PRESLIA (PRAHA)
41 : 1—7, 1969

A Note on the Genus *Chlorhormidium* FOTT *(Ulotrichaceae)*

Poznámka k rodu *Chlorhormidium* FOTT *(Ulotrichaceae)*

Phool Begum Farooqui *

Department of Botany, Caroline University of Prague, Benátská 2, Praha 2

Dedicated to the 60th Anniversary of Birth of Professor Bohuslav Fott, Dr. Sc.

Received July 30, 1968

Abstract — The morphology and taxonomy of some species of the genus *Chlorhormidium* were studied in order to support the validity of the genus. New combinations have been made as *Chlorhormidium flaccidum* (KÜTZ.) FOTT var. *nitens* (MENEGH.) comb. nova and *Chlorhormidium dissectum* (GAY) comb. nova. Zoospores were observed in *Chlorhormidium flaccidum* (KÜTZ.) FOTT var. *nitens* (MENEGH.) comb. nova.

Introduction

Taxonomy in algae has long been in great confusion because earlier algal taxonomy was based on dried materials or on descriptions of the external morphology of algae; now more emphasis is placed on cell structure and the life history of algae, both in natural conditions and in cultures. MATTOX and BOLD (1962) have carried out detailed studies among the members of the family *Ulotrichaceae* with respect to the modern concept of taxonomy on the basis of the organisms in nature and in cultures.

The genus *Hormidium* KÜTZ. emend. KLEBS, *Stichococcus* NÄG., and *Ulothrix* KÜTZ. of the family *Ulotrichaceae* had been in great confusion and phycologists have always puzzled about their identity. The genus *Hormidium* was first proposed by KÜTZING (1843a) and he included three species, *H. moniliforme* KÜTZ., *H. velutinum* KÜTZ. and *H. flaccidum* (DILLWIN) KÜTZ. Three further species, *H. murale* (LYNGB.) KÜTZ., *H. parietinum* (VAUCH.) KÜTZ. and *H. crenulatum* KÜTZ. were added in Phycologia Germanica (KÜTZING 1845). Last three species remained the basis of the genus until 1891. HANSGIRG (1888) and DE TONI (1889) also recorded them as valid species of the genus *Hormidium*. KÜTZING (1849) in his Species Algarum created the section *Hormidium* under *Ulothrix*. This section was variously applied to the filamentous algae. In the same year he placed *H. moniliforme* KÜTZ. in its present position in *Ulothrix*, *H. flaccidum* (DILLWYN) KÜTZ. in the genus *Hormotrichum* KÜTZ. and *H. velutinum* KÜTZ. with its additional forms in the section *Hormidium*. GAY (1891) did not accept KÜTZING's genus *Hormidium*. HAZEN (1902) like GAY did not recognise the genus *Hormidium* and included all the species of *Hormidium* under *Stichococcus* NÄGELI. KLEBS (1896), however, did not agree with GAY in abandoning the genus *Hormidium* due to the absence of any zoospores in the species of *Stichococcus* and revived KÜTZING's genus *Hormidium* which is distinct from *Stichococcus*, and amended the genus with extended diagnosis. Since then most of the authors have accepted the modified version by KLEBS and have kept *Hormidium* as distinct from *Stichococcus* on the basis of the presence of pyrenoid and of the formation of motile reproductive cells.

HEERING (1914), RAMANATHAN (1964), PRINTZ (1927, 1964), FRITSCH (1935), SMITH (1933, 1950) and PRESCOTT (1951) all retained both *Hormidium* (one pyrenoid per cell and biflagellate zoospores) and *Stichococcus* (no pyrenoid and no zoospores) in the family *Ulothrichaceae*.

Recently, FOTT (1959, 1960) has established a new name *Chlorhormidium* for the genus *Hormidium*. He demonstrated that *Hormidium* KÜTZ. (1843a)

* Present address: Department of Botany, Univ. of Karachi, Karachi - 32, West Pakistan.

is a homonym with an Orchid genus *Hormidium* LINDLEY (1840) and therefore not valid according to the Code (1961). He, therefore, proposed a new name *Chlorhormidium* which satisfies the Code and indicates clearly that the former Ulotrichalean genus *Hormidium* KÜTZ. is meant. He did not establisch the combinations of all the species of *Hormidium* as their taxonomy and descriptions are quite unsatisfactory, except for *Hormidium flaccidum* (KÜTZ.) A. BRAUN. RAMANATHAN (1964) considered that, if *Hormidium* KÜTZ. is invalidated, then the next valid name available is *Hormococcus* CHODAT (1902) which is based on the same type species as *Hormidium flaccidum* (KÜTZ.) A. BRAUN. It appears from CHODAT's account that he has included a number of *Hormidium* and *Stichococcus* algae as varieties under the species *H. flaccidum* (KÜTZ.) A. BRAUN, and thus he himself has confused

Comparison table of the genera

	Ulothrix KÜTZING 1833	*Chlorhormidium* FOTT 1960	*Stichococcus* NÄGELI 1849
Filament	Simple, unbranched, uniseriate, differentiated into basal cell arising from the special holdfast. Cell wall thin, mucilagenous sheath absent.	Simple, unbranched, uniseriate. Filaments without any special basal or terminal cell. Cell wall thin, without any mucilagenous sheath.	Simple, unbranched, uniseriate, without mucilagenous sheath, fragmenting easily to form solitary cells.
Form of cell	Cylindrical, compactly united end to end in a filament. Cell ends mostly not rounded.	Cylindrical, united end to end in a filament. In some of the species there is a tendency to dissociate into short *Stichococcus*-like filaments of 2—6 cells. Cell ends are often rounded.	Cylindrical or ellipsoidal, loosely attached to one another along a part of their transverse walls which is very often rounded facilitating fragmentation.
Chloroplast	Chloroplast single, parietal, band-or girdle-shaped, partly or completely encircling the protoplast. Chloroplast lobed towards the longitudinal margins.	Chloroplast parietal, plate-like or disc-shaped, encircling ½ or less of the cell cavity and extending almost the whole length of the cell.	Chloroplast parietal, incompletely encircling the cell cavity, shorter than the whole length of the cell.
Pyrenoid	Pyrenoid one or more in each cell.	Only one pyrenoid.	Pyrenoid absent.
Reproduction	All cells are capable of division except the basal cell. Reproduction by quadriflagellate zoospores which always produce a hold-fast after germination. Sexual reproduction by the union of biflagellate isogametes. Zoospores have a prominent stigma.	All cells are capable of division. Biflagellate zoospores produced singly in each cell and released through an opening in the cell wall. They do not produce holdfast on germination and have no stigma. Sexual reproduction takes place by the fusion of biflagellate isogametes.	Reproduction by fragmentation of the filament. Filaments rebuilt longer by vegetative division. No motile cells.

this name. Therefore, the name *Hormococcus* CHODAT should be rejected as nomen confusum and the name *Chlorhormidium* FOTT should be considered as the valid name.

The present study was made on the morphology and taxonomy of *Chlorhormidium* FOTT from Czechoslovakia in order to establish the validity of this genus.

Chlorhormidium FOTT 1960

Chlorhormidium FOTT 1959 (nomen solum), Algenkunde, p. 265; FOTT 1960, Preslia, 32 : 149.
Basionym: *Hormidium* KÜTZING 1843a, Linnaea, 17 : 89.

Synonym: *Hormidium* sensu KÜTZING 1843a, Phycol. General., p. 244; KÜTZING 1849, Spec. Alg., p. 349; KÜTZING 1845, Phycol. German., p. 192.
Hormidium sensu KLEBS 1896, Bedingungen der Fortpflanzung bei einigen Algen u. Pilzen, p. 326—327; CHODAT 1913, Monographies d'Algues en culture pure, p. 138—139; SMITH 1950, Fresh-water Algae of U.S., 2nd. ed., p. 146—147; PRESCOTT 1951, Algae of the Western Great Lake Area, 31 : 97; RAMANATHAN 1964, *Ulotrichales*, p. 77—81.
Hormidium sensu HEERING 1914, *Chlorophyceae* 3, Süsswasser-Flora, 6 : 41—43; PRINTZ 1964, Hydrobiologia, 24 (1—3) : 22—23.

Chlorhormidium FOTT includes simple, unbranched filaments consisting of uninucleate cells. The cells are cylindrical with a thin cell wall containing a single, parietal plate-like or disc-shaped chloroplast filling $^1/_2$ (or less) of the cell cavity. Pyrenoid elongated or oval, embedded in the chloroplast. The nucleus is in the cytoplasmic bridge opposite the chloroplast. The cell ends often contain prominent vacuoles. Old filaments show a marked tendency to dissociate into short *Stichococcus*-like filaments of a few cells. *Chlorhormidium* FOTT commonly grows in moist places.

The most common method of reproduction is by fragmentation of the filament into solitary cells or by the formation of thick-walled akinetes. Asexual reproduction takes place by biflagellate zoospores which are produced singly in each cell and released through a circular pore in the cell wall. Zoospores lack stigma and do not produce any basal cell on germination. Sexual reproduction is supposed to take place by the fusion of biflagellate isogametes (according to WILLE 1912). The number of species and infraspecific taxa is not known. Only species studied both in nature and cultures are referred to in this article.

1a. *Chlorhormidium flaccidum* (KÜTZ.) FOTT var. *flaccidum* FOTT 1960, Preslia 32 : 149

Basionym: *Ulothrix flaccida* KÜTZ. 1849, Spec. Alg., p. 349.

Synonyms: *Ulothrix flaccida* KÜTZ. 1852, Tab. Phycol., 2 : 95, fig. 2; RABENHORST 1868, Flora Eur. Alg. 3 : 367.

Hormidium flaccidum (KÜTZ.) A. BRAUN in KLEBS 1896, Bedingungen der Fortpflanzung bei einigen Algen u. Pilzen, p. 341—345, Taf. 2 : 21—24; CHODAT 1913, Monographies d'Algues en culture pure, p. 141—142, fig. 128; HEERING 1914, *Chlorophyceae* 3, Süsswasser-Flora, 6 : 46, fig. 48—49; PRINTZ 1927, *Chlorophyceae* in ENGLER-PRANTL, Die natürl. Pflanzenfam., 2nd ed., 3 : 167, fig. 119, FRITSCH 1935, Structure and reproduction of Algae vol. 1, p. 199—206, fig. 58 J-N. RANDHAWA 1948, Proc. Nat. Inst. Sc. of India 14 (8) : 369; MATTOX et BOLD 1962, Phycol. Stud. Univ. Texas, Pub. No. 6222 : 31—32, fig. 41—42; RAMANATHAN 1964, *Ulotrichales*, p. 81—82, fig. A—E; PRINTZ 1964, Hydrobiologia 24 (1—3) : 25—27, fig. 7—32.

Hormiscia flaccida (KÜTZ.) LAGERH. 1888, Flora, 71 : 63; DE TONI 1889, Syll., Alg. 1 : 161.
Hormococcus flaccidus α *flaccida* CHODAT 1902, Beitr. Krypt. Flora Schweiz, 1 : 269.
Stichococcus flaccidus (KÜTZ.) GAY 1891, Recherches Alg. Vert., p. 79, pl. 11, fig. 106; KLERCKER 1896, Flora, 82 : 104.

The filaments are simple, rough, cylindrical and unbranched without any differentiation between the base and the apex, having uninucleate cells united end to end, and are without mucilagenous sheath.

Chloroplast parietal, plate-like, encircling $^1/_2$ (or less) of the cell cavity. One distinct pyrenoid rounded or elongated, embedded within the chloroplast. The nucleus lies in the cytoplasmic bridge opposite the chloroplast.

Dimensions of cells: 5.5—6 μm broad, 6—9 μm long.

Reproduction: (1) By fragmentation of the filament into small portions; each portion is capable of developing into a new filament. (2) By biflagellate zoospores which are formed singly in a cell. (3) Sexual reproduction takes place by fusion of such zoospores, acting as gametes.

Occurrence: KÜTZING 1849 reported *Hormidium flaccidum* for the first time from Lapidias Argentoratis. It is a cosmopolitan species growing in moist places. I studied this species from the Culture Collection of Botany Department, Charles University, Prague, Culture strain FOTT 1960/3.

1b. *Chlorhormidium flaccidum* var. *nitens* (MENEGH.) comb. nova

Basionym: *Hormidium nitens* MENEGHINI in litt., in KÜTZING 1849, Spec. Alg., p. 349.

Synonyms: *Ulothrix nitens* KÜTZING 1849, Spec. Alg., p. 349.

Hormidium nitens MENEGH. in KLEBS 1896, Bedingungen der Fortpflanzung bei einigen Algen u. Pilzen, p. 328—340, pl. 2, fig. 25—29 (icona prima); CHODAT 1913, Monographies d'Algues en culture pure, p. 140—141, fig. 127; HEERING 1914, *Chlorophyceae*, Süsswasser-Flora, 6 : 45, fig. 50; FRITSCH 1935, Structure and Reproduction of Algae, vol. 1, p. 205.

Hormidium klebsii SMITH 1933, Freshwater Algae of U.S., 1st ed., p. 384—385, fig. 257; RAMANATHAN 1964, *Ulotrichales*, p. 85, fig. 21 I—K; PRINTZ 1964, Hydrobiologia, 24 (1—3) : 26—27; fig. 1—3.

The filaments are simple, cylindrical, shiny, waterrepellent, smooth, uniseriate, unbranched, without any differentiation between the base and the apex. Uninucleate cells united firmly end to end. Cell wall without mucilagenous sheath.

Chloroplast parietal, plate-like, encircling $^1/_2$ (or less) of the cell cavity. Pyrenoid one, rounded or elongated embedded in the chloroplast. Nucleus in the cytoplasmic bridge opposite to the chloroplast.

Dimensions: 5—5.6 μm broad, 6—8.5 μm long.

Reproduction: Vegetative reproduction occurs by the disintegration of the filament into solitary cells. The individual cells are than capable of developing into a new filament. Sexual reproduction takes place by the fusion of biflagellate gametes which are formed singly in a cell (KLEBS 1896).

Occurrence: MENEGHINI recorded *Hormidium nitens* growing on stones and rocks in humid places all over Europe. I studied this species from the Culture Collection of the Botany Department, Charles University, Prague, strain MORAVCOVÁ 1965/1.

Note: *Chlorhormidium flaccidum* var. *nitens* comb. nova had been previously considered as an independent species of *Hormidium*. The present studies includes *H. nitens* as a variety of *Chlorhormidium flaccidum* (A. BRAUN) FOTT. The reason for this inclusion is that *Hormidium nitens* has similar arrangement of chloroplast, pyrenoid and nucleus within the cell as *Chlorhormidium flaccidum* (A. BRAUN) FOTT which differs only in physiological behaviour in culture. The characteristic differences can be seen only when both algae are grown in fluid medium. *Chlorhormidium flaccidum* (A. BRAUN) FOTT var. *flaccidum* FOTT grows immersed in fluid culture medium and its threads are rough and twisted, whereas *Chlorhormidium flaccidum* (A. BRAUN) FOTT var. *nitens* comb. nova is water repellent and grows on the surface of water, forming a thin film. There is no distinct mucilagenous sheath in either the water immersing variety or water repellent variety.

BORZI 1895, for the first time observed the zoospores in *Hormidium flaccidum*. Later KLEBS 1896 recorded the zoospores in both *Hormidium flaccidum* and in *Hormidium nitens*. KLEBS

described his observations in detail. In order to verify KLEBS's observations I followed his method. The material was grown in the normal Bristol solution except that instead of KH_2PO_4 I added KNO_3 (see materials and methods).

Zoospore formation takes place in the vegetative filament especially in filaments with cells as broad as they are long. A single zoospore is produced inside a single cell. After formation the zoospores are released through an opening at the side of the cell wall. At the time of zoospore formation, the cell wall begins to protrude outwards like a small papilla and due to pressure from the inside mass, the cell wall becomes very thin, as a result, an opening is formed through which the zoospore escapes.

The zoospores are dorsiventral in shape. The dorsal side is convex and the ventral side is slightly concave. The anterior end is a blunt shape, and the posterior end is narrow. The chloroplast is mostly on the dorsal side, having a distinct pyrenoid. Anterior end is without chloroplast, having two flagella which are not arising at the same point; two contractile vacuoles at the anterior end. Stigma lacking. Zoospores move towards the right and left with an irregular rotation. During movement the zoospore shades off its flagella and becomes an oval cell which is clothed with a thin cellulose wall. If the conditions are favourable, a new filament is grown from the oval cell without the differentiation of base and apex.

Zoospores of *Chlorhormidium* can be compared with the zoospores of *Ulothrix* as follows: The zoospores of *Chlorhormidium flaccidum* var. *nitens* are dorsiventral in structure, having two flagella, two contractile vacuoles and one pyrenoid, and there is no stigma. Zoospores of *Ulothrix* are ovoid in appearance, having a distinct stigma, 4 flagella, 2 or 4 contractile vacuoles and more than one pyrenoid.

2. *Chlorhormidium dissectum* (GAY) comb. nova

B a s i o n y m: *Stichococcus dissectus* GAY 1891, Recherches sur le développement et la classification de quelques Algues vertes, p. 78—79.

S y n o n y m s: *Hormococcus flaccidus* (KÜTZ.) CHODAT γ *dissectus* GAY in CHODAT 1902, Algues Vertes de la Suisse, Pleurococcoides-Chroolépoides, p. 268—269.

Hormidium dissectum (GAY) CHODAT 1913, Monographies d'Algues en culture pure, p. 142, fig. 129; HEERING 1914, *Chlorophyceae*, Süsswasser-Flora, 6 : 43—44, fig. 51; PRINTZ 1964, Hydrobiologia 24 (1—3): 25, taf. 3, fig. 21. RAMANATHAN 1964, *Ulotrichales*, p. 86—87, fig. 21 H.

F i l a m e n t s short, simple, cylindrical, uniseriate, unbranched and easily disintegrating. The cells are loosely attached forming short filaments of 8—10 cells (4 celled filaments are common). Filaments curved or irregular. Cell wall thick and not mucilaginous.

C h l o r o p l a s t parietal, plate-like encircling $^1/_2$ (or less) of the cell cavity. One pyrenoid embedded in the chloroplast. Nucleus in the cytoplasmic bridge opposite to the chloroplast.

D i m e s i o n s of cells: 5.6—7 μm broad, 7—18 μm long.

R e p r o d u c t i o n: either by fragmentation or by akinete formation. Motile cells unknown.

O c c u r r e n c e: Aerophytic alga, grows either as a dark-green coat on the bark of trees, or forming a green surface film on other substrates. The material studied originated from wet sand-stone rocks in Teplické Skály, North Bohemia, isolated and kept in the Culture Collection under the designation strain FAROOQUI 1967/2.

N o t e: The alga is very similar to *Chlorhormidium flaccidum* var. *flaccidum* and *C. flaccidum* var. *nitens* in cell structure. It differs from *C. flaccidum* in having cells r o u n d e d at the ends and forming s h o r t disintegrating filaments.

M a t e r i a l a n d M e t h o d s

Three taxa of *Chlorhormidium* FOTT were studied. Two of them, i.e. strain FOTT 1960/3, No. J 302 and strain MORAVCOVÁ 1966/1, No. J 305, were taken from the Culture Collection of the Botany Department, Charles University, Prague. Both strains were identified as *Chlorhormidium flaccidum* (A. BRAUN) FOTT, but one of them showed different growth in the water solution culture and was identified as *Chlorhormidium flaccidum* var. *nitens* (MENEGH.) c o m b. n o v a. The third is *Chlorhormidium dissectum* (GAY) comb. nova, strain FAROOQUI 1967/2, studied primarily from the wild material.

Morphology and life cycle of the algae were studied from one week old cultures, grown in the normal Bristol fluid medium, pH 5.6, temperature 20—25°C, and illumination fluorescent tubes, approx. 300 Lux. Observations were taken from (1) the fresh mounts (2) preparations with Indian ink (3) with methylene blue. Methylene blue was used to determine the extent of the cell wall and if there was any mucilaginous sheath. (4) MAYER's Iodine was used to determine starch and pyrenoid.

Zoospores were observed in *Chlorhormidium flaccidum* var. *nitens* (MENEGHINI) comb. nova. To observe the zoospore formation the alga was grown in the following medium (modified BOLD basal medium):

KNO_3 (1%)	15 ccm	$MgSO_4$ (0.75%)	2.5 ccm
K_2HPO_4 (0.75%)	10 ccm	$FeCl_3$ (1%)	1 drop
NaCl (0.25%)	10 ccm	Soil extract	5 ccm
$CaCl_2$ (0.25%)	10 ccm	Distilled water	450 ccm
$NaNO_3$ (2.5%)	10 ccm		

The alga was cultivated in the above medium for one week, the well grown culture was transferred into distilled water and kept in the dark. The zoospores were liberated from the cells within 20—24 hours; immediately after liberation the zoospores began to swim gently.

Souhrn

Byla studována morfologie a taxonomie rodu *Chlorhormidium* FOTT 1960 (*Ulotrichaceae*) a zdůvodněna platnost tohoto jména, kterým se nahrazuje dřívější označení *Hormidium* KÜTZ. K typickému druhu *Ch. flaccidum* (KÜTZ.) FOTT byla přiřazena nová varieta *nitens* (basionym *Hormidium nitens* MENEGH.), která se od var. *flaccidum* liší nesmáčivostí povrchu vláken, takže ve vodní kultuře neroste submersně, (jako var. *flaccidum*), nýbrž v kapilární vodě na okraji zkumavky nad hladinou roztoku. Na základě studia vlastního materiálu byla vytvořena další nová kombinace *Chlorhormidium dissectum* (GAY) comb. nova. Použitím upravené KLEBSOVY metodiky se podařilo vytvořit zoospory, které v přírodních podmínkách nebo v normální kultuře se prakticky nevyskytují.

References

BRAND F., (1913): Berichtigungen bezüglich der Algengruppen Stichococcus Näg. und Hormidium Kütz. — Ber. Dtsch. Bot. Ges. 31 : 64—72.

BORZI, R. (1895): Studi algologici, Fasc. II. — Palermo, p. 121—378, Tab. 10—31.

CHODAT, R. (1902): Algues Vertes de la Suisse, Pleurococcoïdes-Chroolépoïdes. — Berne, p. 1—373.

— (1913): Monographies d'Algues en culture pure. In Matériaux pour la Flora Cryptogamique Suisse 4 (2) : 1—266.

DE TONI, J. B. (1889): Sylloge Chlorophycearum Omnium hucusque Cognitarum. — Vol. 1, p. 1—531.

DEASON, T. R. et BOLD H. C. (1960): Phycological Studies, 1. Exploratory studies of Texas Soil Algae. — Univ. Texas Publication No. 6022, p. 1—72.

FRITSCH, F. E. (1935): The Structure and Reproduction of Algae. — Vol. 1, p. 1—791, Cambridge.

FOTT, B. (1959): Algenkunde. — Jena, p. 1—482.

— (1960): Taxonomische Übertragungen und Namensänderungen unter den Algen. — Preslia, 32 (2) : 142—154.

GAY, M. F. (1891): Recherches sur le développement et la classification de quelques Algues vertes. — Thèses à la Faculté des Sciences de Paris, Series No. 147, p. 1—116.

HANSGIRG, A. (1888): Über die aerophytischen Arten der Gattungen Hormidium Kütz., Schizogonium Kütz. und Hormiscia (Fr.) Aresch. (Ulothrix Kütz.). — Flora 71 (17) : 259—266.

HAZEN, T. E. (1902): The Ulotrichaceae and Chaetophoraceae of the United States. — Torrey Bot. Club Mem. 11 (2) : 135—250.

HEERING, W. (1914): Chlorophyceae III. — Süsswasser-Flora, Heft 6, p. 1—250.

HINDÁK, F. et KOMÁREK, J. (1965): Malý klúč výtrusných rastlín. — I diel, Bratislava, p. 1—439.

JAMES, J. (1935): An investigation of the algal growth in some naturally occurring soils. — Beih. Bot. Zbl. A, 53 : 519—553.

KLEBS, G. (1896): Die Bedingungen der Fortpflanzung bei einigen Algen und Pilzen. — Jena, p. 1—543.

KLERCKER, J. (1896): Über zwei Wasserformen von Stichococcus. — Flora, Marburg, 82 : 90—106.

KÜTZING, F. T. (1843a): Über die systematische Eintheilung der Algen. — Linnaea, 17 : 75—107.
— (1843b): Phycologia Generalis. — Leipzig, p. 1—458.
— (1845): Phycologia Germanica. — Nordhausen, p. 1—340.
— (1849): Species Algarum. — Lipsiae, p. 1—922.
— (1852): Tabulae Phycologicae oder Abbildungen der Tange. — Nordhausen, 2, 3.
LAGERHEIM, G. (1888): Über eine durch die Einwirkung von Pilzhyphen entstandene Varietät von Stichococcus bacillaris NÄG.. — Flora, 71 (4) : 61—63.
LANJOUW, J. (1961): International Code of Botanical Nomenclature. — Utrecht, p. 1—338.
MATTOX, K. R. et BOLD, H. (1962): Phycological Studies, III. The Taxonomy of certain Ulotrichacean Algae. — Texas Univ. Publication No. 6222, p. 1—66.
OLTMANNS, F. (1904): Morphology und Biology der Algen. — Jena, p. 1—733.
PETERSEN, J. B. (1932): The algal vegetation of Hammer Bakker. — Bot. Tidsskr. 42 : 44.
PRESCOT, G. W. (1951): Algae of the Western Great Lakes Area, exclusive of Desmids and Diatoms. — Cranbrook Inst. Sci., Bull. No. 31, p. 1—660, Michigan.
PRINTZ, H. (1927): Chlorophyceae. — A. ENGLER und K. PRANTL, Die natürlichen Pflanzenfamilien, 2nd. ed., 3 : 1—463.
— (1964): Die Chaetophoralen der Binnengewässer, eine systematische Übersicht. — Hydrobiologia, (Acta Hydrobiologia, Hydrographica et Protistologica), 24 (1—3) : 1—456.
RABENHORST, L. (1868): Flora Europaearum Algarum. — Lipsiae, 3 : 1—367.
RAMANATHAN, K. G. (1964): Ulotrichales. — I.C.A.R., New Delhi, p. 1—188.
RANDHAWA, M. S. (1948): Notes on some Ulotrichales from northern India. — Proc. Nat. Inst. Sci. India, 14 : 367—372.
ROSA, K. (1959): Actinotaenium pinicolum species nova. — Preslia, 31 (4) : 377—380.
SMITH, G. M. (1933): The fresh-water algae of the United States. — 1st ed., McGraw-Hill Book Company, New York, p. 1—716.
— (1950): The freshwater algae of the United States. — 2nd ed., McGraw-Hill Book Company, New York, p. 1—719.
STROM, K. M. (1928): Active reaction of the medium and the growth of Hormidium forms. — Bull. Soc. Généve, 20 : 9.
WILLE, N. (1912): Om udvikligen af Ulothrix flaccida Kütz. — Svensk. Bot. Tidskr., 6 : 447—458.

Recensent: B. Fott

See also plates I—III in the appendix.