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Contribution to the taxonomic study of the family Botryococcaceae (Trebouxiophyceae, Chlorophyta) in southern Spain

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Abstract – In samples collected between April 2004 and August 2006 from shallow lakes and reservoirs in southern Spain some noteworthy planktonic green algae of the family Botryococcaceae (Trebouxiophyceae, Chlorophyta) were found. A new species, *Lobocystis inconspicua* sp. nov., is described and taxonomic comments on some members of the family Botryococcaceae are made. *Dichotomococcus curvatus* and forms of *Botryococcus* morphologically similar to *Botryococcus protuberans* and *Botryococcus terribilis* are recorded for the first time in the Iberian Peninsula.

Botryococcaceae / *Botryococcus* / *Dichotomococcus* / *Dictyosphaerium* / *Lobocystis inconspicua* sp. nov. / *Quadricoccus* / Spain / taxonomy

Résumé – **Contribution à l'etude taxinomique de la famille des Botryococcaceae (Trebouxiophyceae, Chlorophyta) dans le Sud de l'Espagne.** Dans des échantillons récoltés entre les mois d'avril 2004 et août 2006 dans des réservoirs et lacs peu profonds du Sud de l'Espagne nous avons trouvé plusieurs algues vertes planctoniques intéressantes de la famille des Botryococcaceae (Trebouxiophyceae, Chlorophyta). Une espèce est décrite comme nouvelle, *Lobocystis inconspicua* sp. nov. Quelques commentaires sont fournis à propos de certains membres de la famille des Botryococcaceae. *Dichotomococcus curvatus* et quelques formes de *Botryococcus* morphologiquement proches de *Botryococcus protuberans* et *Botryococcus terribilis* sont signalées pour la première fois dans la Péninsule Ibérique.

Botryococcaceae / *Botryococcus* / *Dichotomococcus* / *Dictyosphaerium* / Espagne / *Lobocystis inconspicua* sp. nov. / *Quadricoccus* / Taxinomie

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INTRODUCTION

Ultrastructural and molecular phylogenetic studies of the order Chlorococcales *sensu lato*, to which the family Botryococcaceae Wille 1909 belongs, have revealed that this group is not monophyletic (Pickett-Heaps & Marchant, 1972; Melkonian, 1980, 1990; Ettl & Komárek, 1982; Komárek & Fott, 1983; Hoek *et al*., 1988; Friedl, 1995, 1997). These algae represent a mixture of organisms belonging to different evolutionary lineages, *i.e.* the two main classes of unicellular green algae: the Chlorophyceae and the Trebouxiophyceae. The conflict between traditional classification schemes based on morphology and new molecular genetic information on the higher taxonomic groups has led to a situation of great taxonomic complexity. Molecular studies have placed some of the families of the traditional Chlorococcales in either of the two classes, but in the case of the Botryococcaceae there is not yet a comprehensive molecular treatment available for the whole family. Only some DNA sequences of the species *Botryococcus braunii* Kützing (Sawayama *et al*., 1995; Okada *et al*., 2000; Senousy *et al*. 2004; Kagiwada *et al*., 2005) and *Dictyosphaerium pulchellum* Wood (Krienitz *et al*., 2004) have been produced and, as result, these species have been placed in the class Trebouxiophyceae.

Since no molecular data are available for any other taxon, it is not clear whether the family Botryococcaceae is monophyletic or not. In the present study, we continue to accept the traditional concept of this family (*sensu* Komárek & Fott, 1983) as there are no molecular data refuting it. However we consider it as belonging to the class Trebouxiophyceae rather than the class Chlorophyceae because we feel that molecular data support the placement in this class of *B. braunii*, the type species of the genus and family. Under the traditional concept, this family includes genera constituted by irregular colonies that live free-floating or fixed to a substratum, with cells united by mucilaginous peduncles or branches formed by old, more or less gelatinized maternal cell walls. The cells are spherical, oval, ovoid to ellipsoidal, and show a parietal chloroplast, with or without a pyrenoid. The reproduction is asexual, exclusively by means of autospores; sexual reproduction by oogamy has been reported only in one species of *Dictyosphaerium* (Iyengar & Ramanathan, 1940, cited by Komárek & Fott, 1983).

Some interesting representatives of the family were found in samples collected from several localities of southern Spain This study presents the results of our observations on these algae based on morphological features observed using light microscopy.

MATERIALS AND METHODS

Samples from different localities of southern Spain (Table 1) were collected during the periods April-August in 2004, 2005 and 2006. Samples were collected for qualitative analysis by horizontal net sampling, using a 25 µm-pore plankton net 1 m long, and 30 cm. After collection, the samples were fixed with formaldehyde. At the time of sampling, pH, conductivity, and water temperature were measured *in situ* with a multi-parametric probe pH/Cond 340i WTW 82362. Taxonomic identifications were based on observations made with a Zeiss Axiovert 35 inverted light microscope.

Table 1. Physical-chemical parameters in the localities studied here.

Code	*Locality*	*Province*	*Temperature (ºC)*	*PH*	*Conductivity (µS/cm)*
1	Laguna de Mojón Blanco	Albacete	15	9.1	70782
2	Balsa de Barjalí	Almería	22	8.8	198
3	Balsa de Caparidal	Almería	24	8.3	177
4	Embalse del Almanzora	Almería	9-15	7.2-8.5	2100-2310
5	Balsa del Sabinar	Almería	19.2	9	102
6	Embalse de la Albuera de Feria	Badajoz	–	–	–
7	Laguna de Maguilla	Badajoz	–	–	–
8	Navajo de Matanegra	Badajoz	–	–	–
9	Laguna Grande, arroyo de la Luz	Cáceres	24	9.7	153
10	Embalse de los Hurones	Cádiz	10.7-27.1	7.4-8.56	501-558
11	Laguna de Montellano	Cádiz	30.3	–	12380
12	Embalse de Guadalmellato	Córdoba	26.6	8.7	260
13	Laguna Amarga	Córdoba	25.2	8.4	7920
14	Laguna de Zóñar	Córdoba	23.2	8.49	2650
15	Embalse de Iznájar	Córdoba	20.3	8.7	971
16	Embalse de Guadalén	Jaén	–	–	–
17	Laguna de Garcíez	Jaén	18.8	8.9	3100
18	Laguna de las Pedrizas	Málaga	26.1	7.96	2720
19	Laguna Grande de Archidona	Málaga	27.4	8	3830
20	Pantano de Algeciras	Murcia	28.5	8.1	1360
21	Embalse de Alcalá del Río	Seville	25	7.8	880
22	Embalse de Cala	Seville	28.2	9.4	235
23	Embalse de la Marciaga	Seville	–	–	–

RESULTS AND DISCUSSION

Details of collection localities and physical-chemical parameters measured are presented in Table 1. The taxa found were as follows.

BOTRYOCOCCUS Kützing 1849

This is a frequent genus in the plankton of waters with different ecological characteristics and wide geographical distribution, even as an important element in blooms and water discolorations. Its taxonomy is complex and the circumscription of its species is difficult.

Komárek & Marvan (1992) recognized 9 species in the genus. They also reported some other morphological forms that they were not able to refer to any known species. Those authors established the diagnostic features for each species; however, our observations suggested that many of those features were not always

detectable in natural populations or they were so variable that our populations could not be referred unambiguously to any of the species described. Nevertheless, we were able to recognise the following species in our material.

Botryococcus braunii Kützing 1849 **Figs 1a, b**

Colonies irregular, compact or consisting of subcolonies connected by mucilaginous strings, up to 107 μm in diameter, composed by numerous cells arranged more or less radially, immersed completely inside the colony or emerging by up to 2/3 of their length; cells narrowly oval, obovoid to subcylindrical, 5.5-8 × 3-3.8 μm in size; chloroplast parietal, with an inconspicuous pyrenoid; reproduction by 2 autospores.

Localities: 5, 17.

Based on the circumscription of Komárek & Marvan (1992) for this species, the specimens from the Laguna de Garcíez do not show the typical mucilaginous caps that cover the distal ends of the cells, while in the population from the Balsa del Sabinar they were observed albeit rarely. In the populations found by Koreivienė & Kasperovičienė (2003) in lakes of Lithuania, the caps were also hardly visible. Their colonies were of higher dimensions and had larger cells.

Botryococcus cf. ***protuberans*** W. *et* G. S. West 1905 **Figs 1c, d**

Irregular colonies 25-64.8 μm wide, elongated in one direction or later in relatively dense agglomeration, generally composed of cell groups connected by more or less narrow mucilaginous tracts, 1.0-4.1 μm wide; cells obovoid, 5.5-8.5 × 3.8-5.4 μm, completely merged within the colony or emerging from the periphery by 1/3 of their length; chloroplast parietal; pyrenoids or similar structures not observed; reproduction by 2 autospores.

Localities: 8.

The specimens of our population (Navajo de Matanegra, Badajoz) were referred to this species mostly based on the gross morphology of the colonies rather than the shape or position of the cells in it. The irregular colonies were elongated in one direction, and composed of cell groups connected by relatively long mucilaginous strings. In the typical *B. protuberans* (at least in the tropical populations referred to this species: Komárek & Marvan, 1992) the elongated-obovoid to cylindrical cells usually emerge from the colony surface, their mucilaginous sheaths covering only 1/3 of the cells; cells totally merged in the colony are also occasionally present, but with low frequency. In our samples, the examined specimens had obovoid cells, somewhat elongated and smaller, emerging from the colony by up to 1/3 of their length.

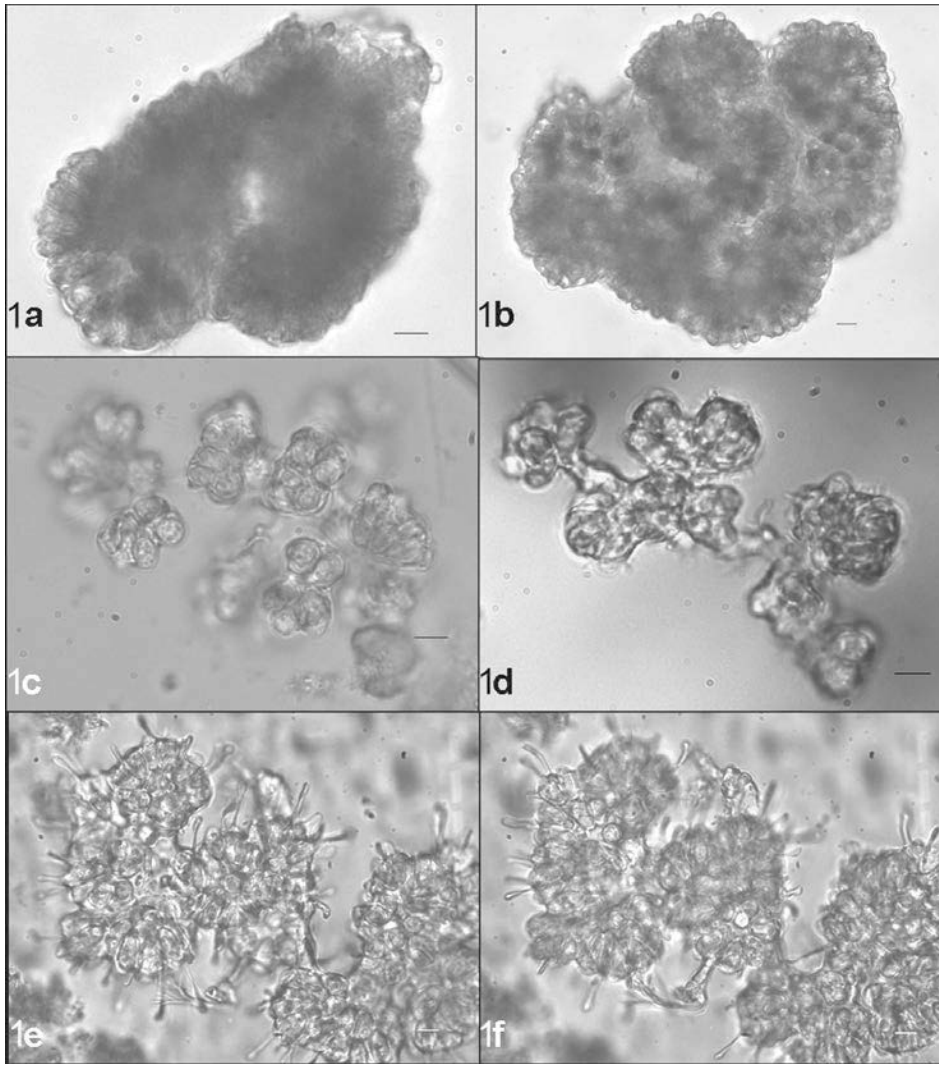
Botryococcus cf. ***terribilis*** Komárek *et* Marvan 1992 **Figs 1e, f**

Syn.: *B. braunii* Kützing 1849 *sensu* Margalef *et al*. 1977, Fig. A-18: 1-3; *B. braunii* Kützing *sensu auctorum.*

Multicellular colonies, irregular, 41-105 μm in diameter, with densely agglomerated cells arranged more or less radially at the periphery of the colony, occasionally completely covered or, but usually emerging from the colony surface by 1/3 to 1/2 of their length; margins of the colonies often with mucilaginous appendices, short or relatively long, irregular; cells ovoid, 5-9 × 4-7 μm; parietal chloroplast with a distinguishable structure similar to a pyrenoid; reproduction by 2 autospores.

Localities: 2, 6, 9, 10, 11, 13, 14, 15, 19, 20.

This was probably the most frequent species in our samples. It could be identified based on colony morphology, especially the presence of mucilaginous



Figs 1a-f. Light micrographs of *Botryococcus* taxa. **1a, b.** *Botryococcus braunii*. **1c, d.** *Botryococcus* cf. *protuberans*. **1e, f.** *Botryococcus* cf. *terribilis*. Scale bars = 5 μm.

appendages at its margins and the cell density within the colony. As described in the literature consulted here, *B. terribilis* has greater cells in relation to the colony diameter in comparison with *B. braunii*, where the cells are smaller relatively to the colony diameter (and therefore the latter has a comparatively higher number of cells).

The cell shape and size of our specimens also agree well with this species. Our material, however, differs in the degree of inclusion of the cells within the colony. In agreement with Komárek & Marvan (1992), in the typical *B. terribilis* the cells are usually embedded in the colony, and only exceptionally do the cell apices emerge somewhat from the margins of the colony. In our populations this

feature is highly variable. The variability of this character has been also noted in collections from Brazil and Cuba (Comas, unpublished observations).

Another species closely related to *B. terribilis* is *B. neglectus* (W. *et* G. S. West) Komárek *et* Marvan, which also shows formation of mucilaginous appendages in the colony margins. However, the marginal mucilaginous appendages are not exclusive of these two species, as they also appear in *B. australis* Komárek *et* Marvan (Comas & Pérez Baliero, 2002). Following the original diagnosis of *B. neglectus* (Komárek & Marvan, 1992), the species has colonies and cells of smaller dimensions, as well as a particular ecology and distribution (from oligo- to mesotrophic waters from the temperate regions of the Northern Hemisphere).

In our samples the most frequent species of the genus was *B. terribilis*, while in the samples from Lithuania collected by Koreivienė & Kasperovičienė (2003) the most frequent species was *B. braunii*. This suggests the possibility that *B. terribilis* may be favoured in warm regions.

DICHOTOMOCOCCUS Koršikov 1928

This genus was transferred to the class Xanthophyceae (Fott & Komárek, 1960), but later Hindák (1978) transferred it back to Chlorophyceaebased on the presence of chlorophyll *b*.

Dichotomococcus curvatus Koršikov 1939 **Figs 2a, b**

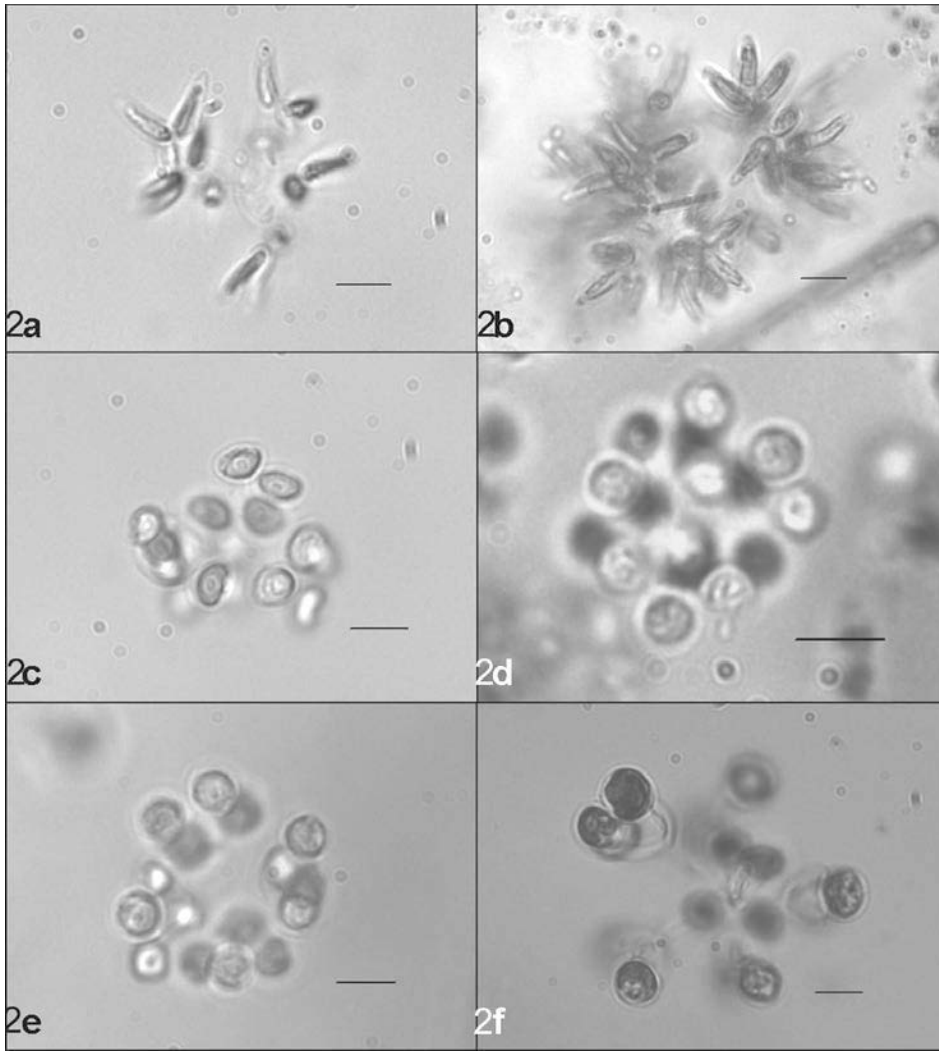
Colonies with 2 to numerous cells attached by a more or less dichotomously-branched system, sometimes inconspicuous, constituted by mucilaginous remnants of mother-cell walls, with a common colourless mucilaginous sheath. Cells elongated and ovoid or ellipsoidal, slightly curved in their basal part, rounded at the proximal end, and progressively acute and truncated at the distal one. Chloroplast situated in the convex side of the cell. Dimensions: cells 6.3-8.1 × 2-2.8 μm; colonies up to 41 μm wide.

Localities: 16, 21.

Dictyosphaerium Nägeli 1849

This genus is one of the most frequently found in plankton and is very frequently cited both in floristic and limnological investigations. However, in spite of wide occurrence species identification is often difficult because the diagnostic characters established in the most recent monograph of this genus (Komárek & Perman, 1978), are not easily detectable. According to these authors, water bodies of different latitudes and ecology contain different morphological types defined as separate species under the names of *D. ehrenbergianum* Nägeli and *D. pulchellum* Wood. A great number of populations attributed to these species correspond in fact to *D. tetrachotomum* Printz sensu Komárek & Perman (1978).

In the tropics, many populations do not correspond closely to any species as circumscribed by the above-mentioned authors. It seems that the typical *D. pulchellum* is rarer, being fundamentally replaced by *D. tetrachotomum* (Comas, 1996). Like ours, many tropical populations cannot be identified with certainty, especially those constituted by less dense colonies with ellipsoidal cells, apparently attached to the mucilaginous tracts at one end (perhaps young cells), in which the presence or absence of pyrenoids in the chloroplasts is difficult to establish with certainty.



Figs 2a-f. Light micrographs of *Dichotomococcus* and *Dictyosphaerium* taxa. **2a, b.** *Dichotomococcus curvatus*. **2c.** *Dictyosphaerium* cf. *ehrenbergianum.* **2d, e.** *Dictyosphaerium pulchellum*. **2f.** *Dictyosphaerium tetrachotomum*. Scale bars = 5 μm.

There is an urgent need for a detailed general study of this genus based on material from different latitudes (especially from the tropics), in order to establish improved morphological criteria for delimiting species. In our samples we recognized the following taxa.

Dictyosphaerium *cf.* ***ehrenbergianum*** Nägeli 1849 **Fig. 2c**

Free-floating colonies, composed of 4-16 cells from oval or ellipsoidal to almost cylindrical, united by their longitudinal axes to the mucilaginous

peduncles; parietal chloroplast, cup-shaped, located in the basal portion of the cells, with a pyrenoid; reproduction mostly by 4 autospores with a cruciate arrangement inside the mother cell, which are released by gelatinization of the wall. Dimensions: colonies up to 19.6 µm in diameter, young cells 4.5-4.8 × 3.2-3.6 µm.

Localities: 16.

The population studied was not typical (Komárek & Fott, 1983), most likely because it consisted mostly of young (and therefore smaller) colonies and cells, and it did not show any dense colonies (with higher number of cells), with somewhat elongated, subcylindrical cells.

D. ehrenbergianum has been erroneously reported for tropical or warmer waters; the typical *D. ehrenbergianum* seems to be typical of clean waters in the northern temperate zones, less frequent than *D. pulchellum* (Komárek & Fott, 1983).

Dictyosphaerium pulchellum Wood 1872 **Figs 2d, e**

Colonies of 4-32 cells, irregularly spherical, sometimes somewhat dense; autospores and young cells irregularly oval or ellipsoidal, the adults spherical; chloroplast parietal, cup-shaped, with a pyrenoid; reproduction by 4 autospores. Dimensions: colonies up to 27.7 µm of diameter; cells 2.7-4.3 µm.

Based on their size, the populations studied correspond to the var. *minutum* Deflandre 1926.

Localities: 6, 18.

This species (as circumscribed by Komárek & Perman, 1978) does not appear to be requent, and it has probably been confused with *D. tetrachotomum*. It appears to prefer clean waters, although it has also been documented in tropical eutrophic water bodies (Tavera *et al*., 2000; Comas *et al*. 2007). In samples from Lithuanian lakes (Koreivienė & Kasperovičienė, 2003) *D. pulchellum* is the most frequent species of the genus, while in southern Spain *D. tetrachotomum* is more abundant.

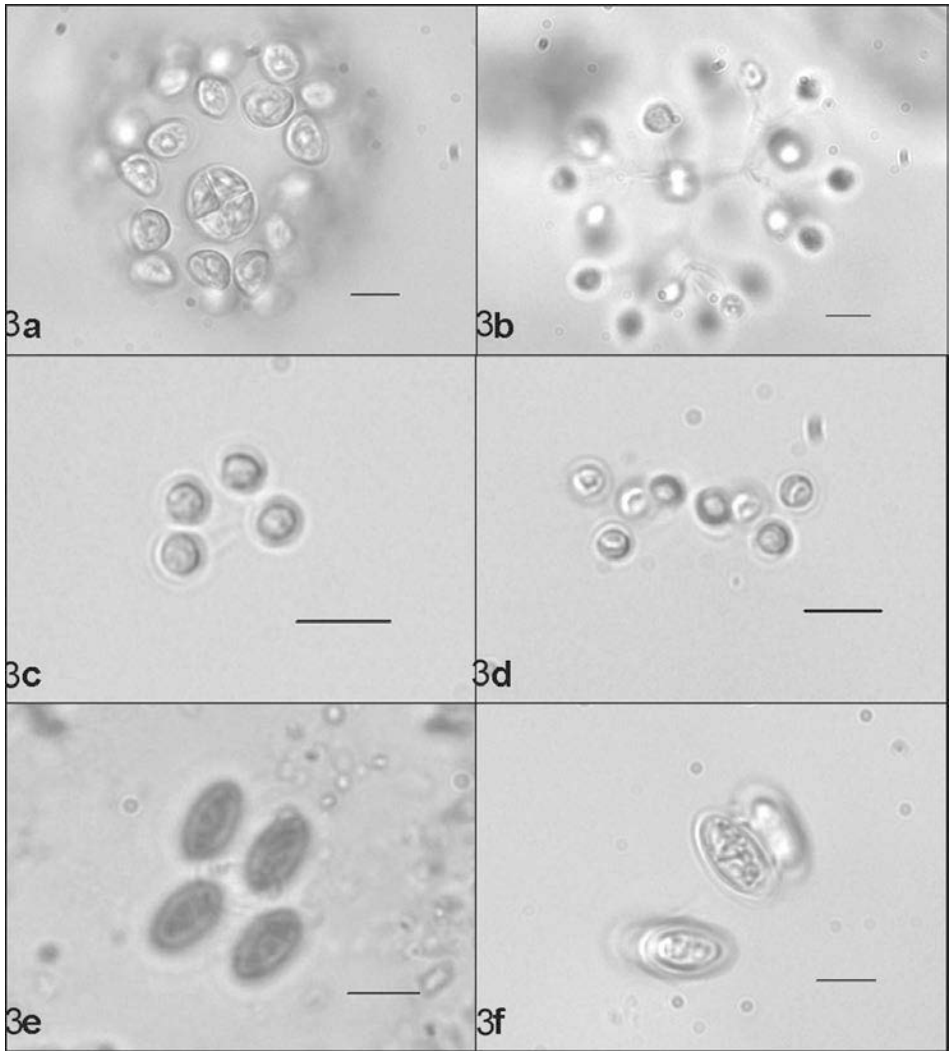
Dictyosphaerium tetrachotomum Printz 1914 **Figs 2f, 3a, b**

Colonies with 4-32 cells, spheroid or irregular; cells connected by gelatinous remnants of the mother cell wall of different length and width, which branch more or less in two; young cells ovoid, somewhat asymmetric; the adults oval, widely oval to irregularly spheroid, asymmetric, arranged slightly obliquely or with their narrower ends on the mucilaginous tracts more or less forking; chloroplast parietal, cup-shaped, with pyrenoid; reproduction by 4 autospores which rotate ca. 180º when released from the mother cell wall. Dimensions: cells 4-8 × 2.9-6.4 µm.

Localities: 3, 4, 6, 7, 10, 23.

This was the most frequent species in our samples. It differs from *D. pulchellum* (with which it has been frequently confused) for its more or less oval, asymmetric adult cells, joined basally to the mucilaginous tracts and for the 180º rotation of its autospores after being released from the mother-cell wall.

At almost all localities the cell dimensions were smaller than in the type variety, more similar to the var. *fallax* Komárek 1983; but in other morphological features it did not correspond to this variety. Some populations, characterized by loose colonies with ellipsoidal cells attached by one of their ends, might belong to *D. elegans* Bachmann; however, it was not possible to establish whether they had a pyrenoid.



Figs 3a-f. Light micrographs of taxa of *Dictyosphaerium* and *Quadricoccus* taxa. **3a, b.** *Dictyosphaerium tetrachotomum*. **3c, d.** *Dictyosphaerium* cf. *subsolitarium*. **3e, f.** *Quadricoccus ellipticus*. Scale bars = 5 μm.

Dictyosphaerium *cf.* ***subsolitarium*** Van Goor 1924 **Figs 3c, d**

Syn.: *Dictyosphaerium simplex* Skuja 1956 *non D. simplex* Koršikov 1953.

Colonies small, irregular, composed of 4-16 cells, surrounded by a thin colourless mucilaginous sheath; cells more or less separate, attached by mucilaginous peduncles of variable width, delicate, often barely visible; autospores and young cells oval, the adults irregularly spherical; parietal chloroplast, cup-shaped, basal; pyrenoid not detected; reproduction by 2-4 autospores which are released by gelatinization of the mother-cell wall. Dimensions: 1.9-4.1 μm in diameter, colonies up to 28 μm in diameter.

Localities: 4, 22.

The population studied corresponds well with this species, except for the absence of the pyrenoid.

QUADRICOCCUS Fott 1948

Quadricoccus ellipticus Hortobágyi 1973 **Figs 3e, f**

Colonies free-floating, composed of 2-4 cells arranged more or less cruciately on the margins of the empty mother cell walls, surrounded by a delicate mucilage, colourless and deliquescent. The remnants of the mother-cell walls sometimes form a branched system. Cells elliptical, with the ends rounded, cell wall smooth, parietal chloroplast with a clearly visible pyrenoid; reproduction by 2-4 autospores released by rupture of the mother-cell wall and remaining joined at a pole or a side to the remnants of the mother-cell wall. Dimensions: cells 6-9.4 × 3-4.9 μm.

Localities: 12, 21.

LOBOCYSTIS Thompson 1952

The genus *Lobocystis* is characterized by the presence of free-floating colonies, composed of several groups of 2 cells which are united by mucilaginous, band-shaped branches originating from the gelatinized mother-cell walls. Around the isolated cells (and at times also around the whole colony) there are thin or wide mucilaginous sheaths. The old mother-cell walls stem approximately from the centre of the colony. The cells can be oval, ovoid, ellipsoidal to oval-cylindrical. They show 1 or 2 chloroplasts with a pyrenoid surrounded by starch. During reproduction the protoplast divides transversally in 2, which later develop as autospores. These remain inside the dilated mother-cell wall, which elongates in the form of a mucilaginous split band. The colonies contain variable numbers of cells and are formed by repeated partitions and the formation of autospores. Type species: *L. planctonica* (Tiff. & Ahlstr.) Fott 1975 (= *Dictyosphaerium planctonicum* Tiff. et Ahlstr. 1931, *L. dichotoma* Thompson 1952).

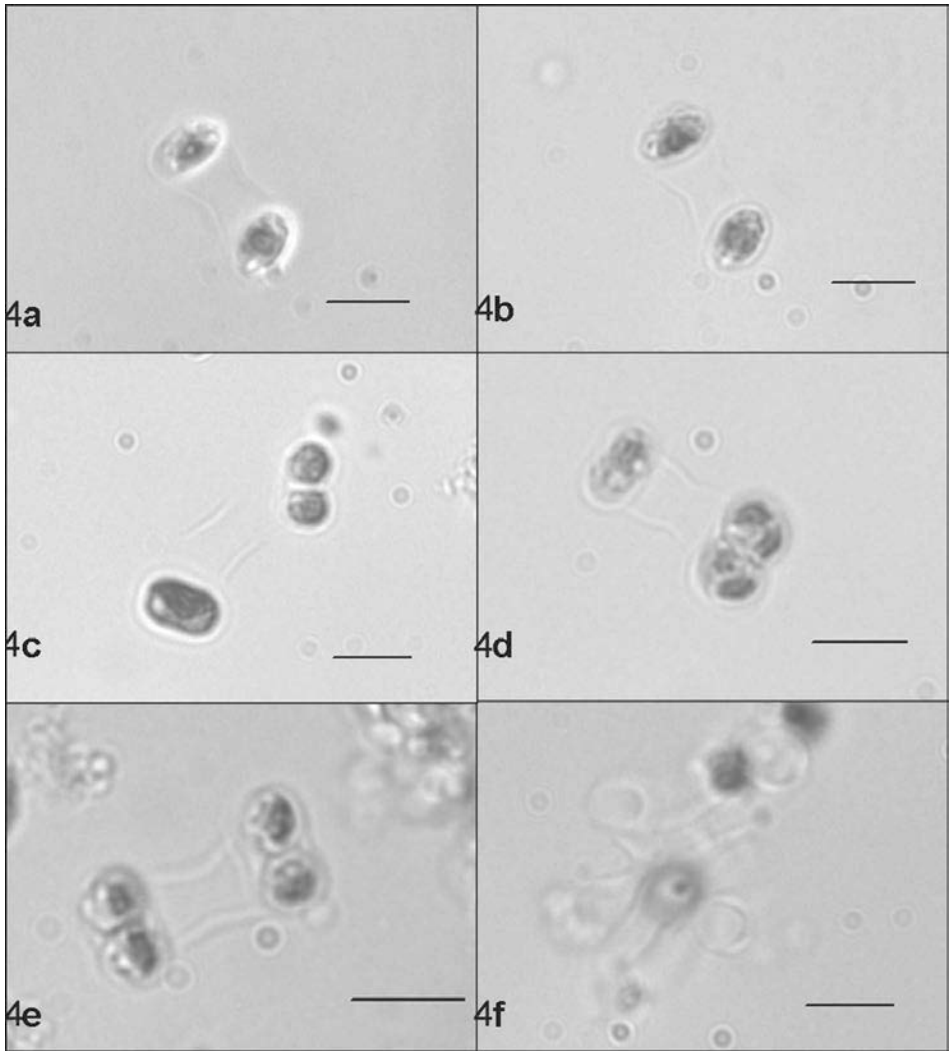
The genus was originally described based on *L. dichotoma* (Thompson, 1952), but later Fott (1975) suggested that this species is identitical with *Dictyospherium planctonicum* described by Tiffany & Ahlstrom (1931). It is not clear whether *D. planctonicum* is identical to *L. dichotoma*, although the concept of Fott (1975) continues to be accepted (Comas & Pérez, 2002).

So far this genus includes three well-defined species: *L. planctonica* (Tiff. & Ahlstr.) Fott, *L. neodichotoma* Izaguirre 1991 and *L. fottiana* Comas, Pérez et Novelo *in* Comas & Pérez 2002.

In samples from the Laguna de Mojón Blanco, Albacete, we found a population with features corresponding to the genus *Lobocystis*; however, based on its morphological features it could not be assigned to any of the species currently included in this genus. For these reasons, we believe that our population represents a new species which we describe here as *Lobocystis incospicua* sp. nov.

Lobocystis inconspicua **Fanés Treviño, Sánchez-Castillo *et* Comas-González** sp. nov. **Figs 4a-f, 5 a-c**

Diagnosis: *Coloniae parvae, natantes, 2-4-(8) cellulatae, plus minusve elongatae, cellularum binarum aggregatarum compositae, interdum cum tegumento*

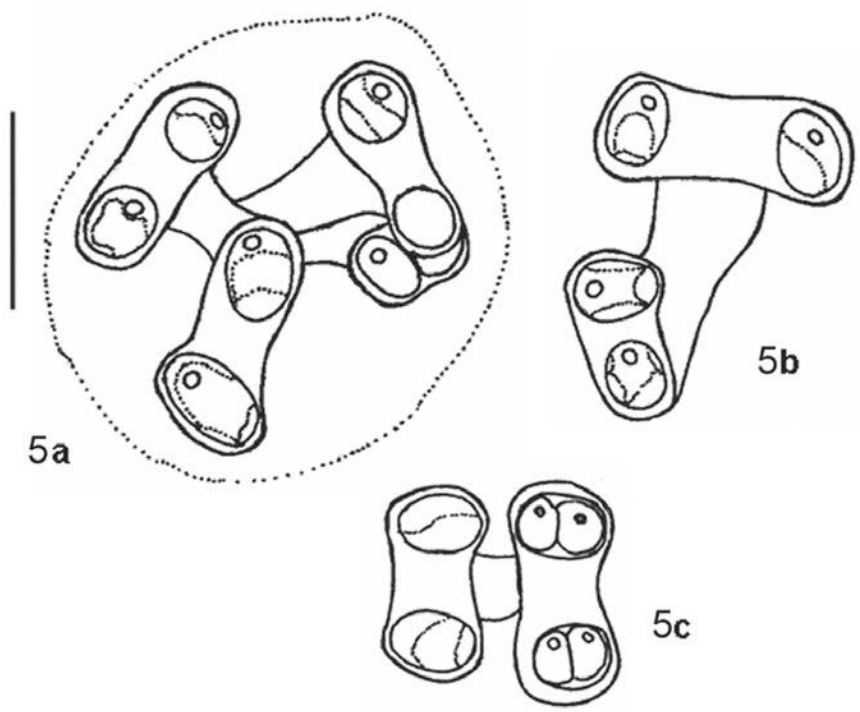


Figs 4a-f. Light micrographs of *Lobocystis inconspicua*. Scale bars = 5 µm.

mucoso indistincto, homogeneo. Paria cellularum intra membranam maternam, partim gelatinosam, remanentia; cellulae binae parallelae, ad extremitates membranae locatae. Cellulae oviformes, cylindrice-ovales vel paene cylindricae in visione laterali, sphericae in visione polari; chloroplastum unum, parietale, cum pyrenoide distincto. Propagatio autosporis binis, parallelis intra membranam maternam. Dimensiones: coloniae 7.5-28 µm latae; cellulae 3.2-6 × 2.2-3.8 µm; autosporae 2.2-3.3 µm latae.

Holotypus: GDA 3736 (figura nostra 5a).

Locus typicus: in plancto lacus Mojón Blanco, Albacete, Hispania, 20 Martio 2006.



Figs 5a-c. Line drawings of *Lobocystis inconspicua*. Scale bar = 10 µm.

Colonies small, free-floating, consisting of 2-4 (8) cells, more or less elongated, formed by grouped pairs of cells, sometimes surrounded by an indistinct, homogeneous, mucilaginous sheath. Pairs of cells remaining in the partially gelatinized mother-cell's wall; cells of each pair located at the extremities of the mother-cell wall, with parallel arrangement. Cell ovoid, ovoid-cylidrical or almost cylindrical in lateral view, spherical in polar view. Chloroplast single, parietal, with distinct pyrenoid. Propagation by couples of autospores, placed with parallel arrangement inside the mother-cell wall. Dimensions: colonies 7.5-28 µm wide; cells 3.2-6 × 2.2-3.8 µm; autospores 2.2-3.3 µm wide.

Holotype: GDA 3736 (Figure 5a).

Type locality: in plancton in lake Mojón Blanco, Albacete, Spain, 20 March 2006.

Localities: 1.

The colonies were small, free-floating, composed of groups of two cells inside the original mother-cell wall (which was widened and elongated, partially gelatinized), located at the two ends of the wall, with a more or less parallel arrangement. Several bicellular groups were joined by short, more or less enlarged band-shaped remnants to form a common elonagated colony, consisting of 2-4-(8) cells; at times the colonies were surrounded by an inconspicuous mucilaginous sheath, hyaline, narrow and homogeneous. The cells were ovoid to almost cylindrical in lateral view, spherical in polar view, with a laminar parietal chloroplast, lateral or located at one of the cell poles, occupying 1/3 to 2/3 of the

cell volume, with a distinct pyrenoid surrounded by starch granules. Reproduction took place by production of 2 autospores following transverse division of the mother cell; the autospores remained more or less parallel inside the mother-cell wall, before gelatinization of the wall and release. The colonies were 7.5-28 μm in diameter; the cells 3.2-6 × 2.2-3.8 μm; the autospores were 2.2-3.3 μm wide.

The new species differs from other species of *Lobocystis* in the number of cells (the colonies of the new species are mostly formed by 2 to 4 cells, rarely 8). In lateral view the cells are ovoid to almost cylindrical and smaller than the other species, being also wider in relation to their length. As in *L. neodichotoma*, and in contrast to the other two species, the cells have only one chloroplast with a pyrenoid. In *L. fottiana* the cell shape in lateral view is similar, but the cells are much larger and more elongated, sometimes asymmetrical, and the cell wall is thickened at the ends; these features are not observable in the new species. *Lobocystis neodichotoma* is the most similar species to our new species but it differs from it in dimensions (in the new species cells of hardly reach 6 μm, whereas in *L. neodichotoma* the cells measure between 6 and 9 μm), cell shape (ellipsoidal to oval in *L. neodichotoma*, ovoid to almost cylindrical in the new species), number of cells per colony (higher in *L. neodichotoma*) and width of the band-shaped remnants (which is larger in our specimens).

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