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Planktonic Chlorophyceae from the lower Ebro River (Spain)

MARÍA DEL CARMEN PÉREZ[1*], AUGUSTO COMAS[2], JULIO G. DEL RÍO[1], JOAN P. SIERRA[3]

[1] Universidad Politécnica de Valencia, Laboratorio de Tecnologías del Medio Ambiente, A.P. 22012, Valencia 46022, Spain.

[2] Centro de Investigaciones Algológicas de Cienfuegos, 55100 Cienfuegos, Cuba.

[3] Laboratori d'Enginyeria Marítima, LIM-CIIRC, DEHMA, Universitat Politècnica de Catalunya, Jordi Girona, 1–3, Campus Nord-UPC, Mòdul D-1, 08034, Barcelona, Spain.

On samples obtained in 4 seasonal periods between April 1999 and February 2000 from the last 18 km of Ebro River (Spain) some interesting planktonic coccal green algae (Chlorophyceae) were found. This paper offers comments and taxonomical observations on 60 taxa. *Crucigenia smithii* (Kirchner) W. et G. S. West, *Crucigeniella pulchra* (W. et G.S. West) Komárek, *Elakatothrix genevensis* (Reverdin) Hindák, *E. subacuta* Koršikov, *Nephrocytium schilleri* (Kammerer) Comas, *Oocystidium ovale* Koršikov, *Pseudoschroederia antillarum* (Komárek) Hegewald et Schnepf, *Scenedesmus denticulatus* var. *fenestratus* (Teiling) Uherkovich, *S. pannonicus* Hortobágyi, *Siderocelis ornata* (Fott) Fott, *Tetrachlorella alternans* (G.M. Smith) Koršikov and *Tetrastrum komarekii* Hindák were found for the first time in this country. The best represented genus was *Scenedesmus,* with 16 taxa.

Key words: Chlorococcales, Chlorophyta, phytoplankton, taxonomy, Ebro River, estuary, Spain

Introduction

The green algae (Chlorophyceae) compose the largest and most varied phylum of algae and they are the most closely related to the higher plants because of their similar photosynthetic pigments, storage of starch and the fine structural organization of the chloroplast (HAPPEY-WOOD 1988). The green algae include a greater diversity of cellular organization, morphological structure and reproductive processes than are found in any other algal division (BOLD et al. 1978).

The composition of some groups of Chlorophyceae (i.e.Chlorococcales) from continental waters is not well known in Spain. The phytoplankton of the Ebro River was studied

* Corresponding author: Fax: +34 96 387 7618, e-mail: mcperez@wanadoo.es

by several researchers. SABATER and MUÑOZ (1990), studying the successional dynamics of the phytoplankton in the lower part of the river, found about 40 species of Chlorococcal algae. SABATER & KLEE (1990) published a special study about central diatoms with special references to some small *Cyclotella*. Other investigations concerning phytoplankton were performed in the Ebro delta (COMIN 1984) and bays (LÓPEZ and ARTÉ 1973, DELGADO 1987, DELGADO et al. 1990, 1995, 1996).

In the framework of the PIONEER European Project, seasonal collecting data campaigns were developed during 1999–2000 to understand nutrient behavior both in the Ebro River and in its plume. In this paper we show the results of four campaigns realized on April, July and October 1999 and February 2000 in which a phytoplankton monitoring was performed at six collecting points. The present paper contributes to the knowledge of the phytoplankton species composition from the Ebro River, especially to do with some planktonic Chlorophyceae (Chlorophyta) including original drawings and pictures. The main chemical variables found during the study are also provided.

Materials and methods

Study area and sampling

The Ebro River has a drainage area covering 88,835 km^2 of the NE part of the Iberian Peninsula. This is one of the main rivers draining Spain; it is 960 km long and has an important flow (IBÁÑEZ et al. 1999). Our study area comprises the lower part of the river (18 km) from Isla de Gracia to its mouth in the Mediterranean Sea (Fig. 1) with mean values of depth and width of 6.8 and 237 m respectively.

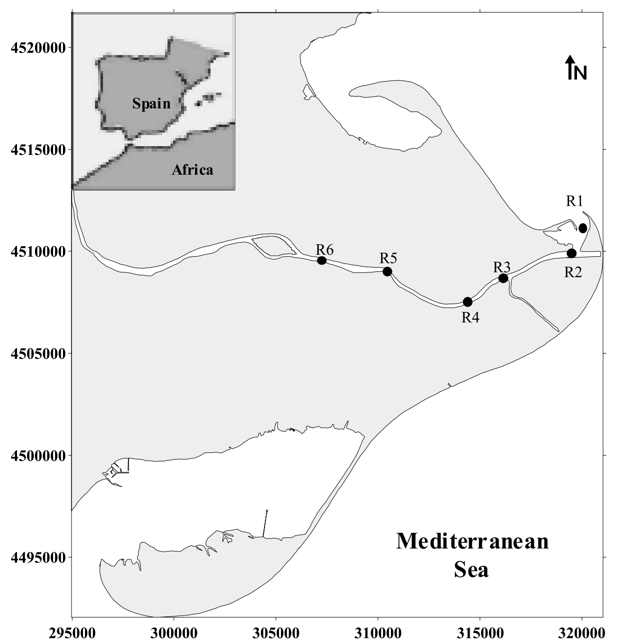


Fig. 1. Location of sampling stations at the lower Ebro River.

The annual discharge distribution is smoothed by the presence of many dams (about 170 according to IBÁÑEZ et al. 1999). In particular, the Mequinenza and Riba-Roja dams (located 100 km upstream from the mouth) have an important regulatory effect on the discharges in the delta. A mean discharge value of 10000 hm^3 $year^{-1}$ (varying between 5000 and 14000 hm^3) is estimated.

In the Ebro delta, rice crops and cultivated fields alternate with coastal lagoons. The region has Mediterranean dry climate with a mean annual temperature around 16–17 °C, with around 550 mm of precipitation per year (MARTÍNEZ et al. 1999).

A multiparametric sounding Hydrolab Surveyor 3 was used for the following parameters: conductivity, temperature and pH.

Phytoplankton samples for qualitative analyses were collected with a 20 μm mesh plankton net by horizontal tows in the centre of the stream at every sampling station (Fig. 1) in April, July and October 1999 and February 2000. The material was fixed *in situ* with glutaraldehyde (2% final concentration) according to SOURNIA (1978).

Identification and Taxonomy

Detailed examinations and drawings of the material were made with a Leitz Laborlux and a Nikon Optiphot light microscope with phase contrast. For cryo-SEM analysis a concentrated subsample was frozen with liquid N_2, coated with gold and examined using a Jeol JSM-5410 scanning microscope equipped with cryo-station. All samples are deposited at the Environmental Laboratory of the Polytechnic University of Valencia.

The taxonomic classification used in this paper is based mainly on KOMÁREK and FOTT (1983); in special cases, other authors are cited in the text. Concerning the problematic genus *Scenedesmus,* two recent papers were published (AN et al. 1999 and HEGEWALD 2000), which modified the traditional concept of the genus. According to these authors, *Scenedesmus* is divided in two separate genera: *Scenedesmus s.s*. and *Desmodesmus* AN. et al. 1999; however the consequent taxonomical changes are not yet completed.

Records new for Spain are based on CAMBRA SÁNCHEZ et al. (1998), while records new for the locality refer to the lower part of the river and the Catalunya region.

Results and discussion

The pH values varied between 7.86 and 8.55 (μ= 8.2), the values of surface temperature varied between 9.81 and 27.26 °C (μ= 18.5) and the conductivity between 928 and 9070 $\mu S.cm^{-1}$ (μ= 3777). The surface salinity was measured on July 12th and October 5th 1999 and varied between 2.3 and 5.1 psu.

Taxonomical remarks

According to our results 60 taxa were identified, 58 belonging to the Chlorococcales while 2 are included in the Ulotrichales: *Elakatothrix genevensis* (Reverdin) Hindák and *Elakatothrix subacuta* Koršikov.

Actinastrum hantzschii Lagerheim 1882

var. *hantzschii* (Figs. 2.1, 2.47). Dimensions: cells 16–24 × 2.4–6 μm. New record for the locality.

var. *subtile* Woloszynska 1911. Dimensions: cells 46–48 × 3 µm. New record for the locality.

Ankyra ancora (G.M. Smith) Fott 1957 (Fig. 2.49). Dimensions: cells 54–100 × 7–10 µm, basal end up to 12 µm long. New record for the locality.

Chlorotetraedron incus (Teiling) Komárek et Kováčik 1985 (Figs. 2.35, 2.50). Dimensions: cells 13.2 µm in diameter. New record for the locality.

Closteriopsis longissima (Lemmermann) Lemmermann 1899 (Figs. 2.9, 2.46). Dimensions: cells 156.8–370 × 4.4–6 µm

Coelastrum indicum Turner 1892 (Fig. 2.2). Dimensions: cells 10–11.2 µm in diameter. Registered in Spain *sub Coelastrum cambricum* Archer var. *intermedium* (Bohlin) Koršikov (CAMBRA SÁNCHEZ et al. 1998). New record for the locality.

Coelastrum microporum Nägeli 1855 (Fig. 2.5). Dimensions: cells 8–10 µm in diameter.

Coelastrum pseudomicroporum Koršikov 1953 (Fig. 2.6). Dimensions: cells 5–8 µm in diameter. New record for the locality.

Coelastrum reticulatum (Dangeard) Senn 1899 var. *polychordum* Koršikov 1953 (Figs. 2.4, 2.54, 2.56, 2.80). Dimensions: coenobia 22–24 µm in diameter, cells 7.2–8 µm in diameter. Registered in Spain *sub Coelastrum polychordum* (Koršikov) Hindák (CAMBRA SÁNCHEZ et al. 1998). New record for the locality.

Crucigenia smithii (Bourrelly et Manguin) Komárek 1974 (Figs. 2.16, 2.61). Dimensions: coenobia 19 × 18 µm, cells 5–10 × 3.2–7 µm. New record for Spain.

Crucigenia tetrapedia (Kirchner) W. et G.S. West 1902 (Fig. 2.59). Dimensions: cells 4 µm in diameter.

Crucigeniella cf. *pulchra* (W. et G.S. West) Komárek 1974 (Figs. 2.7, 2.58). Dimensions: cells 5–6.4 × 3.2–4 µm. New record for Spain.

Dictyosphaerium ehrenbergianum Nägeli 1849. Dimensions: colonies 24–29 µm in diameter, cells 8–10 × 4 µm. New record for the locality.

Dictyosphaerium tetrachotomum Printz 1914 (Figs. 2.21, 2.55). Dimensions: colonies 35.2–46.4 µm in diameter, cells 5–6.4 × 3.2–5.8 µm. New record for the locality.

Elakatothrix genevensis (Reverdin) Hindák 1962 (Fig. 2.37). Dimensions: cells 24 × 3.2 µm. New record for Spain.

Elakatothrix subacuta Koršikov 1939 (Figs. 2.13, 2.63). Dimensions: colonial mucilage 23.2–25 µm in diameter. 2–6 µm distant from the cells, cells 7–11 × 3.3–4.9 µm. New record for Spain. This species was described by KORŠIKOV (1939) from the plankton of stagnant waters of Ukraine and it is also known from the Danube River (HINDÁK 1987). The specimens from the Ebro River correspond very well with the diagnostic features of the species. The alga is characterized by 2–16-celled colonies surrounded by an irregularly oval to almost spherical envelope. In the colonial matrix, the cells are single, in pairs or in groups without a definite arrangement. Cells are ovally fusiform, cylindrically fusiform or nearly ovoid, heteropolar (after cell division). Ends are rounded or roundly pointed. The chloroplast is parietal with a, sometimes not very visible, pyrenoid. Reproduction occurs by perpendicular or oblique division of the mother cell. The daughter cells are in pairs at first, then separate from each other.

Eutetramorus fottii (Hindák) Komárek 1979 (Figs. 2.14, 2.65). Dimensions: cells 5–10 µm in diameter. New record for the locality, but known from Spain *sub Coenochloris polycocca* (Koršikov) Hindák (CAMBRA SÁNCHEZ et al. 1998).

Golenkinia radiata Chodat 1894 (Fig. 2.64). Dimensions: cells 12 μm in diameter. setae 18–20 μm long. New record for the locality.

Kirchneriella obesa (W. West) Schmidle 1893 (Fig. 2.15). Dimensions: cells 5–8 × 1.6–4 μm. New record for the locality.

Micractinium pusillum Fresenius 1858 (Figs. 2.23, 2.57). Dimensions: cells 5.8–6.6 μm in diameter.

Monoraphidium arcuatum (Koršikov) Hindák 1970 (Fig. 2.11). Dimensions: cells 154 × 3.2 μm. New record for the locality.

M. contortum (Thur.) Komárková-Legnerová 1969. Dimensions: cells 23.2 × 2.4 μm.

Monoraphidium griffithii (Berkeley) Komárková-Legnerová 1969 (Fig. 2.10). Dimensions: cells 64–132 × 2.6–4.4 μm.

Nephrocytium schilleri (Kammerer) Comas 1980 (Fig. 2.12). Dimensions: cells 15.4–22 × 9 μm. New record for Spain. This species occurs very rarely in the samples, but according to its features corresponds somewhat to this taxon. The presence of two unequal pyrenoids in each cell (may be in reproduction process) is remarkable.

Oocystidium ovale Koršikov 1953 (Fig. 2.52). Dimensions: colonies 26 μm in diameter, cells 12 × 8 μm. New record for Spain.

Oocystis lacustris Chodat 1897 (Fig. 2.3). Dimensions: cells 9–10 × 4.4–5.8 μm.

Oocystis marssonii Lemmermann 1898 (Fig. 2.28). Dimensions: cells 10–18 × 8–14.4 μm. New record for the locality. The specimens from the Ebro River present broad oval cells with rounded ends without polar thickenings. In the mature vegetative cells 1–2 parietal chloroplasts with pyrenoids are observed. Such organisms were frequently misinterpreted as *O. borgei* (s. HINDÁK 1988), in which the vegetative cells have a higher number of chloroplasts.

P. boryanum (Turpin) Meneghini 1840 var. *boryanum* (Figs. 2.22, 2.68). Dimensions: coenobia up to 56 μm in diameter, cells 11.2–13 × 8–11.2 μm, horns 3.5–5 μm long. New record for the locality.

P. duplex Meyen 1829 var. *duplex* (Fig. 2.24). Dimensions: coenobia 41.6–65.6 μm in diameter, cells 7.2–18 μm in diameter.

P. simplex Meyen 1829 s.l. Dimensions: cells 6.4–18 × 8–10 μm, horns up to 6.4 μm long. The species occurs in all samples in relatively high amount. It shows, however, a wide morphological variability: irregularly or concentric arranged cells in coenobia, with or without spaces between internal cells and different ornamented cell walls. Abnormalities in the cell and coenobia morphology were also found. In the samples were observed organisms identical with few described infraespecific taxa: var. *simplex* (Figs. 2.20, 2.70), var. *sturmii* (Reinsch) Wolle and var. *echinulatum* Wittrock (Fig. 2.71), therefore the taxonomical evaluation of these different types at infraspecific ranks was not easy because transition types were found in one and the same population.

P. tetras (Ehrenberg) Ralfs 1844 (Figs. 2.25, 2.69). Dimensions: coenobia up to 42.4 μm in diameter, cells 9–11.2 μm in diameter.

Pediastrum sp. (Figs. 2.26, 2.66, 2.67). Dimensions: coenobia 31.2–48 μm in diameter, cells 7.2–11.2 μm in diameter. This interesting alga, scarce in our samples (only observed in samples from the river mouth) is remarkable for the morphological differences between the young and the mature coenobia. In the young, flat and unperforated coenobia, the marginal cells at the outsides form two short lobes (without horns or processes) with a slightly incision between them. When the incision is relatively deep (V-shaped), the lobes could be oriented in different planes, sometimes touching by their ends. The chloroplasts do not fill the whole cell cavity, usually forming a distinct depression just where the incision of the marginal cells is formed. The marginal cells resemble those of *P. tetras* (Ehrenberg) Ralfs, but the lobes at marginal cells are not well developed and the secondary incisions in the internal cells are complete absent. The ornamentation of the cell walls is not very visible on LM. The mature coenobia are slightly campanulate without or with small spaces between cells. The marginal cells, at the outsides, are straight, slightly convex or nearly pronounced just between neighboring cells, forming a shallow incision in the middle. Sometimes a wart-like thickening of the cell wall (processes?) are present at the corners of the marginal cells. The cell wall in the adult cells is irregularly granulated, very visible at the corners of the external cells as in *P. argentiniense* Bourrelly et Tell.

Planktosphaeria gelatinosa G.M. Smith 1918 (Fig. 2.36). Dimensions: cells 18–22 µm in diameter. New record for the locality.

Pseudoschroederia antillarum (Komárek) Hegewald et Schnepf 1986 (Fig. 2.18). Dimensions: cells (without ends) 26.4 × 6.6 µm, ends up to 13.2 µm long. New record for Spain. *Schroederia antillarum* was described by KOMÁREK (1983) from Cuba, where it is very common in the plankton and periphyton of stagnant eutrophic waters (COMAS GONZÁLEZ 1996); later it was found also in Germany and India. The species was transferred to the genus *Pseudoschroederia* Hegewald et Schnepf (HEGEWALD and SCHNEPF 1986), which differs from *Schroederia* Lemmermann 1898 by its heteropolar cells (demonstrated by EM, but according to HEGEWALD and SCHNEPF 1986, sometimes visible also in LM). By the cell shapes and dimensions it is amply differentiated from the other *Schroederia* species.

Pseudoschroederia robusta (Koršikov) Hegewald et Schnepf 1986 (Fig. 2.53). Dimensions: cells (without ends) 28 µm long, with ends 55 µm long, 12 µm wide. New record for the locality.

Raphidocelis contorta (Schmidle) Marvan et al. 1984 (Fig. 2.48). Dimensions: cells 5.6–6.2 × 2.3–2.5 µm. Recorded for the Ebro River by SABATER and MUÑOZ (1990), determined however as *Kirchneriella contorta* (Schmidle) Bohlin. The species is known from other localities of Spain but *sub Pseudokirchneriella contorta* (Schmidle) Hindák (CAMBRA SÁNCHEZ et al. 1998).

Scenedesmus abundans (Kirchner) Chodat 1913 (Fig. 2.73). Dimensions: cells 9.6 × 3.2 µm. Registered to the locality as *S. sempervirens* Chodat (SABATER and MUÑOZ 1990)

S. acuminatus (Lagerheim) Chodat 1902 (Fig. 2.39). Dimensions: cells 16–26.4 × 4.4–5 µm

S. arcuatus (Lemmermann) Lemmermann 1899 (Figs. 2.29, 2.30, 2.74). There are different interpretations about *S. arcuatus* and other morphologically related species. Therefore several modifications in the taxonomy and nomenclature of the taxon were published (KOMÁREK and FOTT 1983, HEGEWALD and SILVA 1988, HEGEWALD et al. 1988, HINDÁK 1990, etc.). This alga occurs relatively often in our samples. It appears in two easily distinguishable morphological types: 1) coenobia are composed of two rows of cells, irregularly arranged, arcuated with bigger spaces between cells (almost bigger than the cell diameter), surrounded by a mucilaginous envelope. Cells cylindrical, oval to kidney shaped. Dimensions: cells 8–17.6 × 3.2–8.8µm. This type corresponds with the var. *arcuatus* (Figs. 2.29, 2.74); 2) Coenobia are flat, also formed by two rows of cells, regularly arranged, with or without small (smaller than cell diameter) spaces between cells. Dimensions: cells 10–13.2 × 5.8–11.2 µm. This type corresponds with the var. *platydiscus* G.M. Smith 1916 (Fig. 30). New record for the locality.

S. armatus Chodat 1913 (Fig. 2.33). Dimensions: cells 11.2 × 3.2 µm. New record for the locality.

S. brasiliensis Bohlin 1897 (Fig. 2.76). Dimensions: cells 20 × 8 µm. New record for the locality.

S. denticulatus Lagerheim 1882 var. *fenestratus* (Teiling) Uherkovich 1966 (Figs. 2.41, 2.77). Dimensions: cells 11.2–20.2 × 7–9 µm. New record for Spain. This population shows characteristics almost identical to those of the specimens found by HINDÁK (1990) and UHERKOVICH et al. (1995). It forms 4–8-celled coenobia. In the 4-celled coenobia the internal cells are oriented more or less in parallel to the long axis of the coenobia, each external cell being joined to this pair forming intercellular spaces (like as *S. fenestratus* Teiling 1942), or the cells are irregularly arranged in different planes. Typical *S. denticulatus*-like coenobia were not observed. The 8-celled coenobia are markedly arcuated, appearing frequently with a central opening considerably broader, so that the two opposite cell pairs do not touch at all with their conical ends, or without central opening, but with small spaces between the other cells. The alga is morphologically high variable, especially in the shape of the cells as well as the number and disposition of the teeth. Cells are oval, straight, slightly arcuated to conical, joined laterally by their basis (mainly in 8-celled coenobia with central opening). This morphological type is very similar to the typical *S. denticulatus*, but it is taxonomically distinguishable, at least within infraspecific rank. *S. fenestratus* Teiling 1942 differs, in the original sense, from *S. denticulatus* only by the small opening between the cells (the 8-celled coenobia with a broad central opening were not involved), therefore it was considered a variety of *S. denticulatus* (UHERKOVICH 1966). HINDÁK (1990), found from Slovakia specimens with 8-celled coenobia with a central opening. He identified them however as *S. denticulatus* «*fenestratus*« type (without taxonomical status). Such a morphological type was considered by UHERKOVICH et al. (1995) and HEGEWALD (2000) as a good variety (this later considered it however as *Desmodesmus denticulatus* var. *fenestratus* (Teiling) Hegewald). Indeed, *S. denticulatus* var. *fenestratus sensu auct. post*. seems to be an interpretation of the taxon, which we are following in this paper. A definite rank for *S. denticulatus* var. *fenestratus sensu auct. post*. could be determined in the future.

S. ellipticus Corda 1835 (Figs. 2.42, 2.75). Dimensions: cells 21–24 × 6–10 µm. New record for the locality.

S. intermedius Chodat 1926 (Figs. 2.40, 2.79). Dimensions: cells 9 × 4.4 µm. New record for the locality.

S. magnus Meyen 1829 (Figs. 2.34, 2.72). Dimensions: 10–24.8 × 3.2–9.6 µm.

S. obliquus (Turpin) Kützing 1833 var. *dimorphus* (Turpin) Hansgirg 1888 (Fig. 2.38). Dimensions: cells 18 × 4,4 µm

S. obtusus Meyen 1829 (Fig. 2.31). Dimensions: cells 10–11.2 × 3.2 µm. Probably recorded in the locality by SABATER and MUÑOZ (1990) *sub S. ovalternus* Chodat.

S. opoliensis Richter 1896 (Fig. 2.43). Dimensions: cells 16–26.4 × 3.2–6.4 µm. New record for the locality.

S. pannonicus Hortobágyi 1944 (Figs. 2.32, 2.78. 2.81). Dimensions: cells 9–18 × 4.4–8 µm. New record for Spain. The species presents high variation in morphological features, especially in the number and position of spines, ribs and granules, hence several infraspecific taxa were described. According to KOMÁREK and FOTT (1983) and HINDÁK (1990), all these types of coenobia constituted the frame of morphological variability, and are therefore without taxonomic value. *S. pannonicus* Hortobágyi is very similar to *S. pecsencis* Uherkovich and to *S. dispar* Brébisson (KOMÁREK and FOTT 1983), the position of which is not yet clear, but according to HINDÁK (1990), in *S. dispar* the coenobia are with short apical or subapical teeth and without ribs. The specimens of the Ebro River correspond with the species: coenobia are arcuated, with cells turned to each other, apical spines or teeth were one at each pole of the external cells, mostly in diagonally symmetrical position, but this population has the tendency to form heterocaudate coenobia (bicaudate coenobia are very common in this species).

S. spinosus Chodat 1913. Dimensions: cells 8.8 × 4 µm.

Scenedesmus westii (G.M. Smith) Chodat 1926. (= *S. quadricauda* (Turpin) Brébisson *sensu* Chodat 1926, *S. communis* Hegewald 1977) (Fig. 2.44). Dimensions: cells 11.2–14.4 × 3.2–5 µm. Registered to Spain as *S. quadricauda* (Turpin) Brébisson (CAMBRA SÁNCHEZ et al. 1998).

Schroederia setigera (Schröder) Lemmermann 1898. Dimensions: cells 150 × 4 µm. New record for the locality.

Selenastrum bibraianum Reinsch 1867 (Fig. 2.51). Dimensions: distance between cell ends 18 µm long, 6 µm wide. Recorded for Spain as *Ankistrodesmus bibraianus* (Reinsch) Koršikov (CAMBRA SÁNCHEZ et al. 1998). New record for the locality.

S. gracile Reinsch 1867 (Fig. 2.8). Dimensions: cells 14.4–21 × 2.4 µm. Recorded in Spain as *sub Ankistrodesmus gracilis* (Reinsch) Koršikov (CAMBRA SÁNCHEZ et al. 1998). New record for the locality.

Siderocelis ornata (Fott) Fott 1934 (Fig. 2.62). Dimensions: autosporangia 18.4 × 16 µm, cells 8–12.8 × 4.8–11.2 µm. New record for Spain.

Tetrachlorella alternans (G.M. Smith) Koršikov 1939 (Fig. 2.27). Dimensions: cells 5–17.2 × 3.2–10.4 µm. New record for Spain.

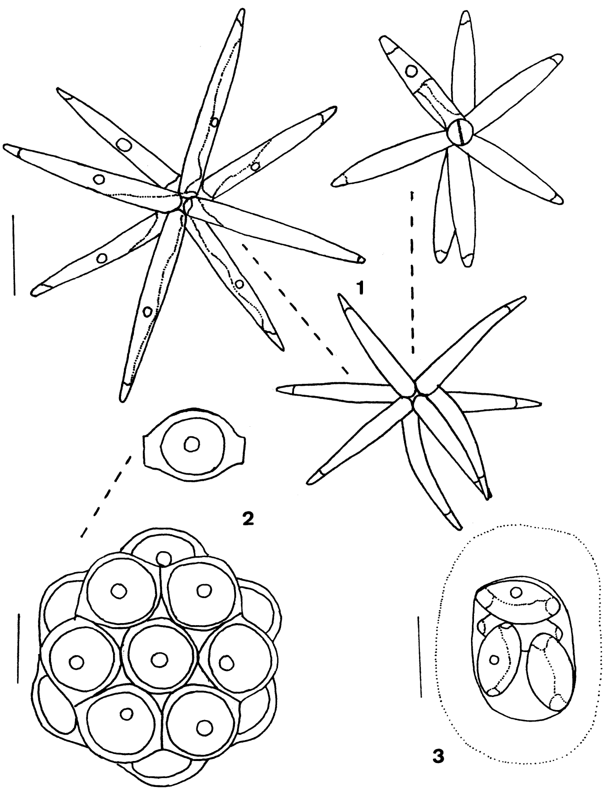
Tetraedron caudatum (Corda) Hansgirg 1888. Dimensions: cells 8.5 µm in diameter.

Tetrastrum komarekii Hindák 1977 (Figs. 2.17, 2.60). Dimensions: cells 2.4–4.4 µm in diameter. The species differs from *T. triangulare* basically by lack of pyrenoid. New record for Spain.

Treubaria triappendiculata Bernard 1908 (Fig. 2.45). Dimensions: cells 15.4 µm in diameter, processes 18 µm long. New record for the locality.

Fig. 2. Planktonic Chlorophyceae observed at the lower Ebro River. 2.1- *Actinastrum hantzschii* var. *hantzschii*, 2.2- *Coelastrum indicum*, 2.3- *Oocystis lacustris*, 2.4- *Coelastrum reticulatum* var. *polychordum*, 2.5- *C. microporum*, 2.6- *C. pseudomicroporum*, 2.7- *Crucigeniella pulchra*, 2.8- *Selenastrum gracile*, 2.9- *Closteriopsis longissima*, 2.10- *Monoraphidium griffithii*, 2.11- *M. arcuatum*, 2.12- *Nephrocytium schilleri*, 2.13- *Elakatothrix subacuta*, 2.14- *Eutetramorus fottii*, 2.15- *Kirchneriella* cf. *obesa*, 2.16- *Crucigenia smithii*, 2.17- *Tetrastrum komarekii*, 2.18- *Pseudoschroederia antillarum*, 2.19- *Crucigeniella* sp., 2.20- *Pediastrum simplex*, 2.21- *Dictyosphaerium tetrachotomum*, 2.22- *Pediastrum boryanum*

var. *boryanum*, 2.23- *Micractinium pusillum*, 2.24- *Pediastrum duplex* var. *duplex*, 2.25- *P. tetras*, 2.26- *Pediastrum* sp., 2.27- *Tetrachlorella alternans*, 2.28- *Oocystis marssonii*, 2.29- *Scenedesmus arcuatus* var. *arcuatus*, 2.30- *S. arcuatus* var. *platydiscus*, 2.31- *S. obtusus*, 2.32- *Scenedesmus pannonicus*, 2.33- *S. armatus*, 2.34- *Scenedesmus magnus*, 2.35- *Chlorotetraedron incus*, 2.36- *Planktosphaeria gelatinosa*, 2.37- *Elakatothrix genevensis*, 2.38- *Scenedesmus obliquus* var. *dimorphus*, 2.39- *S. acuminatus*, 2.40- *S. intermedius*, 2.41- *Scenedesmus denticulatus* var. *fenestratus*, 2.42- *S. ellipticus*, 2.43- *Scenedesmus opoliensis*, 2.44- *S. westii*, 2.45- *Treubaria triappendiculata*, 2.46- *Closteriopsis longissima*, 2.47- *Actinastrum hantzschii* var. *hantzschii*, 2.48- *Raphidocelis contorta*, 2.49- *Ankyra ancora*, 2.50- *Chlorotetraedron incus*, 2.51- *Selenastrum bibraianum*, 2.52- *Oocystidium ovale*, 2.53- *Pseudoschroederia robusta*, 2.54–56- *Coelastrum reticulatum* var. *polychordum*, 2.55- *Dictyosphaerium tetrachotomum*, 2.57- *Micractinium pusillum*, 2.58- *Crucigeniella pulchra*, 2.59- *Crucigenia tetrapedia*, 2.60- *Tetrastrum komarekii*, 2.61- *Crucigenia smithii*, 2.62- *Siderocelis ornata*, 2.63- *Elakatothrix subacuta*, 2.64- *Golenkinia radiata*, 2.65- *Eutetramorus fottii*, 2. 66–67- *Pediastrum* sp., 2.68- *Pediastrum boryanum* var. *boryanum*, 2.69- *P. tetras*, 2.70- *Pediastrum simplex* var. *simplex*, 2.71- *P. simplex* var. *echinulatum*, 2.72- *Scenedesmus magnus*, 2.73- *S. abundans*, 2.74- *S. arcuatus* var. *arcuatus*, 2.75- *Scenedesmus ellipticus*, 2.76- *S. brasiliensis*, 2.77- *S. denticulatus* var. *fenestratus*, 2.78- *S. pannonicus*, 2.79- *S. intermedius*, 2.80- *Coelastrum reticulatum* var. *polychordum* (SEM micrograph), 2.81- *Scenedesmus pannonicus* (SEM micrograph) Bar = 10 µm.



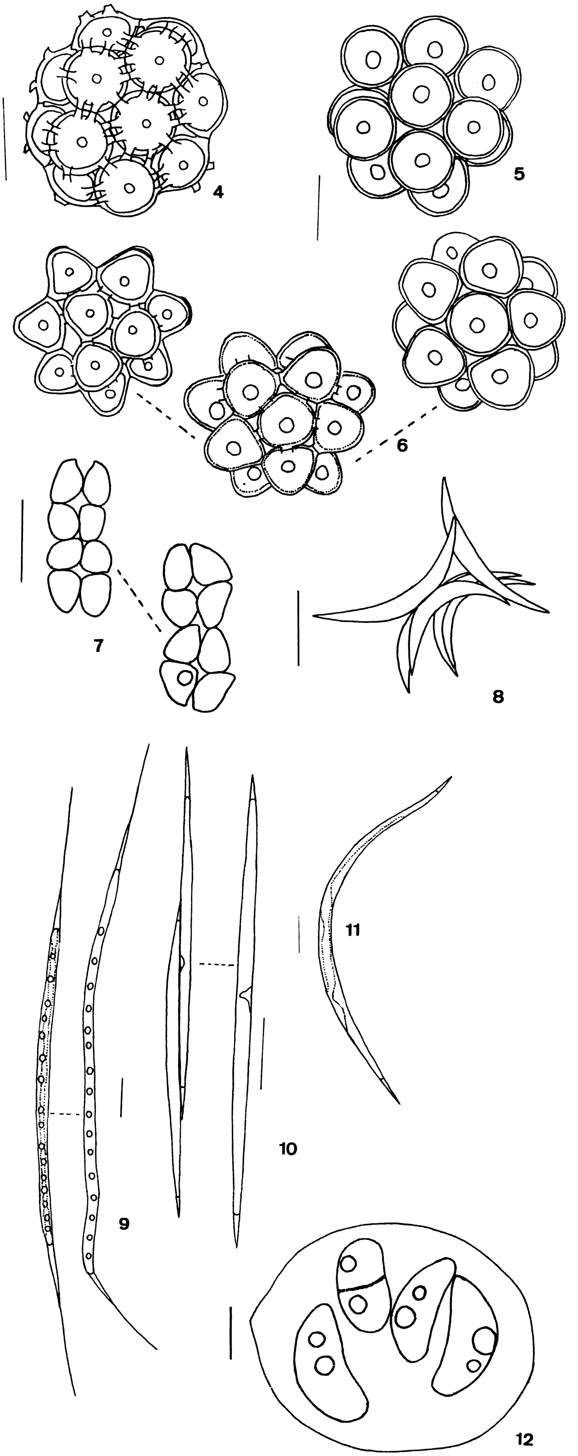


Fig. 2. – continued

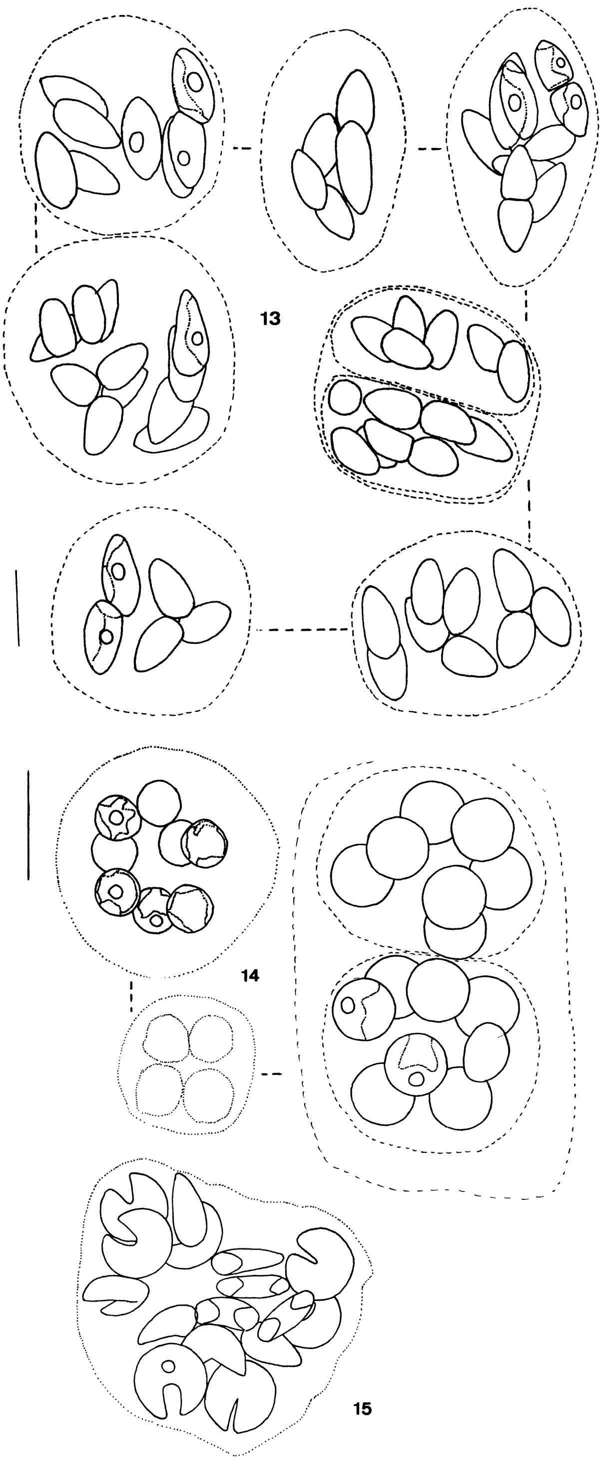


Fig. 2. – continued

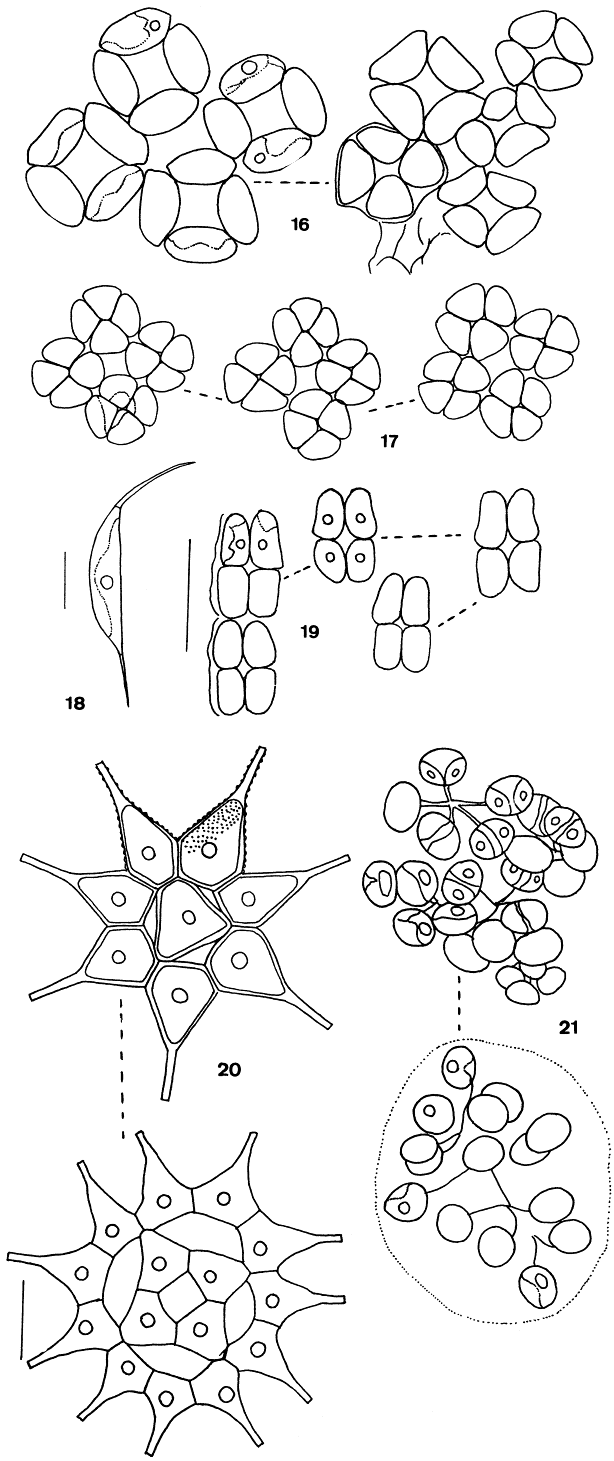
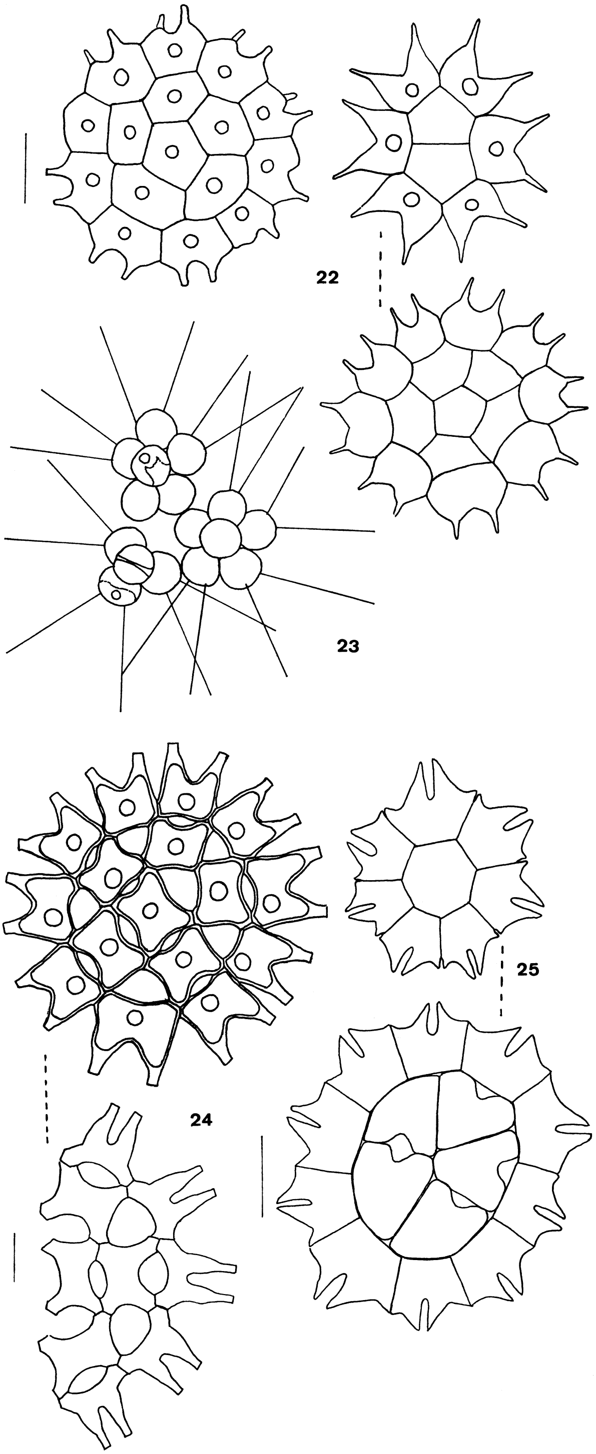


Fig. 2. – continued



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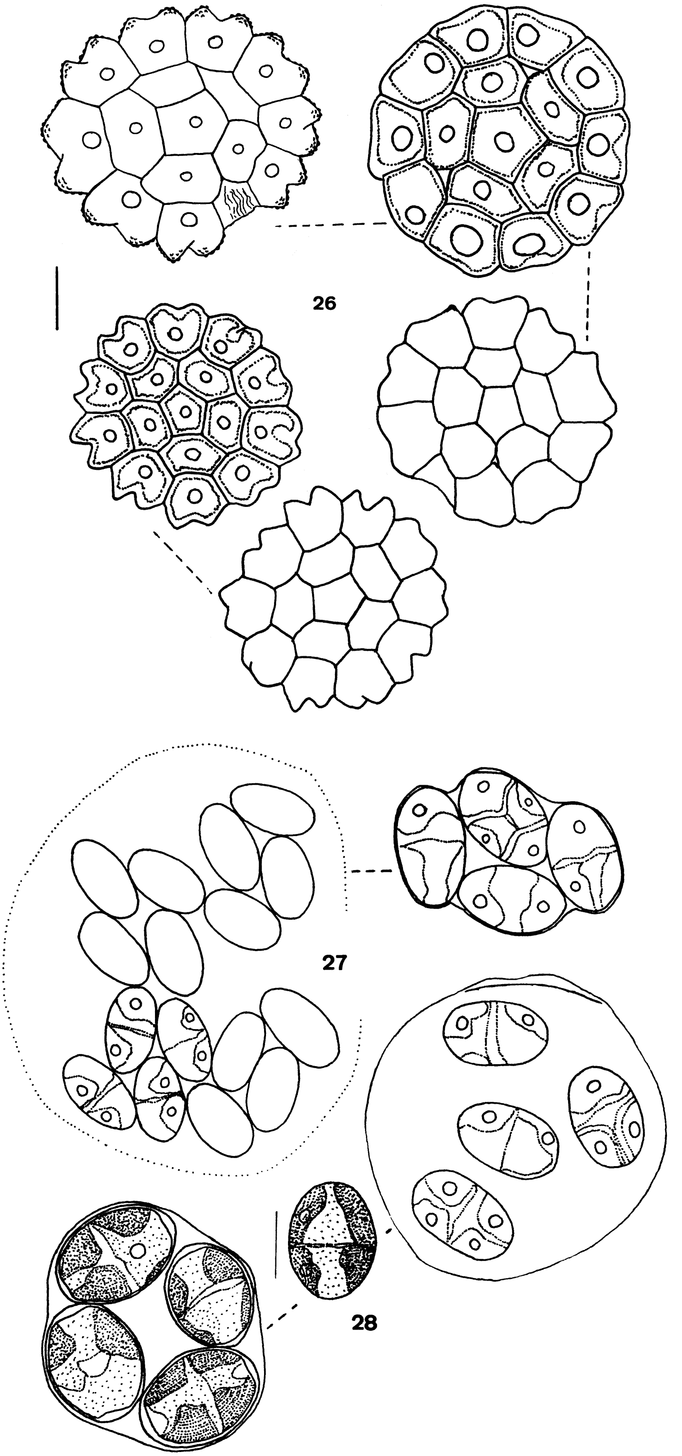

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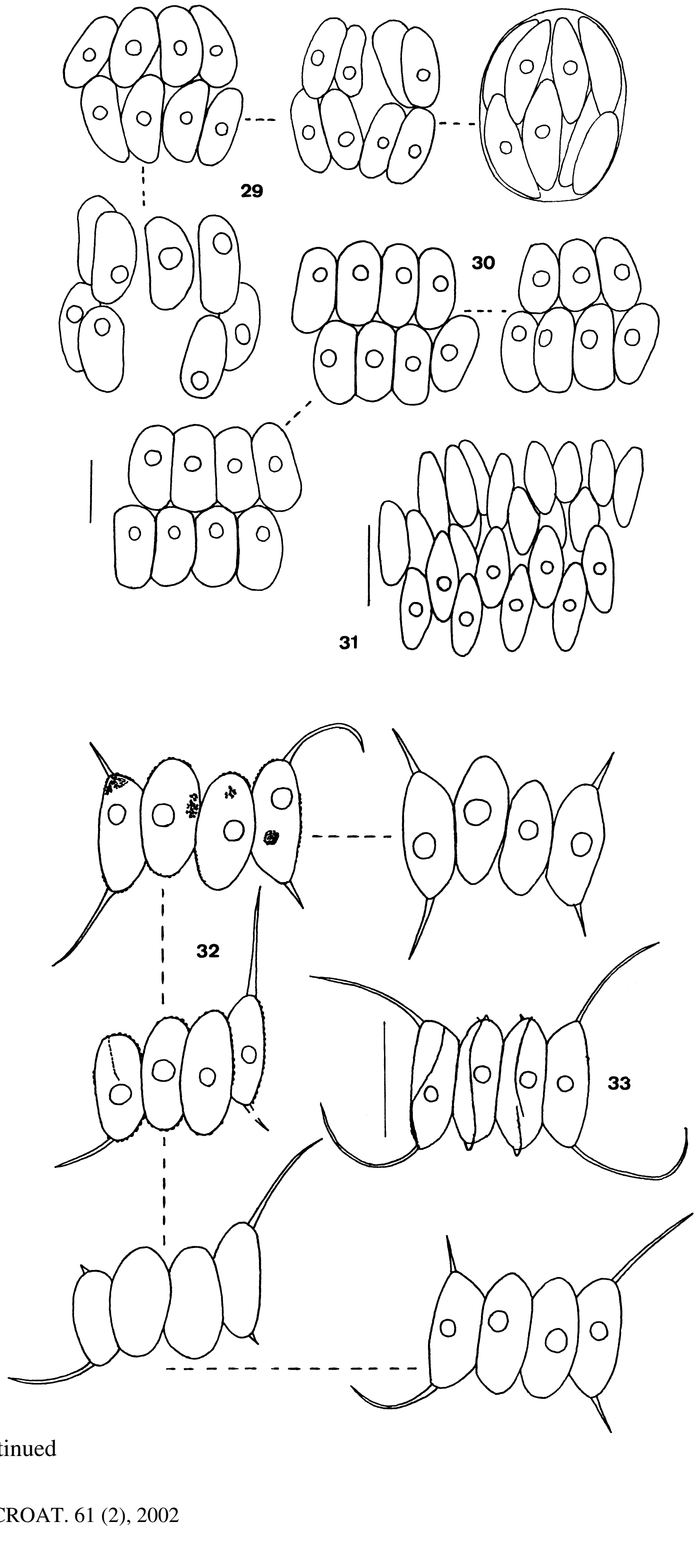

Fig. 2. – continued

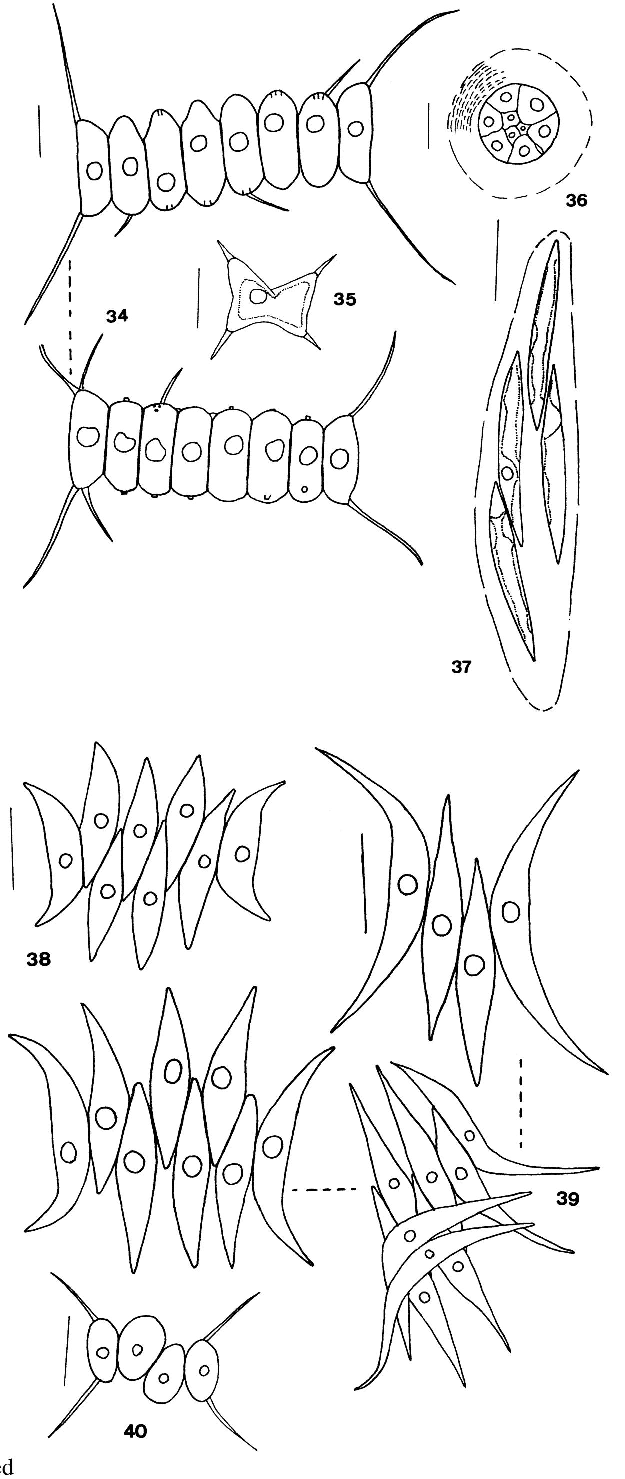

Fig. 2. – continued

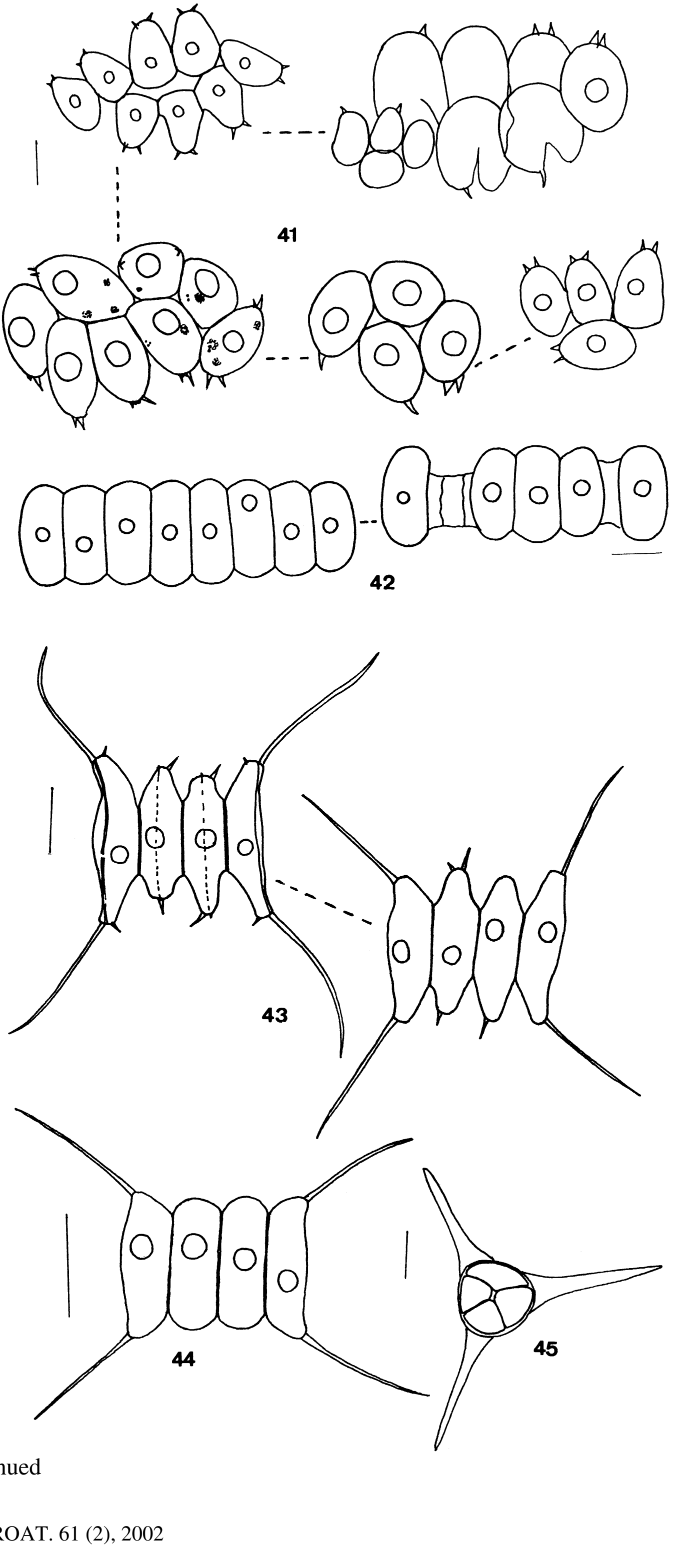

Fig. 2. – continued

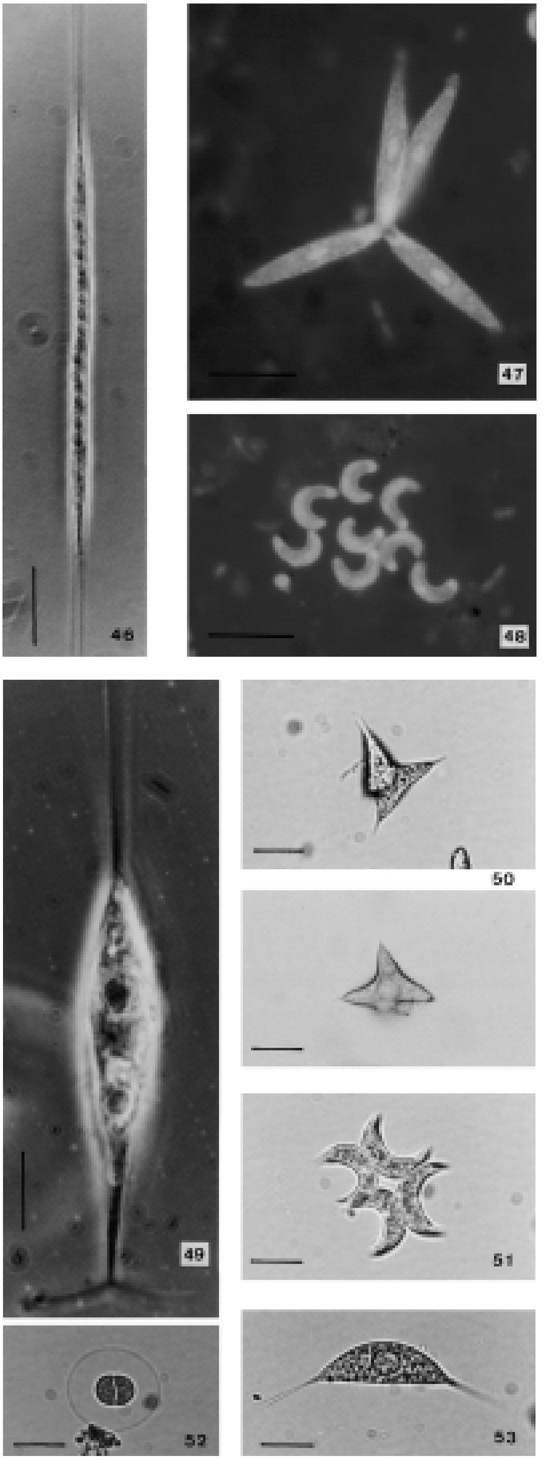

Fig. 2. – continued

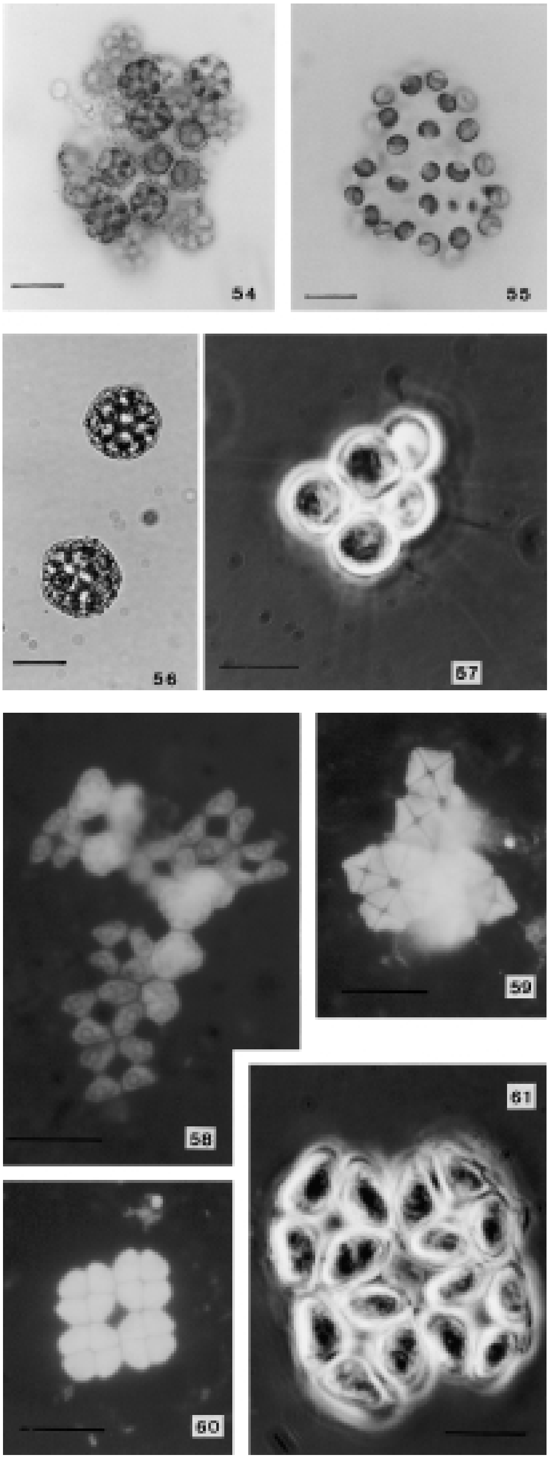

Fig. 2. – continued

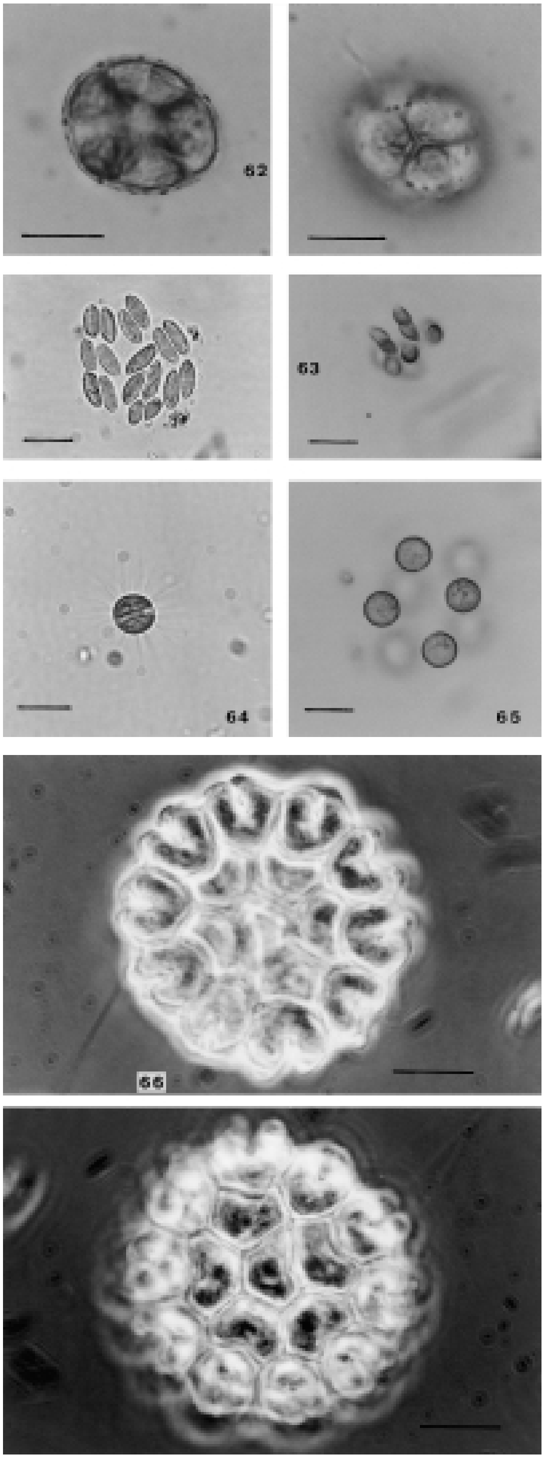

Fig. 2. – continued

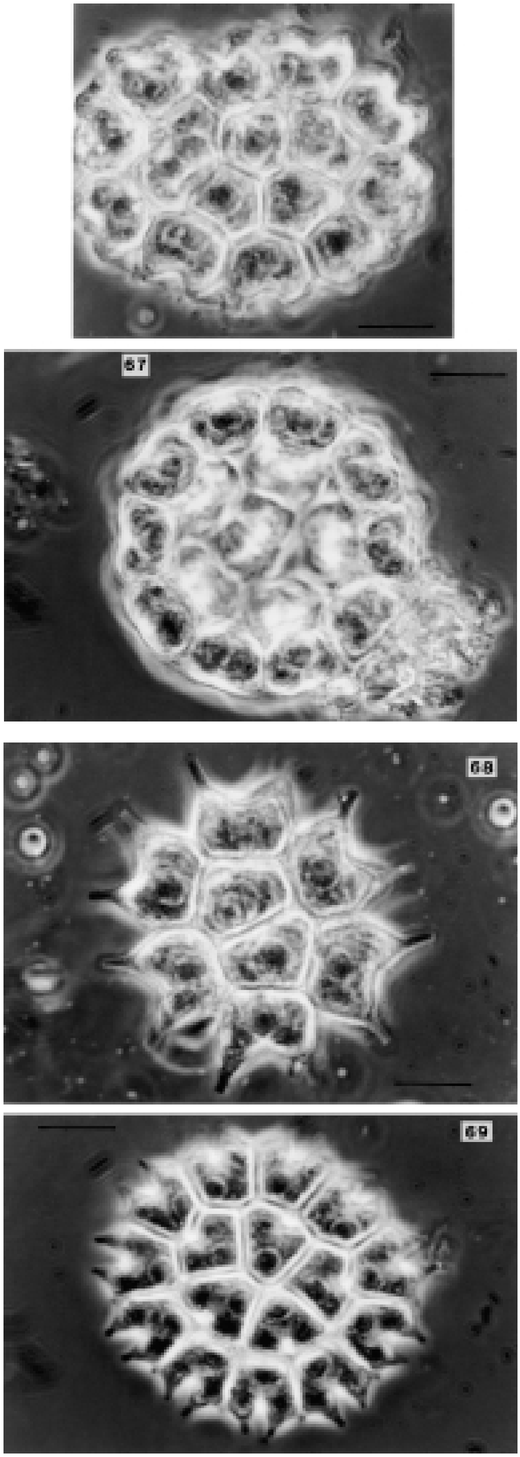

Fig. 2. – continued

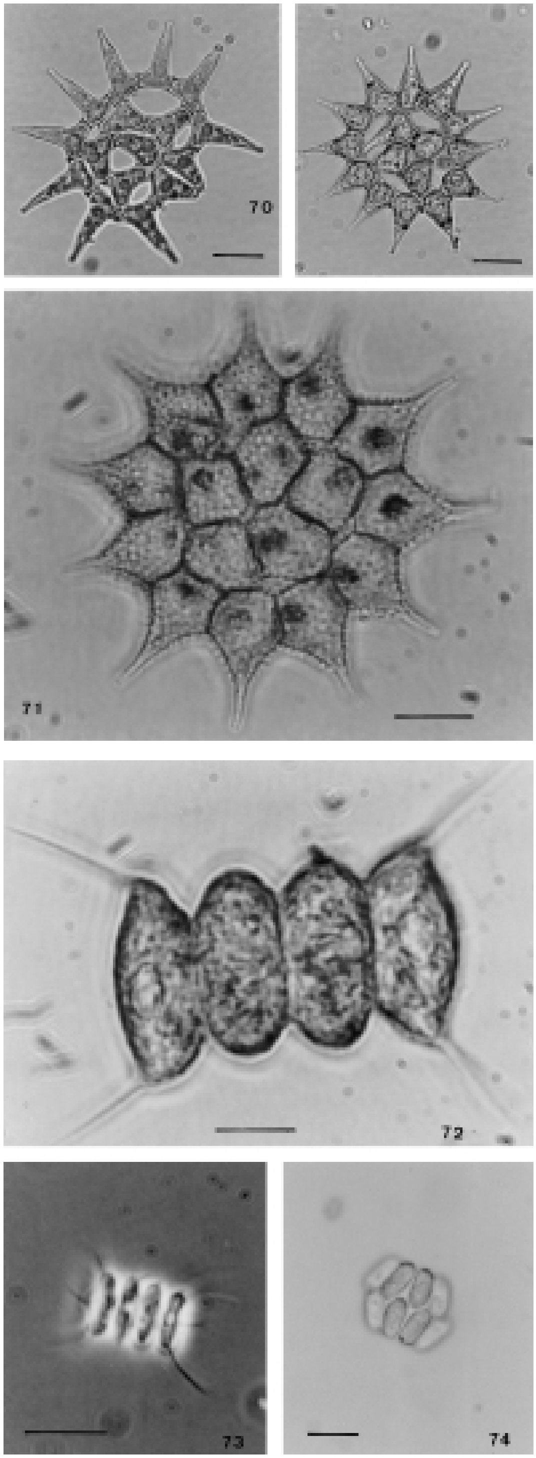

Fig. 2. – continued

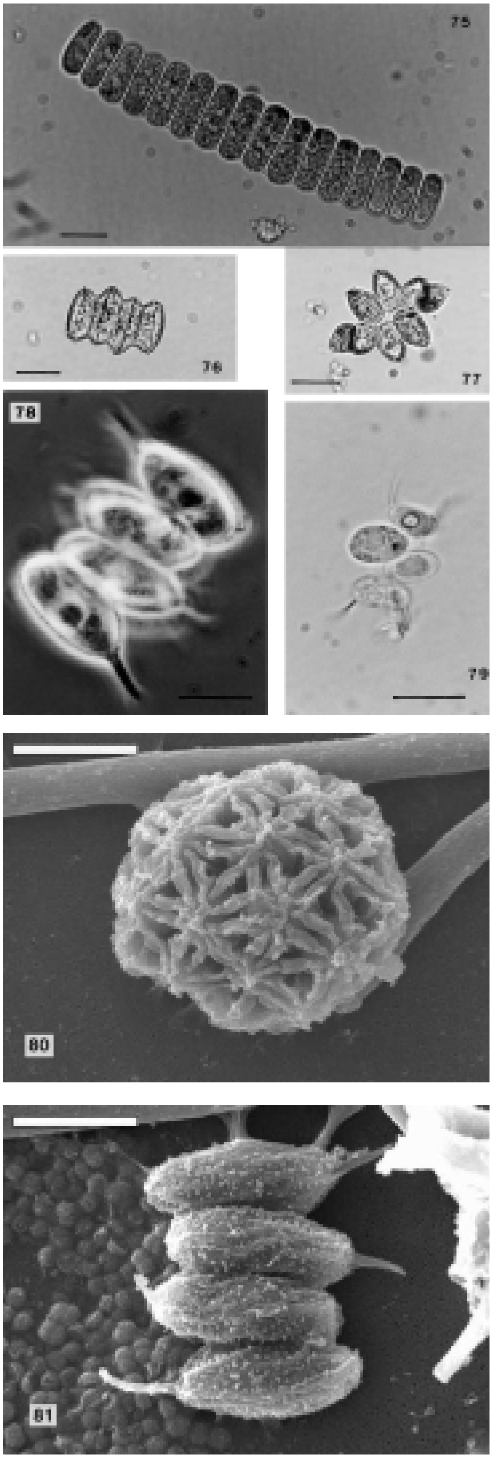

Fig. 2. – continued

Conclusion

Twelve species of chlorococcal algae were recorded for first time in Spain and 27 for the locality. *Scenedesmus* was the best represented genus with 16 taxa. In a comparison of observations with those of SABATER and MUÑOZ (1990), the following species were not observed in our samples: *Ankistrodesmus falcatus* (Corda) Ralfs, *Chlorella vulgaris* Beijerinck, *Dicellula planctonica* Svirenko, *Dictyosphaerium pulchellum* Wood, *Golenkiniopsis parvula* (Voronichin) Koršikov, *Kirchneriella subcapitata* Koršikov, *Quadrigula lacustris* (Chodat) G.M. Smith, *Q. quaternata* (W. et G.S.West) Printz, *Q. sabulosa* Hindák, *Radiococcus nimbatus* (De Wildemann) Schmidle, *Scenedesmus apiculatus* (W. et G.S. West) Chodat, *S. brevispina* (G.M. Smith) Chodat, *S. ellipsoideus* Chodat, *S. longispina* Chodat, *Schroederia indica* Philipose, *Tetraedron minimum* (A. Braun) Hansgirg, *Tetrastrum staurogeniaeforme* (Schröder) Lemmermann and *T. triangulare* (Chodat) Komárek.

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