

Mougeotia mesocarpiana (Zygnematophyceae, Chlorophyta), a new freshwater species of the Mesocarpus Section from Argentina

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ABSTRACT – A *Mougeotia* C. A. Agardh population with a particular combination of vegetative and reproductive traits, not shared by any other known species of the genus, appeared in a temporary pond of Argentina. Therefore, a new species is proposed and discussed: *M. mesocarpiana* sp. nov. This species is characterized by having spheric to doliiform zygospores with a thin exospore and a double thick granulated mesospore.

Key words: aplanospores, *Mougeotia*, *M. mesocarpiana* sp. nov., Section Mesocarpus, Argentina.

RESUMO – *Mougeotia mesocarpiana* (Zygnematophyceae, Chlorophyta), uma nova espécie da Seção Mesocarpus da Argentina. Num corpo de água temporário da Argentina encontrou-se uma população de *Mougeotia* C. A. Agardh, mostrando combinação peculiar de características vegetativas e reprodutivas, não presentes em nenhuma das espécies descritas para o gênero. Portanto, uma nova espécie é proposta e discutida: *M. mesocarpiana* sp. nov. Esta espécie caracteriza-se por ter zigósporos esféricos ou doliiformes com uma exóspora delgada e uma mesóspora dupla, delgada e granulada.

Palavras-chave: aplanósporos, *Mougeotia*, *M. mesocarpiana* sp. nov., Seção Mesocarpus, Argentina.

INTRODUCTION

Algae belonging to the genus *Mougeotia* C.A. Agardh were described as early as 1803 by Vaucher in his *Histoire des Conferves*. Agardh, however, was the first to classify this genus in order to distinguish it from other “conjugates”. Thalli of *Mougeotia* are generally simple filaments of cylindrical cells. Each cell has one or two axial flat chromatophores with pyrenoids arranged in one or two linear rows. The vegetative characters themselves are not enough to characterize a species. The reproductive traits are more specific and allow separation, in first place, by those species which reproduce only by aplanospores (Gonatonema section). However, since most species have sexual reproduction, it is possible to distinguish three other sections in the genus: Plagiospermum section, in which the sporangium is formed in one of the gametangium; Mesocarpus section, which includes the species in which the sporangium is formed between the two gametangia without their division; and Staurospermum section,

in which the sporangium divides both gametangia (Gauthier-Lièvre, 1965).

In Argentina, the genus *Mougeotia* is undoubtedly less known in the taxonomical level than some of its partners of the Zygnemataceae family (viz. *Spirogyra* and *Zygnema*). From the 138 species of *Mougeotia* accepted in the extensive Kadlubowska's Zygnemataceae monograph (1984), and the other two species published lately (Rundina, 1995; Panikkar *et al.*, 1997), just a few have been found in Argentina [*Mougeotia drouetii* Trans., *M. elegantula* Wittr., *M. genuflexa* (Dillw.) Ag., *M. gracilima* (Hass.) Wittr., *M. kerguelensis* Krieger, *M. laetevirens* (A. Braun) Wittr., *M. minutissima* Lemm., *M. parvula* (Hass.) Kirch., *M. parvula* var. *angusta* (Hass.) Kirch., *M. quadrangulata* Hass., *M. scalaris* Hass., *M. tibestica* Gauthier-Lièvre; (Tell, 1985; Lacoste *et al.*, 1987; Ferrer & Cáceres, 1994)].

The present study is part of a large research of the Zygnemataceae from the South of Buenos Aires Province, Argentina (Ferrer, 1998; Ferrer & Cáceres,

1994, 1995, 2001). While this study was carried out, a population of *Mougeotia* appeared in a temporary pond exhibiting a particular combination of vegetative and reproductive traits not shared by any other of the species described. Therefore, a new species is proposed and discussed.

MATERIAL AND METHODS

Fertile filaments were collected from a small natural temporary pond (*circa* 100 m²) situated beside the national Route n° 3, km 654, Buenos Aires Province, Argentina, on November 9, 1994. The shallow pond is recurrently formed by rainwater in a depression on the field. The climate of the region can be described as arid temperate according to the climate classification of Walter *et al.* (1975), with average air temperatures ranging from 4.3-15.9°C in winter and 16.6-42.5°C in summer (Donnari & Torre, 1974). Surface samples were taken by hand from two distant sectors of the pond at no more than 20 cm depth. In the laboratory, specimens were directly mounted and photographed while still alive. The cell diameter measurements were taken of fifty filaments (n = 50). The material was examined with a Leitz SM-LUX compound light microscope equipped with a Wild Semiphotomat MPS 15. Filaments were then fixed and preserved in a 8.5/1/0.5 mixture of 50% ethanol, 30% formaldehyde, and 20% acetic acid. At the same time, fertile filaments were isolated and maintained in a Woods-Hole medium (Simons *et al.*, 1984) at 8-10°C to follow the process of zygospore maturation.

RESULTS

Mougeotia mesocarpiana Ferrer et Cáceres, sp. nov.

(Figs. 1-8)

Cellulae vegetativae 16-17.5 µm latae. *Chromatophorum* 1, *pyrenoidibus* 5-8 *seriatim dispositis*. *Conjugatio* scalariformis. *Zygosporae* globosae ad doliformes, 34-37 × 37-42 µm, *intra canalem conjugationis formatae et ambobus gametangiis partialiter occupantes*. *Exosporium* leve et tenue, *mesosporio duplici: strato externo crasso et valde granuloso, flaveo-brunneo; strato interno tenuiore et minus granuloso*. *Reproductio asexualis ab aplanosporis globosis, 40-45 µm latis, simili ornamentatione quam zygosporis, in cellulis geniculatis formatis*.

Holotypus: lectus in loco: ARGENTINA, Prov. Buenos Aires, Pdo. Cnel. Rosales, Route n° 3, km 654, locus temporarius, leg. N.C. FERRER & E.J. CÁCERES, coll. 9.XI.1994, (Ferrer 75 y 75 bis). Typus positus in Herbario Universidad Nacional del Sur, Bahía Blanca Biología (BBB), sub numero BBB 75.

Vegetative cells 16-17.5 µm in diameter; chloroplast 1, with 5-8 pyrenoids in a single row. Conjugation scalariform. Zygosporae globose to doliiform, 34-37 × 37-42 µm, formed inside the conjugation canal and occupying partially both gametangia; exospore thin, smooth; mesospore double, with the external stratum thick and distinctly granulate, yellowish-brown colored, and the internal one thinner and slightly granulate. Asexual reproduction by globose aplanosporae, 40-45 µm in diameter, with exospore and mesospore appearance and ornamentation similar to those of zygosporae, formed in geniculate cells.

Type locality: ARGENTINA, Prov. Buenos Aires, Pdo. Cnel. Rosales, Route n° 3, km 654, temporary pond.

Holotype: N° BBB 75 kept in the Laboratorio de Fisiología y Micología, Departamento de Biología, Universidad Nacional del Sur, Bahía Blanca, Argentina and the Bahía Blanca Biología Herbarium (BBB).

Etymology: belonging to section Mesocarpus.

Observations: filaments of *M. mesocarpiana* were intermingled with other Zygnemataceae filaments: *Spirogyra ellipsospora* Trans., *S. majuscula* Kütz., *S. aff. longata* Kütz., *Sirogonium sticticum* Kütz. and *Zygnema subcylindricum* Krieger.

DISCUSSION

Mougeotia mesocarpiana possesses a combination of vegetative and reproductive features that is not present in anyone of the species of *Mougeotia* heretofore described in literature (Borge & Pascher, 1913; Czurda, 1932; Kolkwitz & Krieger, 1941; Transeau, 1951; Randhawa, 1959; Gauthier-Lièvre, 1965; Kadlubowska, 1972, 1984; Rundina, 1995; Panikkar *et al.*, 1997).

Mougeotia mesocarpiana clearly belongs to the Mesocarpus section on the account that its zygotes are formed inside the conjugation canal, and that they, by the end of their development, extend into the gametangia, but without touching their longitu-

dinal walls (Figs. 7, 8). To date, 88 species for this section have been described throughout the world (Kadlubowska, 1984; Rundina, 1995). From these, 40 have been mentioned for the American Continent and seven for Argentina (Seckt, 1924, 1929, 1951-1956; Thomasson, 1959, 1963; Guarrera & Kühnemann, 1949; Tell, 1985; Lacoste *et al.*, 1987; Ferrer, 1998; Ferrer & Cáceres, 1994).

In the diagnosis of the species belonging to the Zygnemataceae family, features of zygospores (shape, dimensions, color, number of layers of the wall, and primarily, their ornamentation) are specially taken in account since they are considered the most valuable characteristics to define them (Hull *et al.*, 1985). Then, the closest species to *M. mesocarpiana* is *M. verrucosa* Wolle, since it also shows zygospores with a granulate mesospore (Tab. 1). Nevertheless, both species clearly differ by other vegetative and reproductive characteristics: the vegetative cells diameter in *M. verrucosa* (13-14 μm) is less than in *M. mesocarpiana* (16-17.5 μm); spore dimensions in *M. mesocarpiana* (34-37 \times 37-42 μm) are greater than those in *M. verrucosa* (20-25 \times 40 μm). Other differences are the shape, the color, and the number of mesospore layers.

The zygospore morphology of *M. mesocarpiana* could also be comparable to that of *M. granulosa* Trans., which sometimes shows a twofold granulate wall (Tab. 1). Nevertheless the zygospore envelope of *M. granulosa* is not accurately described in literature, where it is referred to as a single or double wall, but not using the term "mesospore" (Transeau, 1951; Randhawa, 1959; Gauthier-Lièvre, 1965; Kadlubowska, 1984). On the contrary, in the zygospores of *M. mesocarpiana*, three layers are clearly differentiated: an outer exospore and two inner granulated mesospores (Fig. 7). Moreover, the shape of the zygospores is different: broadly ovoid to quadrangular ovoid for *M. granulosa*, spheric to doliiform for *M. mesocarpiana*. Another difference between both species is that individuals of *M. granulosa* form partenospores [see Transeau (1951), Pl. XVIII, Fig. 20] and do not form aplanospores in geniculate cells as seen in *M. mesocarpiana* (Fig. 2). For last, the relationships with this species should be ruled out since *M. granulosa* belongs to Staurospermum section, with the zygosporangium penetrating extensively into the gametangia and touching completely the longitudinal walls of the gametangia.

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REFERENCES

- BORGE, O.; PASCHER, A. 1913. Zygnemales. In: PASCHER, A. (Ed.). **Die Süßwasser-Flora Deutschlands, Österreichs und der Schweiz**. Jena: Gustav Fischer. Heft 9, 51 p.
- CZURDA, V. 1932. Zygnemales. In: PASCHER, A. (Ed.). **Die Süßwasser-Flora von Mitteleuropa**. Jena: Gustav Fischer. Heft 9, 232 p.
- DONNARI, M. A.; TORRE, L. E. 1974. **Análisis de algunos aspectos del clima de Bahía Blanca**. Bahía Blanca, Universidad Nacional del Sur. 32 p.
- FERRER, N. C. 1998. **Biología y taxonomía de Zygnemataceae (Zygnematophyceae, Chlorophyta) del Sur de la Provincia de Buenos Aires**. 172f. Tesis (Doctorado en Biología) – Universidad Nacional del Sur, Bahía Blanca.
- FERRER, N. C.; CÁCERES, E. J. 1994. Primera cita de *Mougeotia tibestica* (Zygnemataceae, Chlorophyta) para el Continente Americano. **Boletín de la Sociedad Argentina de Botánica**, San Isidro, n. 30, p. 77-79.
- _____. 1995. *Spirogyra salmonispora* sp. nov. (Zygnematophyceae, Chlorophyta), a New Freshwater Species of the Section Conjugata. **Archiv für Protistenkunde**, Jena, n. 146, p. 101-106.
- _____. 2001. Nuevas citas de Zygnemataceae (Zygnematales, Chlorophyta) para el Continente Americano. **Darwiniana**, San Isidro, n. 39, p. 209-213.
- GAUTHIER-LIÈVRE, L. 1965. Zygnemacées africaines. **Nova Hedwigia**, Weinheim, n. 20, p. 1-210.
- GUARRERA, S. A.; KÜHNEMANN, O. 1949. Catálogo de las "Chlorophyta" y "Cyanophyta" de agua dulce de la República Argentina. **Lilloa**, San Miguel de Tucumán, n. 19, p. 219-318.
- HULL, H. M.; HOSHAW, R. W.; WANG, J. C. 1985. Interpretation of zygospore wall structure and taxonomy of *Spirogyra* and *Sirogonium* (Zygnemataceae, Chlorophyta). **Phycologia**, Oxford, n. 24, p. 231-239.
- KADLUBOWSKA, J. Z. 1972. Zygnemataceae. In: STARMACH, K.; SIEMINSKA J. (Ed.). **Flora Ślaskowa Polska**, Krakow, t. 12A, p. 1- 431.
- _____. 1984. Conjugatophyceae I. Chlorophyta VIII. Zygnemales. In: ETTL, H.; GERLOFF, J.; HEYNIG, H & MOLLENHAUER, D. (Ed.). Stuttgart: Gustav-Fischer. 532p. (**Die Süßwasserflora von Mitteleuropa**, 16).
- KOLKOWITZ, R.; KRIEGER, H. 1941. Zygnemales. Leipzig: Akademische Verlagsgesellschaft. Abt. 2, 499 p. (**Rabenhorst's Kryptogamenflora von Deutschland, Österreich und der Schweiz**, 13).

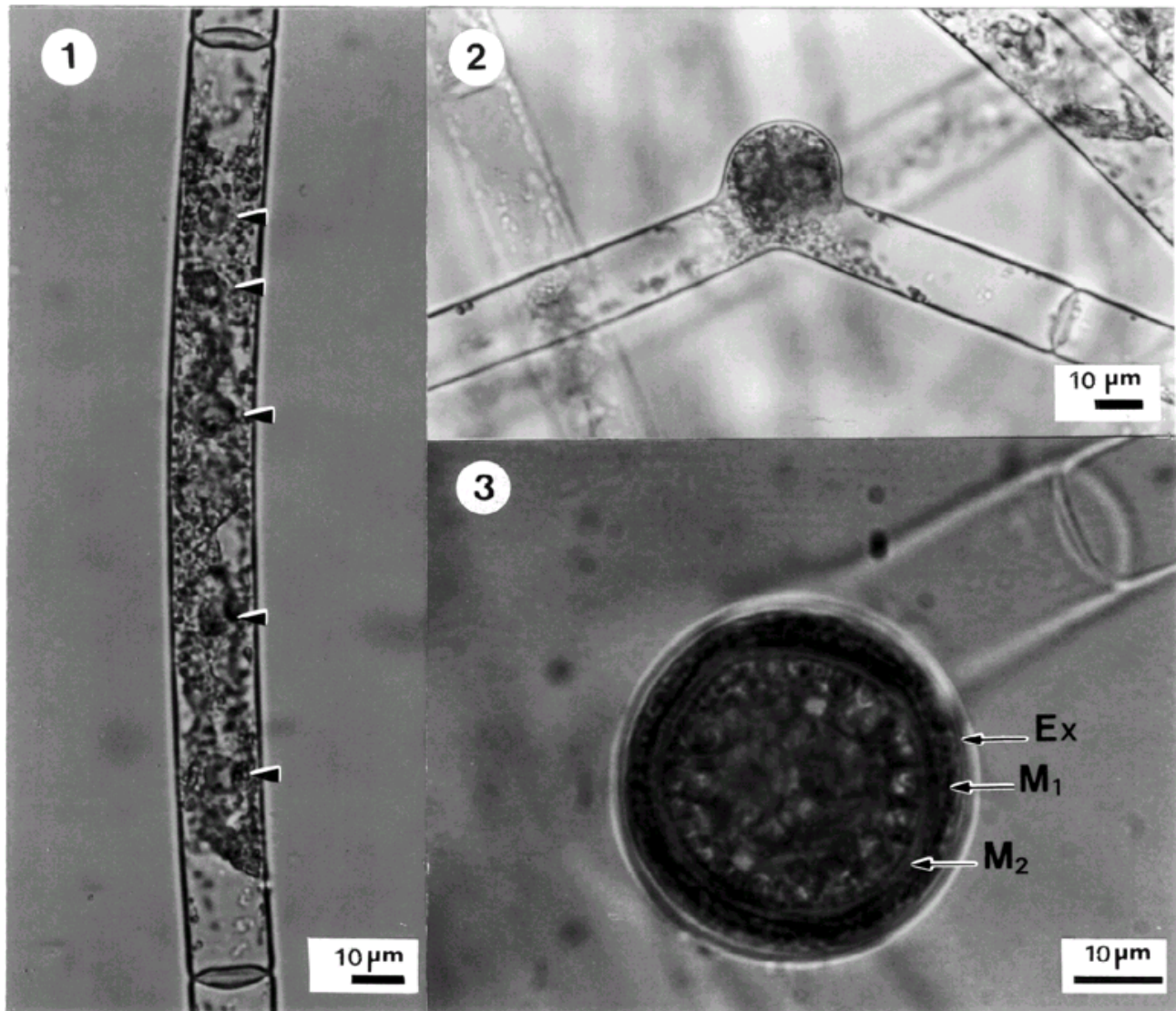
- LACOSTE, E. N.; VIGNA, M.S.; MAC CARTHY, S.; MAIDANA, N. 1987. Algas de aguas continentales de Argentina VII. Entre Ríos II. **Darwiniana**, San Isidro, n. 28, p. 105-145.
- PANIKKAR, M. V. N.; USHA DEVI, K.; AMPILI, P. 1997. A new species of *Mougeotia* (Zygnematales, Chlorophyceae) from Kerala. **Journal of Economic and Taxonomic Botany**, Jodhpur, v. 21, n. 3, p. 691-693.
- RANDHAWA, M. S. 1959. **Zygnemaceae**. New Delhi: Indian Council of Agricultural Research. 478 p.
- RUNDINA, L. A. 1995. A new species of *Mougeotia* (Zygnematales, Chlorophyta). **Botanicheskii Zhurnal**, St. Petersburg, v. 80, n. 5, p. 89-93.
- SECKT, H. 1924. Estudios hidrobiológicos en la Argentina. Contribución al conocimiento de los microorganismos del agua dulce y de sus condiciones vitales. **Revista de la Universidad Nacional de Córdoba**, Córdoba, v. 11, p. 55-110.
- _____. 1929. Estudios hidrobiológicos en la Argentina. Conjugatae. **Boletín de la Academia Nacional de Ciencias de Córdoba**, Córdoba, n. 31, p. 54-71.
- _____. 1951-1956. Estudios hidrobiológicos hechos en las aguas de la Cordillera del Sud. **Boletín de la Academia Nacional de Ciencias de Córdoba**, Córdoba, n. 39, p. 290-339.
- SIMONS, J.; VAN BEEM, A. P.; DE VRIES, P. J. R. 1984. Induction of conjugation and spore formation in species of *Spirogyra* (Chlorophyceae, Zygnemataceae). **Acta Botanica Neerlandica**, Groningen, n. 33, p. 323-334.
- TELL, G. 1985. **Catálogo de las algas de agua dulce de la República Argentina**. Vaduz: J. Cramer. 283 p. (Bibliotheca Phycologica, Bd. 70).
- THOMASSON, K. 1959. Plankton of some lakes in an Argentine national park, with notes on terrestrial vegetation. **Acta Phytogeográfica Suecica**, Uppsala, n. 42, p. 1-83.
- _____. 1963. Plankton studies in north Patagonia with notes on terrestrial vegetation. **Acta Phytogeográfica Suecica**, Uppsala, n. 47, p. 101-137.
- TRANSEAU, E.N. 1951. **The Zygnemataceae**. Columbus: Ohio State University Press. 327 p.
- WALTER, H., HARNICKELL, E.; MÜLLER-DOMBOIS, D. 1975. **Climate diagram maps of the individual Continents and the ecological climatic regions of the Earth**. Berlin: Springer Verlag. 36 p.

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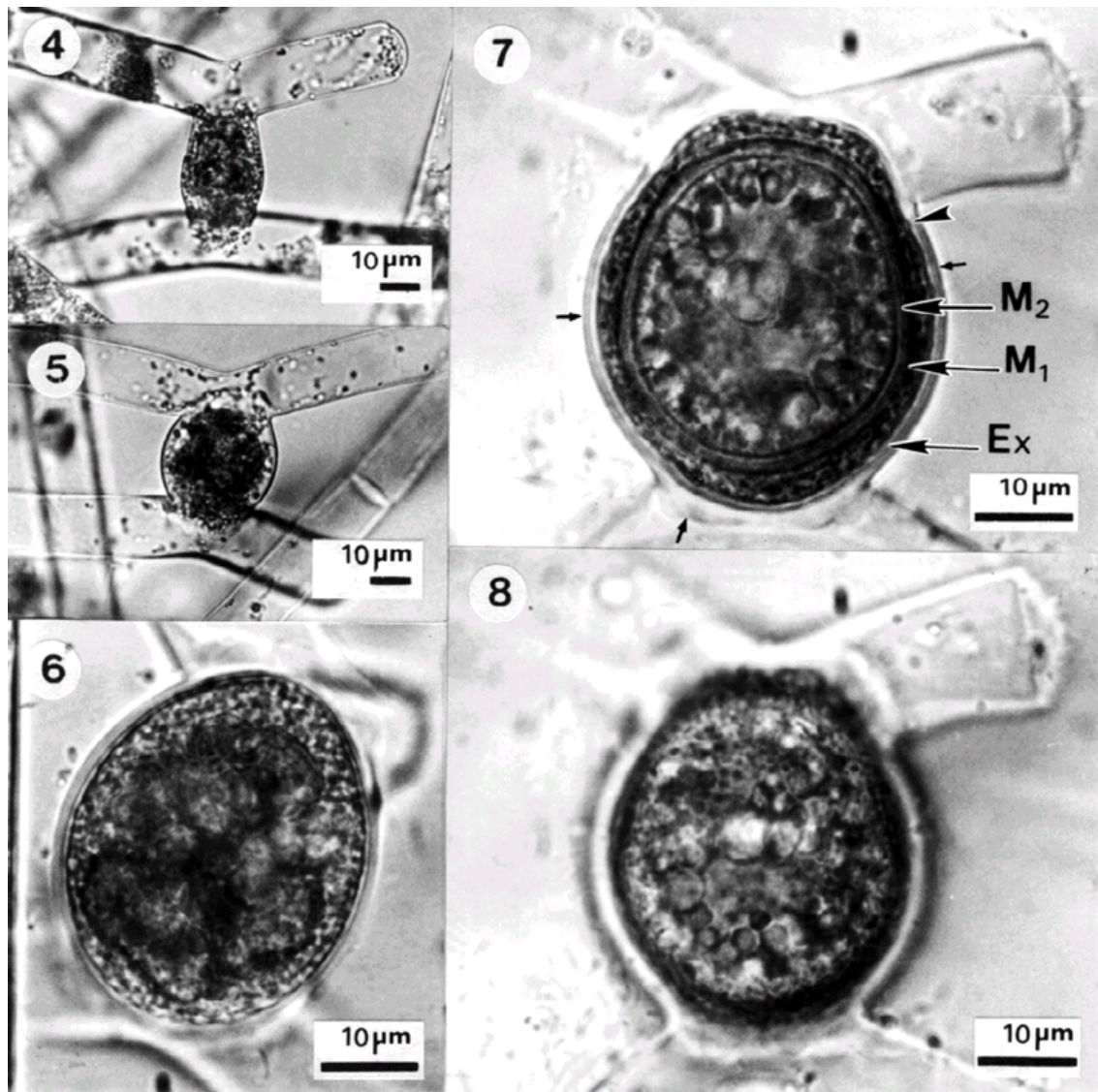
TABLE 1 – Comparison between *Mougeotia mesocarpiana* sp. nov. and related species. Characteristics of *M. verrucosa* and *M. granulosa* as given by Randhawa (1959)*.

	<i>M. mesocarpiana</i>	<i>M. verrucosa</i>	<i>M. granulosa</i>
Section	Mesocarpus	Mesocarpus	Staurospermum
Vegetative cells			
diameter	16-17.5 µm	13-14 µm	14.4-18 µm
number of pyrenoids	5-8	no data	4-8
Zygosporos			
dimensions	34-37 × 37-42 µm	20-25 × 40 µm	36-47 × 42-52 µm
shape	spheric to doliiform	ellipsoid	ovoid to ovoid quadrangular
color	yellowish-brown	dark brown	yellow or brown
wall layers	thin exospore and double thick mesospore	single mesospore	either apparently single or distinctly double*
ornamentation	exospore smooth, external and internal mesospore granulate	mesospore granulate	both layers granulose when separated
Azygosporos	aplanosporos in geniculate cells	no data	partenosporos

* Without reference to the terms exospore or mesospore.



Figs. 1-3. *Mougeotia mesocarpiana* sp. nov. **1.** vegetative filament. The arrowheads indicate the pyrenoids; **2.** aplanospore formation in a geniculate cell; **3.** details of an aplanospore. The exospore (Ex) and both strata (M₁ and M₂) of the mesospore are seen.



Figs. 4-8. *Mougeotia mesocarpiana* sp. nov. **4.** scalariform conjugation. Gametes have fused inside the conjugation canal; **5.** young zygosporangium; **6.** zygosporangium with an immature zygospore in which the zygospore wall is not yet completely synthesized; **7.** zygosporangium with a mature zygospore in which the exospore (Ex) and mesospore (M_1 and M_2) are fully synthesized. The arrowhead pinpoints a granulate ornamentation. Small arrows indicate the zygosporangium wall; **8.** the same zygosporangium in another focal plane to see the granulate ornamentation of the mesospore.