells somewhat longer as oogonium, bracteoles about as long as anterior bract-cells, posteriors short and globose (Figs 52, 54). Gametangia conjoined at lowest branchlet segments (Fig. 54), oogonia solitary or geminate, immature. Mature oospores are dark brown to black, fossa 50-60 µm across. Oospore wall shows low pustular elevations with apical openings (Fig. 56). Antheridia small and solitary, *ca* 250 µm in diametre.

Chara tomentosa L., *Sp. Pl.* 2: 1156, 1753. **Figs 57-81**

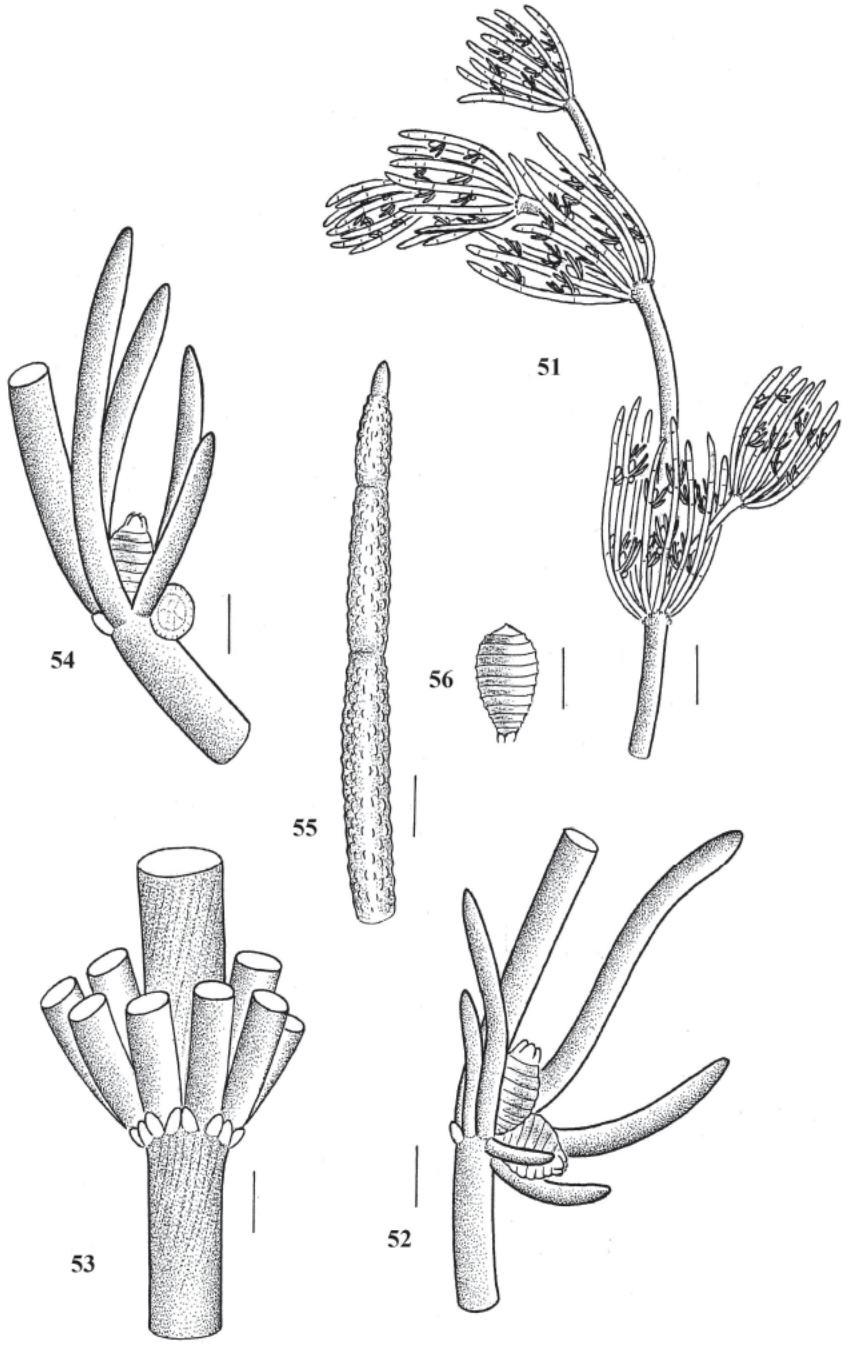
Synonyms: *Chara latifolia* Willd., *Ges. Naturf. Freunde Berlin Mag. Neuesten Entdeck. Gesammten Naturk.* 3: 298 (1809). *C. ceratophylla* Wallr., *Annus Bot.* 192 (1815).
Lectotype [per R.D. Wood 1960]: Herbarium Linnean Society, London (Linn).
Distribution: Northern Africa, Asia, Europe. Sites from Iran are given in Table 2.

Plants dioecious, 10-60 cm high, robust, green to brown heavily encrusted (Fig. 57). Cortex diplostichous, tylacanthous. Spine cells solitary rarely geminate, swollen, up to 3 mm long (Fig. 59). Stipulodes in 2 well developed rows, ovoid or acuminate, upper row longer as first branchlet segment (Figs 57, 60). Lower internodes 2-3 times the length of the branchlets, up to 6 cm long, upper internodes much shorter. Branchlets 6-8 in a whorl, 1-2 cm long, 3-4 of segments 2-corticated, ecorticated end segment rather long, 2-3-celled; cells swollen and constricted at the nodes, end-cell acute (Figs 58, 60, 61). Anterior bract-cells longer than the gametangia, posteriors somewhat shorter, swollen, acuminate (Figs 58, 61). Gametangia on separate plants, at 2-3 lowest branchlet nodes (Fig. 61), oogonia solitary, 650-950 µm long (excl. coronula), *ca* 14 convolutions, coronula *ca* 250 µm high, *ca* 410 µm wide. Antheridia solitary and large, 800-950 µm in diametre.

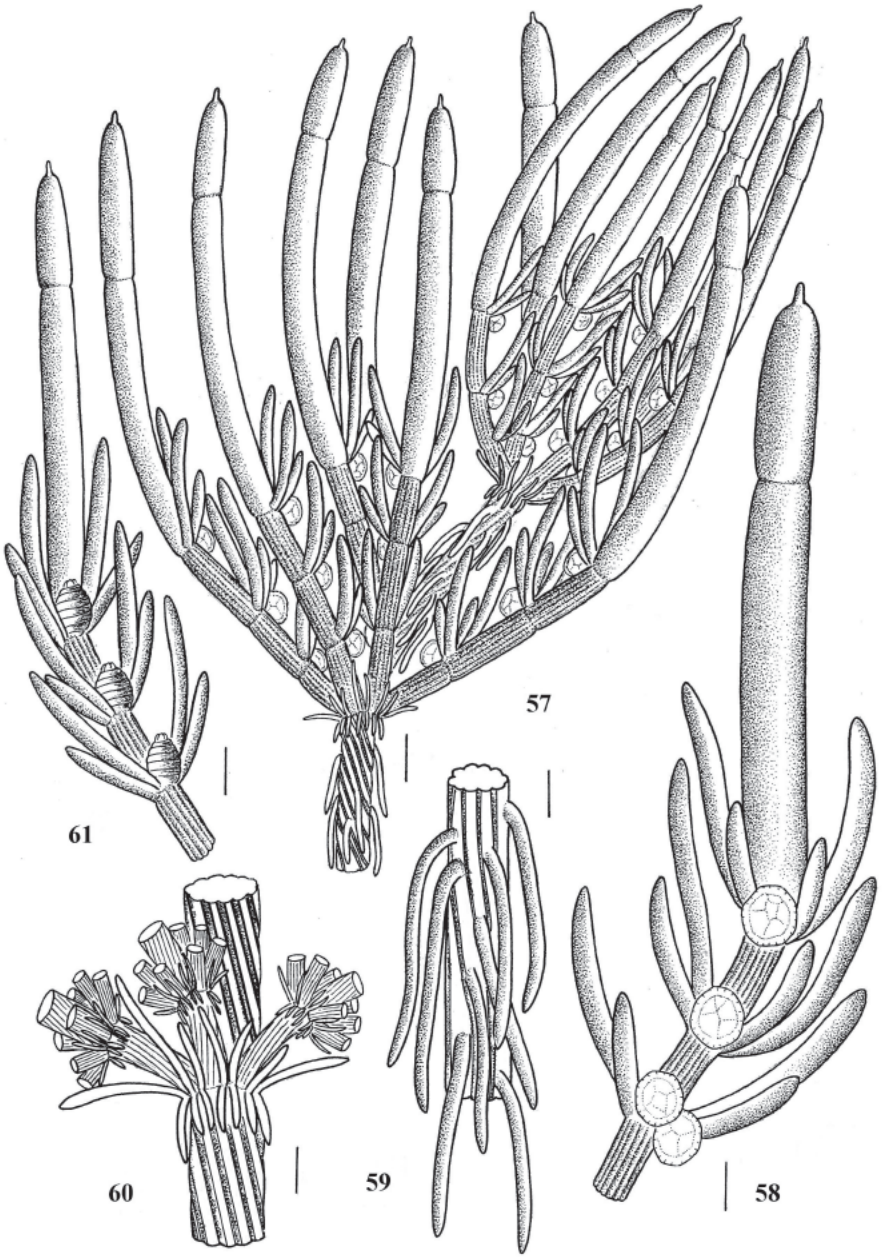
Chara vulgaris L., *Sp. Pl.* 2: 1156, 1753. **Figs 62-71**

Synonyms: *Chara foetida* A. Braun, *Ann. Sci. Nat. Bot.*, sér. 2, 1: 354, 1834.
Lectotype [per R.D. Wood 1960]: Herbarium Linnean Society, London (Linn), in herbarium Linnaeus (no. 1088.3), as *C. vulgaris*.

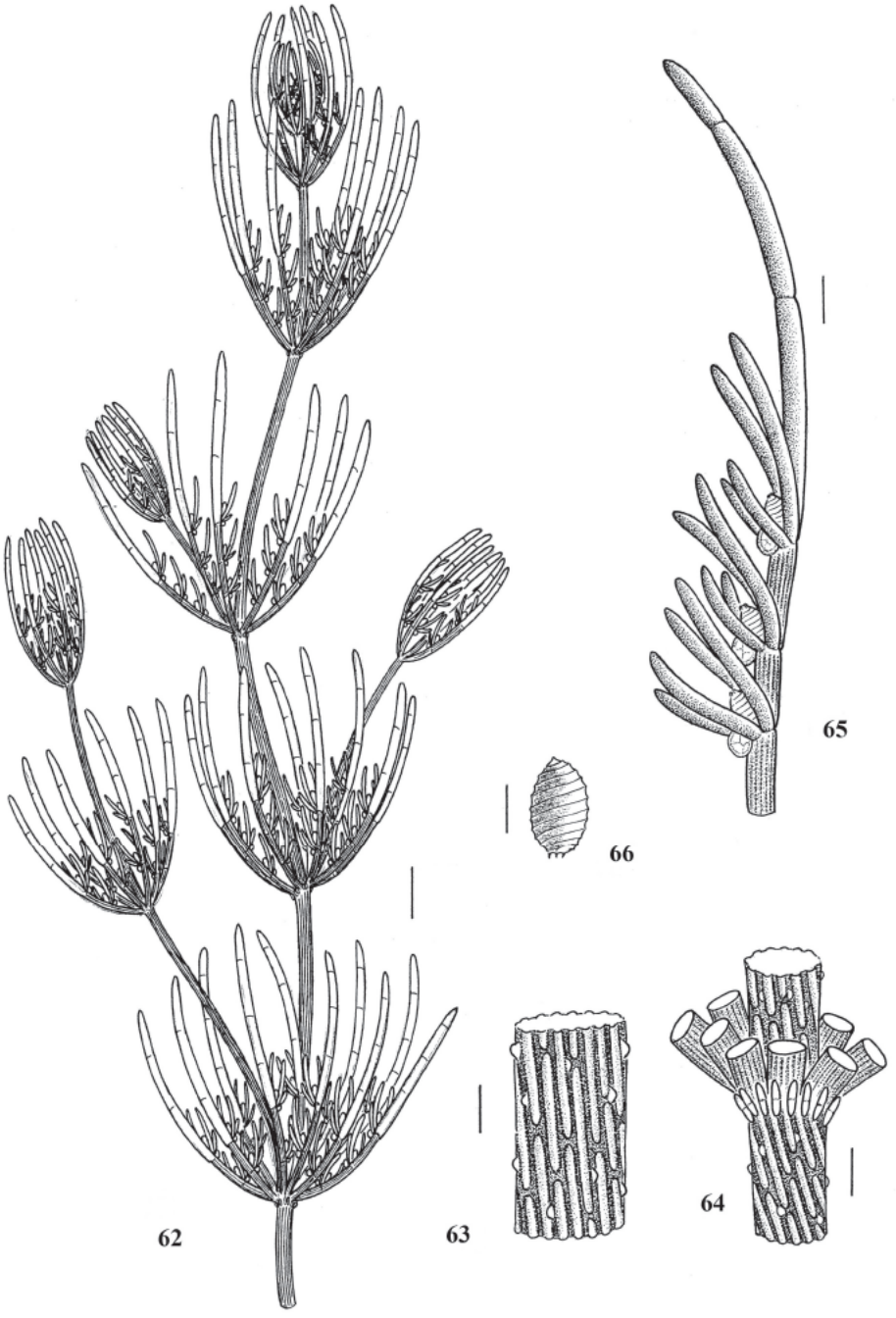
Distribution: Worldwide, records from South America, Africa, Asia, Europe, rarely on remote oceanic islands (Dambaska, 1964; Wood & Imahori, 1965; Krause, 1997). Sites from Iran are given in Table 2.



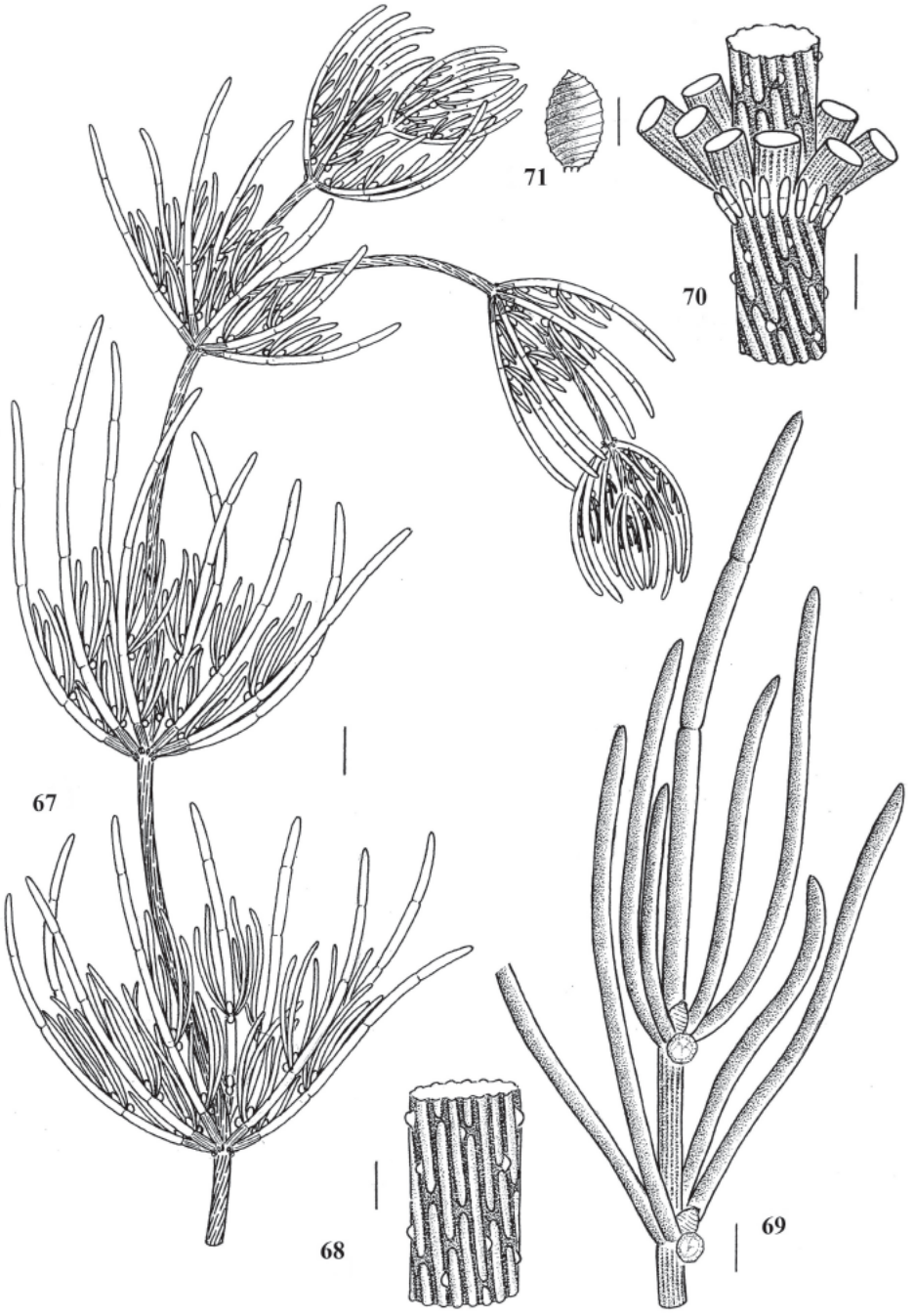
Figs 51-56. *Chara socotrensioides*: **51.** Habit. **52.** Geminate gametangia. **53.** Whorls of stipulodes and branchlets. **54.** Single gametangia with the bract-cells. **55.** End segment of the branchlet. **56.** Oospore. Scale bars 2500 µm (Fig. 51), 500 µm (Fig. 55), 400 µm (Fig. 52, 53, 54) and 250 µm (Fig. 56).



Figs 57-61. *Chara tomentosa*: **57.** Habit. **58.** Male branchlet. **59.** Spine cells. **60-61.** Whorls of stipulodes and branchlets: **60.** Female branchlet. **61.** Ends of the branchlets. Scale bars 2500 µm (Fig. 57, 61), 1250 µm (Figs 59), 1000 µm (Figs 58, 60).



Figs 62-66. *Chara vulgaris* var. *vulgaris*: **62.** Habit. **63.** Spine cells. **64.** Whorls of stipulodes and branchlets. **65.** Branchlet with oogonia and antheridia. **66.** Oospore. Scale bar 2500 (Fig. 62), 625 µm (Fig. 65), 500 (Fig. 64) and 250 (Figs 63, 66).



Figs 67-71. *Chara vulgaris* var. *longibracteata*: **67.** Habit. **68.** Spine cells and cortex. **69.** Branchlet with oogonia and antheridia. **70.** Whorls of stipulodes and branchlet. **71.** Spore. Scale bars 2500 µm (Fig. 67), 833 µm (Fig. 69), 500 µm (Fig. 70) and 250 µm (Fig. 68, 71).

Chara vulgaris is highly polymorphic. Plants monoecious, up to 30 cm tall, much branched, axes slender or moderately stout, 400-800 µm in diameter, green to dark green, moderately to heavily encrusted (Figs 62, 67). Cortex diplostichous, aulacanthous (Figs 63, 68). Spine cells solitary, rudimentary or small and globose (Figs 63, 68). Stipulodes in 2 rows, variable in size and blunt (Figs 64, 70). Internodes 1-3 times the length of the branchlets; branchlets 6-10 in a whorl (Figs 62, 64), 0-4 corticated segments, end segment 2-5-celled; end cell long or short conical and blunt. Anterior bract-cells 1-2 times as long as oogonium, bracteoles about as long as anterior bract-cells or very much longer and as long as branchlet endsegment, posteriors absent or rudimentary. Gametangia conjoined at 1-4 corticated branchlet segments, oogonia solitary or sometimes geminate, 500-650 µm long (excl. coronula), 350-450 µm wide, *ca* 14 convolutions, coronula 75-120 µm high, 150-300 µm wide at base. Mature oospores dark brown or black, 400-550 µm long, 300-375 µm wide, with ca 10 weak ridges, membrane nearly smooth or very finely granulate (Figs 66, 71). Antheridia small and solitary, up to 480 µm in diametre.

Chara vulgaris* var. *vulgaris **Figs 62-67**

Branchlets with 2-4 corticated segments, bracteoles about as long as anterior bract-cells (Fig. 65).

Chara vulgaris* var. *longibracteata (Kütz.) J. Groves *et* Bull.-Webst., *Brit. Charoph.* 2: 24. 1924. **Figs 68-71**

Chara longibracteata Kütz. *in* Rchb., *Fl. Germ. Excurs.* 2: 843. 1832.
Chara vulgaris L. f. *longibracteata* (Kütz.) H. Groves *et* J. Groves, *J. Bot.* 18: 133. 1880.

Branchlets with 0-2 corticated segments, bracteoles much longer as anterior bract-cells (Fig. 69).

Nitella hyalina (DC.) C.A. Agardh. *Syst. Alg.*: 126. 1824. **Figs 72-75**

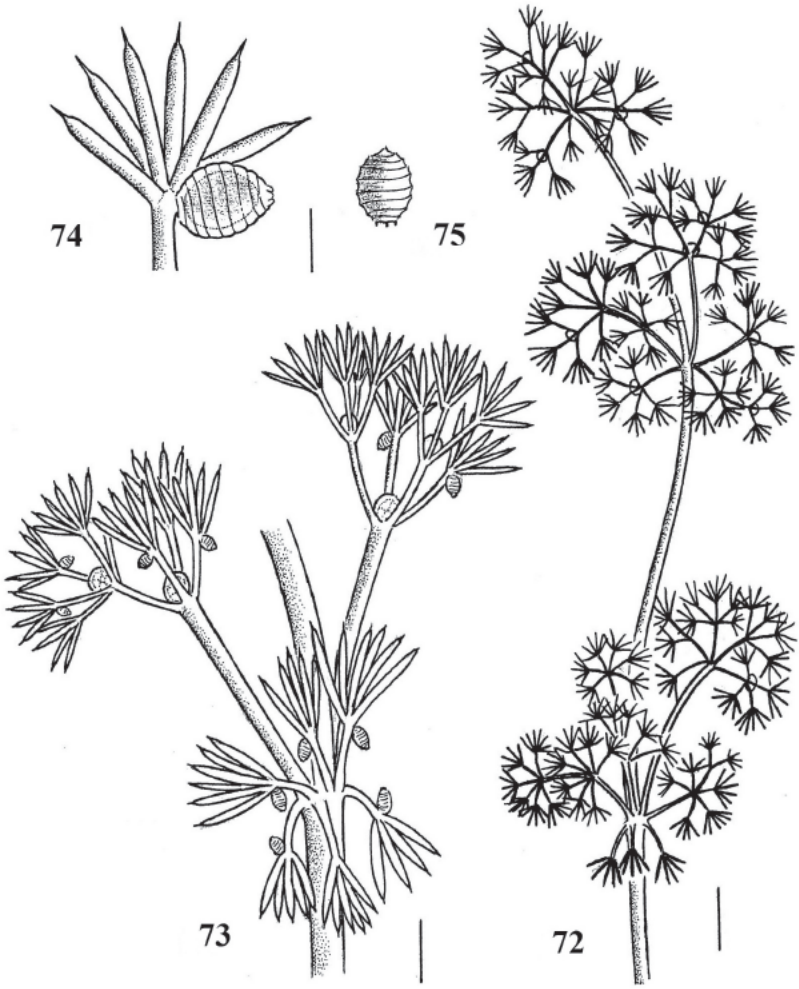
Basionym: *Chara hyalina* DC. *in* Lam. *et* DC., *Fl. Franç.*, éd. 3, 6: 247. 1815.

Synonyms: *Chara condensata* Ruprecht 1845; *Chara interrupta* Ruprecht 1845.

Syntype, Lectotype [small bit in packet per R.D. Wood Sept. 14, 1956; ref. Wood 1965, p. 660 spec. g]: *Herbarium, Conservatoire et Jardin Botanique de la Ville de Genève, Genève (G), ex herbarium De Candolle. Lac de Grand Lieu [France, Nantes], Hectot, 1805.*

Distribution: Worldwide in temperate and subtropical regions, south USA to Mexico, South America, north- and south Africa, Australia, New Zealand, New Caledonia, western- and southern Europe, southern Russia, Uzbekistan, Turkmenistan, Saudi Arabia, China, Japan, Pakistan, India. The sites from Iran are given in Table 2.

Plants monoecious, up to 20 cm. high, slightly calcified, consisting of strings of isolated branchlet whorls with thick mucus, slender, axes 200-600 µm in diameter (Fig. 72). Internodes 1-3 times as long as branchlets; branchlets both normal and accessory branchlets in each whorl normal, branchlets 0.5-1 cm long, 2- 3-furcate; accessory branchlets shorter in 2 whorls below and above the normal branchlet whorl, 0-1-furcate (Figs 73, 74). Dactyls bicellulate, up to 1 mm long. End cells long or short, conical, acuminate (Fig. 74). Gametangia conjoined at second and third branchlet furcations (Fig. 73). Oogonia solitary, 400-550 µm long (excl. coronula) 320-450 µm wide, 9-10 convolutions, coronula small, *ca* 40 µm



Figs 72-75. *Nitella hyalina*: **72.** Habit. **73.** Placement of antheridia. **74.** Dactyls consisting of two cells and oogonia. **75.** Oospore. Scale bar 1666 µm (Fig. 72), 625 µm (Fig. 73), 250 µm (Figs 74, 75).

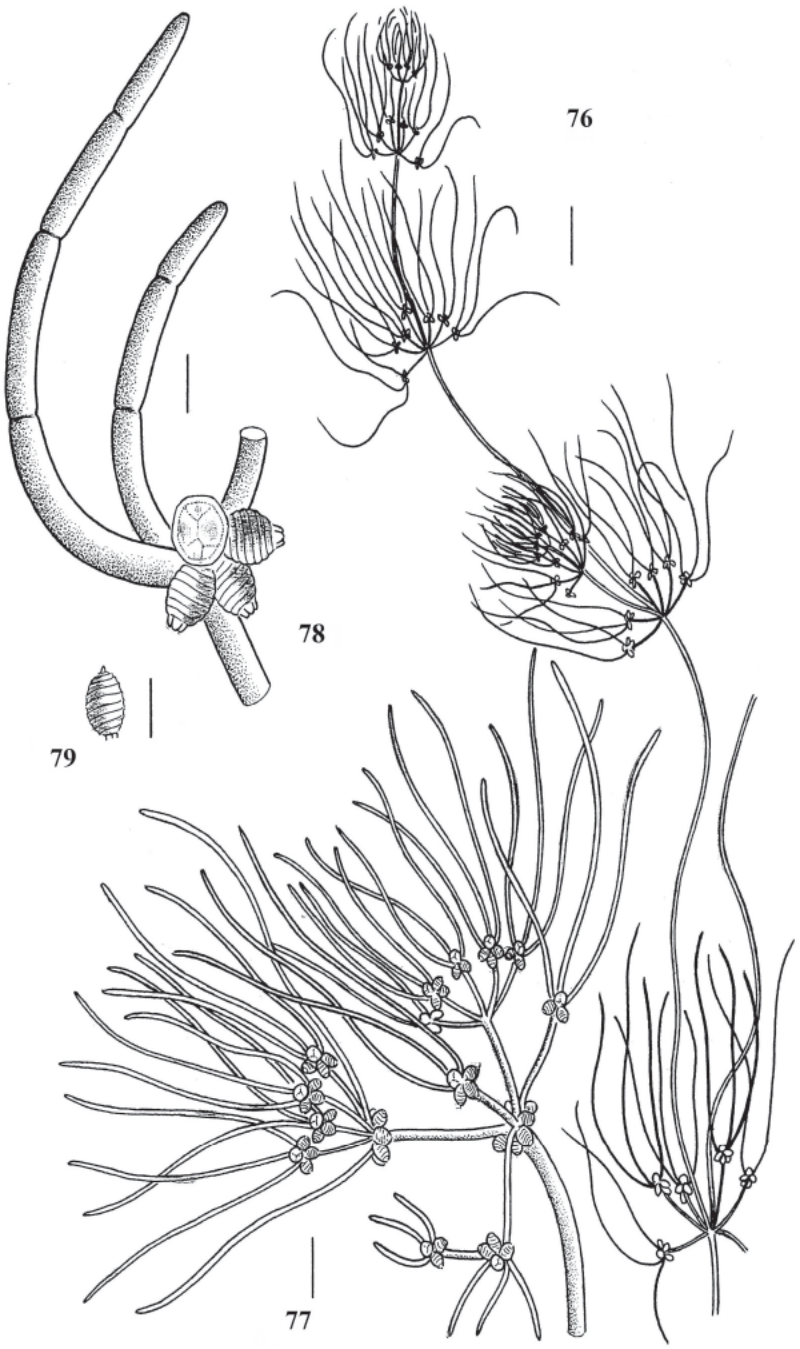
high, *ca* 60 µm wide at base. Oospores 290-350 µm long, 250-290 µm wide, with *ca* 8 flanged ridges, oospore wall and flanged structure is spongy to fibrous (Fig. 75). Antheridia 250-320 µm in diametre.

Tolypella glomerata (Desv.) Leon., *Lotos* 13: 129. 1963. **Figs 76-79**

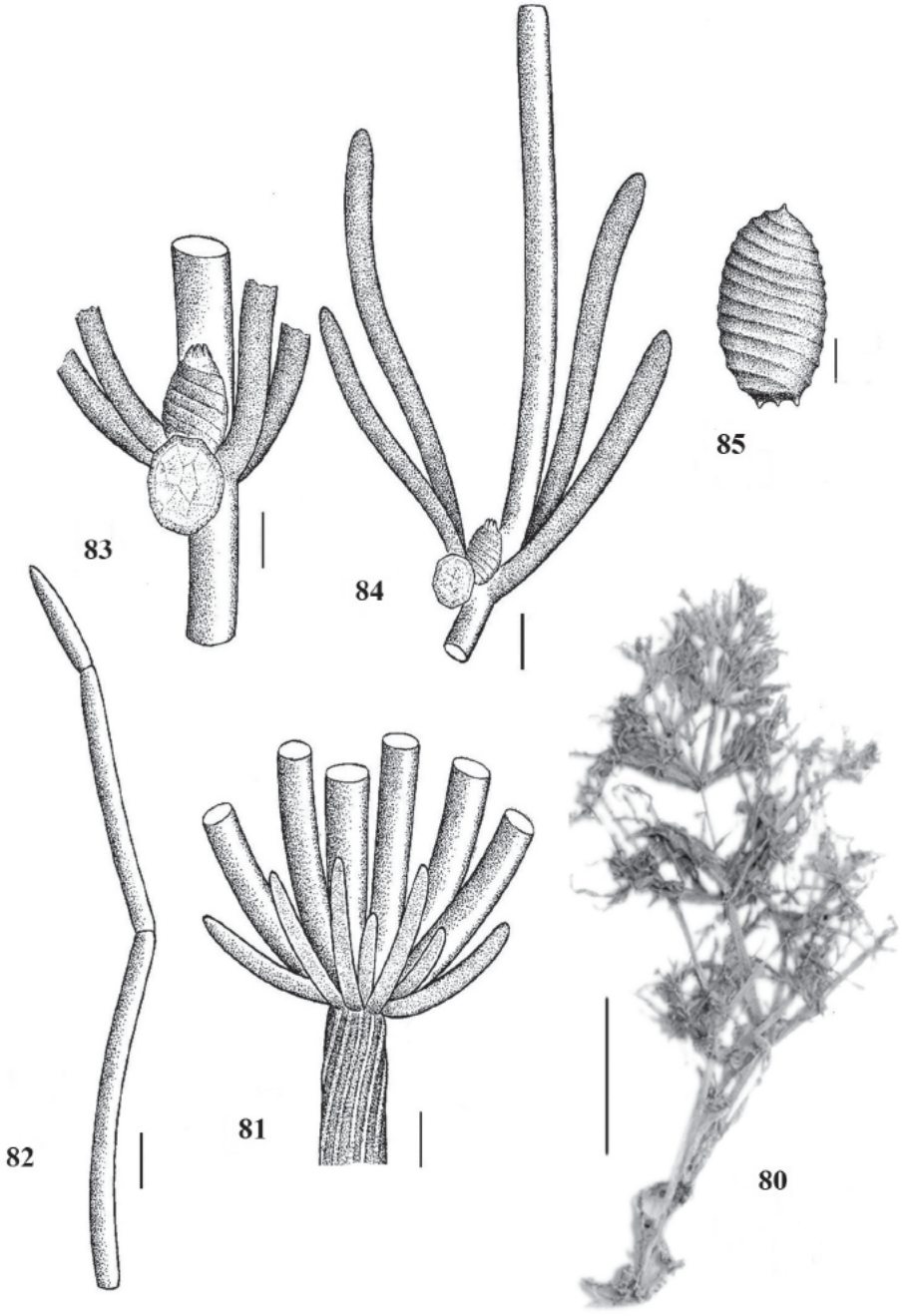
Basionym: *Chara glomerata* Desv. *in* Loisel., *Not. Fl. France*: 135 (1810)

Synonyms: *Chara smithii* Bab., *Ann. Mag. Nat. Hist.*, Ser. 2, 5: 86 (1850), *Chara glomerulifera* Ruprecht, *Distr. crypt. vasc. imp. Rossico* 7 (1845).

Nomina: *Tolypella nidifica* (O. Müll.) Leonh. var. *glomerata* (Desv.) R.D. Wood, *Taxon* 11: 23. 1962.



Figs 76-79. *Tolypella glomerata*: **76-77.** Habit. **78.** Branchlet with oogonium and antheridium. **79.** Oospore. Scale bar 2500 µm (Fig. 76), 1250 µm (Fig. 77), 312 µm (Fig. 78), 250 µm (Fig. 79).



Figs 80-85. *Chara kohrangiana*: **80.** Habit. **81.** Whorl of stipulodes and branchlets. **82.** End segment and end cells. **83.** Gametangia with antheridium and oogonium. **84.** Gametangia and bract-cells. **85.** Oospore. Scale bar 1 cm (Fig. 80): 625 µm (Figs 81, 82), 500 µm (Fig. 84), 250 µm (Fig. 83) and 100 µm (Fig. 85).

Holotype [ref. Wood 1965, p. 733, spec. c]: Herbier Laboratoire de Cryptogamie, Muséum National d'Histoire Naturelle, Paris (PC), ex herbarium Desvaux. Hab. in rivulis.

Isotype: National Herbarium Nederland, Leiden (L), ex herbarium Persoon, ex herbarium Desvaux. Gallia.

Distribution: Europe, northern Africa, Asia, localities from Iran are listed in Table 2.

Plant monoecious, 5-20 cm. high, slender, with few coarse heads, incrusted (Fig. 76) Axes moderately slender, 520-650 µm in diameter, green to dark green; internodes 2-3 times the length of branchlets up to 7 cm. long; branchlets 13-15 fertile in dense heads. 0.5 1.5 cm long, 1-2 divided, branchlet axis with 1 node with 2 lateral rays, basal cell short up to 4 mm long, end segment to 1 cm long, sterile 3-5 in a whorl, *ca* 1.5-2 cm. long, simple, 5-7 celled. Rays 3-4 celled, of uniform diameter. Heads numerous 3-17 per shoot, 0.3-0.5 cm in diameter (Fig. 77). Gametangia conjoined at the fertile branchlet node; generally 1 central adaxial antheridium with 3 lateral oogonia (Fig. 78). Oogonia three at a node, 450 500 µm (incl. coronula) long, 310-400 µm wide, convolutions 9-10, coronula 50-70 µm high, 60-90 µm wide. Oospores golden brown to dark brown, 280-470 µm long, 190-300 µm wide, striae 8-9, often flanged ridges, 30-37 µm across, membrane smooth (Fig. 79). Antheridia one at a node, 360-410 µm diametre, sessile.

***Chara kohrangiana* sp. nov. A. Ahmadi, M. Sheidai, H. Riahi, JC. Van Raam**
Figs 80-85

Holotype: Collected as a submerged, deposited in IRAN Herbarium, voucher number 53985-IRAN.

Type locality: Jahangiri area, Darre Dorr area, 5 km to Kohrang, Farsan to Chelgerd road, Chahar mahal and Bakhtiari province, Iran.

Etymology: The name Kohrangiana is after the collection site.

Plantae monoicae; ad 12 cm alta; caulis ad 650-700 µm in diam., disjunctis imperfecte diplostichis corticatus; spinula absentia. Stipulae haplostephanae, brevis. Ramuli c. 8, ecorticati, sterilis usque ad 2 cm longioris, fertilis minus quam 1 cm leviter incurvus, segmenta 3-4, segmentis apicalis longis 3-4 cellularis. Bracteis monolateralis tumidis, ventralibus 3-4 duplo longioribus quam oogonia, dorsalibus 2-4 brevissimus, bracteolis 2. Gametangia conjunctis ad 1-4 nodis basalibus. Oogonia solitarius, 550 µm longa (coronula exclusa), 380 µm lata; cellulae spirales 11-14 convolutas exhibentes; coronula 70 µm alta, 130 µm basi lata. Oosporae brunea, circa 540 µm longa, 280 µm lata, 10-12 striae tenuis, fossulla circa 60 µm; membrana subtilitera granulata. Antheridia ad 350 µm diametro.

Plants green, partly slightly incrusted, 3-12 cm height; much branched; lower internodes about as long as sterile branchlets, upper internodes much shorter. Axes rather slender, 650-700 µm in diameter (Fig. 80). Cortex essentially 2-corticated, however secondary cortex cells nearly absent; primary cortex cells often not complete, absent on lower internodes; spine cells absent. Stipulodes in 1 row, 2 per branchlet; short or as long as axis diameter; swollen; blunt (Fig. 81). Branchlets *ca* 8 in a whorl, sterile up to 2 cm long, straight, fertile less than 1 cm, slightly incurved, 3-4 segments, ecorticate (Fig. 81). End segment ecorticated, long; 3-4-celled, endcell rather long, blunt or acute (Fig. 82). Bract-cells unilateral, at all branchlet segments, swollen, acute; interiors, 3-4, 2-times as long as oogonium; posteriors 2-4, very short; bracteoles, 2, longer as anterior bract-cells (Fig. 84). Gametangia conjoined or sejoined at lowest branchlet nodes (Fig. 83). Oogonia solitary, 550 µm long (excl. coronula), 380 µm wide; convolutions 11-14;

coronula *ca* 70 µm high, 130 µm wide. Mature oospores brown, *ca* 510 µm long, 280 µm wide; 10-12 faint ridges ending in small claws, fossa *ca* 60 µm across, oospores membrane light brown, very finely granulate (Fig. 85). Antheridia *ca* 350 µm in diameter.

DISCUSSION

The new species of *C. kohrangiana* has stipulodes in 1 row, well developed, anterior and posterior bract-cells, axial cortex incomplete diplostichous, branchlets ecorticate, end segment of the branchlet longer than the adjoining bract-cells (no terminal corona), and is monoecious. Following Wood's revised "Synopsis of the Characeae" (Van Raam & Stewart, 2009), *Chara kohrangiana* belongs to the genus *Chara* subgenus *Charopsis* section *Agardhia* subsection *Agardhia*. *Chara kohrangiana* is differing from all other species in subsection *Agardhia* by its incomplete axial cortex. Also differing from all other species with incomplete axial cortex (as *C. denudata*, *C. imperfecta*) by having only 1 row of stipulodes (including *C. socotrensioides* where the lower row is often rudimentary).

The oldest records of Characeae from Iran are *Chara vulgaris*, *Nitella hyalina* by Braun (1849) and Leonard (1981) and *C. tomentosa* by Carle & Frey (1977). In this study, *Chara* is more diversified in the central part of Iran, while *C. gymnophylla* and *C. vulgaris* are the most common species in the western region. Distribution of some species such as *C. kirghisorum* and *C. grovesii* are restricted to one location. They grow in clean and slow running ditchs, and according to Wood & Imahori (1959) these species are rare and restricted to Asia. *C. grovesii* has also been reported from India by Subramanian (2005). The streams are often located in the western part of Iran, while in the central part pools and ponds are more abundant. *C. connivens* also occurs in Europe, Africa and southwest Asia (Wood & Imahori, 1964). *C. tomentosa* and *C. pedunculata* were found together with *C. connivens* (Appelgren *et al.* (2004) reported *C. connivens*, *C. tomentosa* and *C. horrida* growing together in Finland). In Iran, the charophytes found in ponds and pools show more diversity than the ones growing in streams. In the streams the common species are *C. vulgaris* and *C. gymnophylla*, it seems that these species can tolerate water running better than other species.

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