Bollettino della Società Paleontologica Italiana, 45 (1), 2006, 35-42. Modena, 30 settembre 2006

Landereria decastroi n. gen., n. sp., a giant dasyclad (Chlorophyta) from the lower Aptian of eastern Spain

Antonietta CHERCHI & Rolf SCHROEDER

A. Cherchi, Dipartimento di Scienze della Terra, Università di Cagliari, Via Trentino 51, I- 09127 Cagliari (Italy); acherchi@unica.it
R. Schroeder, Forschungsinstitut Senckenberg, Senckenberg-Anlage 25, D-60325 Frankfurt am Main (Germany)

KEY WORDS - Chlorophyta, Dasycladales, Cretaceous, Aptian, Eastern Spain, Iberian Ranges.

ABSTRACT - A new dasyclad alga, Landereria decastroi *n. gen., n. sp., is described from the lower Aptian of Morella (Castellon province, Iberian Ranges, eastern Spain). The only weakly calcified thallus of this taxon is compared with morphologically similar dasyclads* (*Ordovician-Silurian* Cyclocrinites spaskii *Eichwald; Oxfordian-Kimmeridgian* Goniolina hexagona *d'Orbigny; Recent* Bornetella sphaerica *[Zanardini]) in order to get supplementary indications to the construction of this new form.*

RIASSUNTO - [*Landereria decastroi* n. gen., n. sp., una Dasicladale gigante dell'Aptiano inferiore della Spagna orientale] - *Viene descritto un nuovo taxon appartenente alle Dasicladali,* Landereria decastroi, *n. gen., n. sp., proveniente dall'Aptiano inferiore della regione di Morella (Provincia di Castellon, Catene Iberiche). Il tallo di questa forma, non è completamente calcificato: non sono conservati l'asse centrale, i peduncoli dei laterali e la parte distale delle vescicole terminali. Inoltre non è chiaro se i laterali nella loro parte distale si siano ramificati in laterali di secondo ordine.* Landereria decastroi *viene confrontato con altri taxa di Dasicladali morfologicamente simili (Ordoviciano-Siluriano,* Cyclocrinites spaskii *Eichwald; Oxfordiano-Kimmeridgiano,* Goniolina hexagona *d'Orbigny; Recente,* Bornetella sphaerica *(Zanardini)), allo scopo di ottenere indicazioni supplementari sull'architettura di questa nuova forma. La parte basale assai appiattita di* Landereria decastroi *potrebbe indicare che il tallo era direttamente ancorato sul fondo fangoso mediante un ciuffo di rizoidi.*

INTRODUCTION

More than twenty years ago, one of us (R.S.) received some enigmatic subspherical fossils exhibiting a fine, very regular reticulate pattern on their surface which were collected by the late Mr. Luis Milian in Aptian deposits north of Morella (Maestrat Basin, Iberian Ranges, E Spain). Later on, Dr. Xavier Querol and Dr. Carles Martín-Closas (University of Barcelona) found several other specimens in the environs of the same town.

During the III Coloquio del Cretácico de España (Morella, September 1991), organized by the Grupo Español del Mesozoico, we have already presented our specimens regarding them as a new taxon of dasyclad algae. However, a publication of our results still had yet to come. Now we describe this new dasyclad under the name *Landereria decastroi* n. gen., n. sp.

Landereria decastroi is only weakly calcified, so that several systematically important details are unfortunately unknown. For this reason we compare it with some morphologically similar and more completely calcified dasyclads (*Cyclocrinites* Eichwald, *Goniolina* d'Orbigny, *Bornetella* Munier-Chalmas) in order to get supplementary indications to the reconstruction of the new taxon. The ovoidal or spherical thallus of the latter three genera (e.g. *Cyclocrinites*; Fig. 4) was attached to the substrate by a central axis, which supported laterals radiating outwards in all directions and expanding at their distal ends to form lateral heads. These heads are hexagonal in outline and packed tightly together in a honeycomb-like fashion.

The studied material is stored in the collections of the Forschungsinstitut und Museum Senckenberg (Frankfurt am Main) under the numbers SM.B 20853 to 20860.

GEOLOGICAL AND STRATIGRAPHICAL SETTING

The lower Cretaceous sediments in the environs of Morella are predominantly marine shallow-water carbonates that were deposited during a late Oxfordian-late Albian rifting episode within the Mesozoic intracratonic Maestrat Basin situated in the eastern part of the Iberian Ranges (NE Spain) (Salas & Guimerà, 1997; Salas et al., 2001). In this connection the early Cretaceous megasequence developed, formed by at least 10 depositional sequences (Salas et al., 1995).

A first detailed stratigraphic description of the region of Morella, largely considering micropaleontologic data, was presented by Marie (1964). Canérot et al. (1982) introduced formal names for the different Cretaceous formations and members in the Maestrat Basin.

The Aptian in the environs of Morella is at present subdivided into four lithostratigraphic units representing the depositional sequences K1.8 and K1.9 (Salas et al., 2001; Martín-Closas & Salas, 2003):

4. Villarroya de los Pinares Formation

ISSN 0375-7633

3. Forcall Formation
2. Xert Formation
1. Morella Formation
Base: Artoles Formation (Barremian)

The lowermost Aptian Morella Formation, characterized by a tidally dominated low-stand delta complex is followed by shallow-water carbonate platform sediments (Xert to Villarroya de los Pinares Formation) frequently bearing abundant larger foraminifers (*Palorbitolina*, *Choffatella*) as well as calcareous algae and rudists.

The predominantly marly Forcall Formation was subdivided by Canérot et al. (1982) in the environs of Morella into three members:

3. Margas de Morella la Vella Member (=Marnes à Plicatules *in* Marie, 1964; 65 m). The fossiliferous sites Morella la Vella and Forcall have yielded ammonites of the middle part of the lower Aptian (*Deshayesites deshayesi* Zone): *Deshayesites consobrinoides* (Sinzow), *D. deshayesi* d'Orbigny, *Pseudosaynella bicurvata* (Michelin), *P.* cf. *raresulcata* (Leymerie), *Pseudohaploceras* sp. ex gr. *liptoviense* (Zeus.), *Cheloniceras* ex gr. *cornuelianum* and *Valdedorsella* sp. (Marie, 1964; Marin & Sornay, 1971; Martinez et al., 1994). In addition, Marin & Sornay (1971) cited *Cheloniceras* (*Epicheloniceras*) *martini* (d'Orbigny), found below the Villarroya de los Pinares Formation and indicating a late Aptian age for the uppermost part of the Morella la Vella Member.

2. Barra de Morella Member (20 m), supporting a large part of the city-wall of Morella. Beige bioclastic limestone with abundant Palorbitolinas.

1. Margas de Cap de Binet [= Vinyet] Member (? 30 m). Beige marls and marly limestone.

According to Martinez et al. (1994), the basal part of the Forcall Formation has yielded in the Oliete Subbasin, north of Morella, some species of *Deshayesites* (*D. spathi, D. euglyphus*) indicating an early Aptian age (*Deshayesites forbesi* Zone).

The specimens of *Landereria decastroi* studied in this paper were found in the Margas de Cap de Vinyet Member. Marly sediment attached to one of the specimens from the type locality contains *Palorbitolina lenticularis* (Blumenbach) and *Choffatella decipiens*.

LOCALITIES

Landereria decastroi was found at three locations situated on sheet Morella (no. 545) of the Mapa Geológico de España 1:50,000 (Fig. 1).

(1) Type locality. The specimens found by L. Milian (SM.B 20853 to SM.B 20855, SM.B 20857, SM.B 20859, SM.B 20860) come from "Mas del Cap de Vinyet", a farmhouse two kilometers northwest of Morella, near the way to Morella la Vella. This locality could be identical with the fossiliferous site, located 300 m west of Mas del Cap de Vinyet, marked by Marie (1964) on his geological map 1:25,000 of the Morella region. The coordinates of this site are: lat. 40°38'03"N, long. 0°07'02"W.

(2) The two specimens (SM.B 20856, SM.B 20858) received from X. Querol were found near the Ermita de Santa Lucia, about 400 m north of Morella. The coordinates of this site are: lat. 40°37'02"N; long. 0°06'00"W.

(3) C. Martín-Closas informed us that several specimens (not studied in this paper) were found on the western slope of the Barranc de la Penella, 1 km west of Morella. The coordinates of this site are: lat. 40°37'11"N; long. 0°06'58"W.

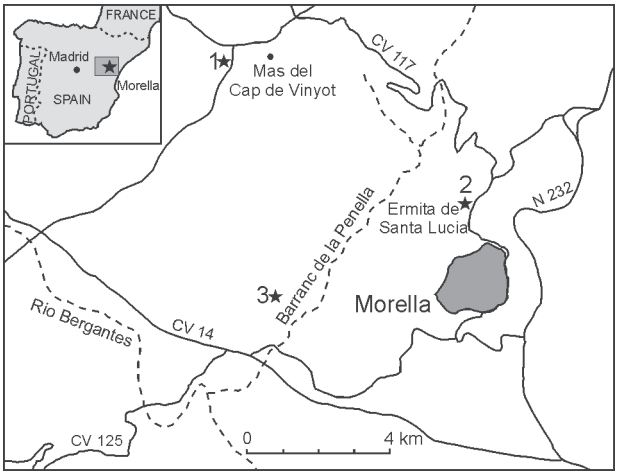

Fig. 1 - Sites with *Landereria decastroi* in the environs of Morella (Castellon province, eastern Spain). 1) Mas del Cap de Vinyet; 2) Ermita de Santa Lucia; 3) Barranc de la Penella.

DESCRIPTION OF *LANDERERIA DECASTROI*

Order Dasycladales Pascher, 1931
Family Dasycladaceae Kützing, 1843
Genus *Landereria* n. gen.

Type species - *Landereria decastroi* n. sp.

Derivation of name - In memory of José Joaquín Lánderer (1841-1922; Gozalo Gutiérrez & Navarro Brotons, 1995), who proposed to combine the Urgonian and the Aptian on the basis of faunistical arguments by introducing (1874) in eastern Spain the new stage Tenencian ("piso tenéncico").

Diagnosis - See diagnosis of the type species *Landereria decastroi* n. sp.

Landereria decastroi n. sp.
(Figs. 2a-c, 3a-c)

Derivation of name - We dedicate the new species to our dear friend and colleague Piero de Castro, Professor of Micropaleontology at the University Federico II, Napoli, Italy.

Material - Eight specimens; from two of them 16 thin sections were made. Specimens and thin sections are stored in the collections of the Forschungsinstitut Senckenberg, Frankfurt am Main (SM.B 20853 to 20860).

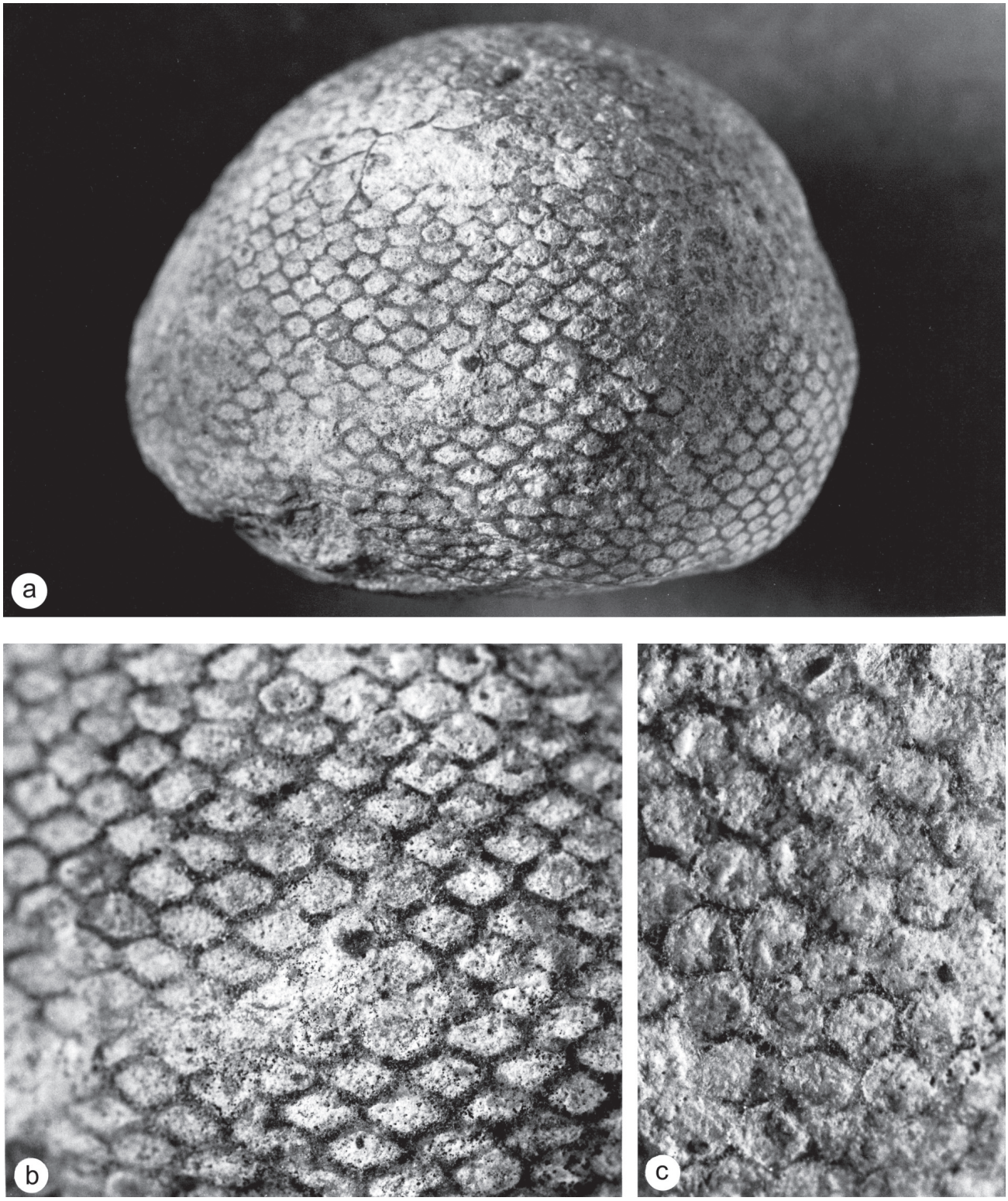

Fig. 2 - *Landereria decastroi* n. gen., n. sp. Mas del Cap de Vinyet, Morella (Castellon province, eastern Spain). Lower Aptian. Holotype (SM.B 20857). a) Lateral view, x 4.8. b) Detail of Fig. 2a showing the pattern of the heads, x 8.4. c) Pattern of the heads in the apical region of the thallus, x 13.

Holotype - Isolated specimen (SM.B 20857), illustrated in Fig. 2a-c.

Type locality - Mas del Cap de Vinyet, north of Morella (Castellon province, Eastern Spain).

Type horizon - Margas de Cap de Vinyet Member, Forcall Formation.

Age - Early Aptian.

Diagnosis - Thallus wider than high. Upper side regularly vaulted; lower side flattened showing a central morphological depression. Heads of the laterals with hexagonal outline generally wider than high, but isometric in the apical area of the thallus. Central axis, shafts of the laterals and distal parts of the heads not calcified and therefore unknown.

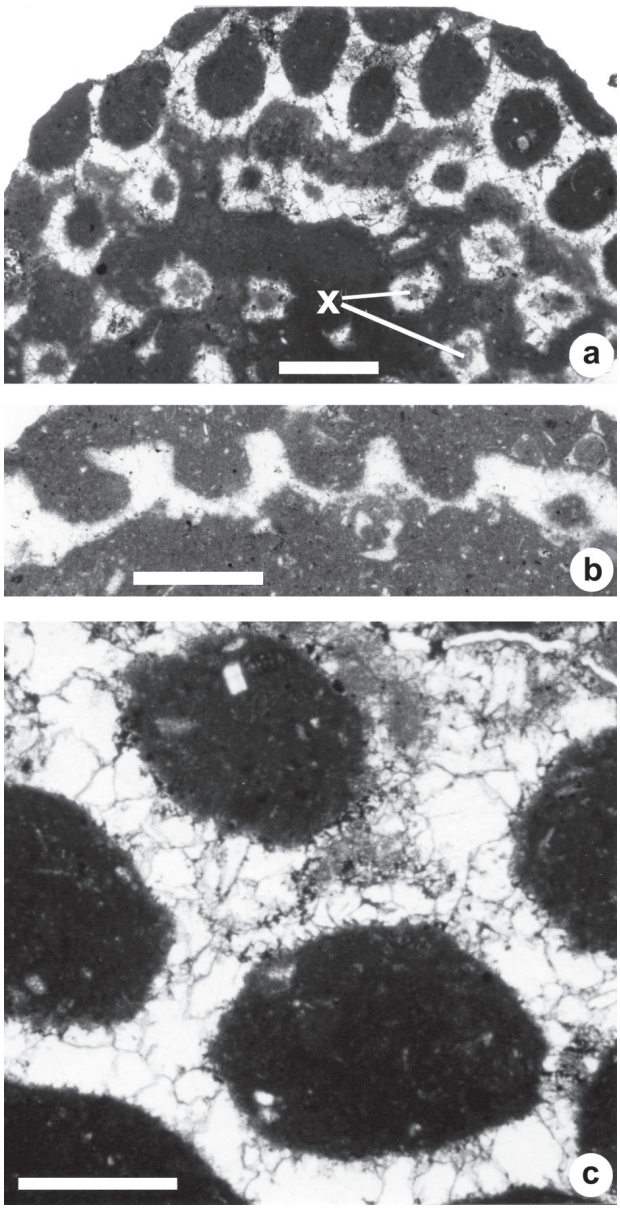

Fig. 3 - *Landereria decastroi* n. gen., n. sp. - Mas del Cap de Vinyet, Morella (Castellon province, eastern Spain). Lower Aptian.
a) Oblique tangential section through the calcified head layer of a thallus. The two white lines (x) point to small holes in the centre of the bottoms, corresponding to the insertion of the uncalcified shafts of the laterals. SM.B 20860/10. Scale bar = 1 mm.
b) Vertical section through a part of the head layer. SM.B 20856/5. Scale bar = 1 mm.
c) Tangential section through some heads. SM.B 20860/1. Scale bar = 0.5 mm.

Description

Shape - The always incompletely calcified thallus of *Landereria decastroi* is characterized by a cushion-like skeleton enclosing a central cavity. The upper side of the thallus is regularly vaulted, the lower side is distinctly flattened (Fig. 2a) showing a pronounced central depression.

Measurements of the thallus - The thallus is always wider than high. Its diameter (measured on 6 specimens) ranges between 17 and approx. 23 mm; its height ranges between 12.5 and 19 mm.

specimen	breadth (in mm)	height (in mm)
SM.B 20857 (holotype)	approx. 23	19
SM.B 20853	19	16.5
SM.B 20854	23	approx. 18
SM.B 20855	17	12.5
SM.B 20858	19	18.5
SM.B 20859	21	17.5

Skeleton - The preservation of *Landereria decastroi* is in the typical mosaic calcite (Fig. 3c), characteristic of originally aragonitic skeletons.

The interior of the subspherical skeleton is completely filled with micrite sometimes containing rare microfossils and fragments of larger shells, which obviously came in through an opening situated in the centre of the basal depression of the thallus. However, this opening was not observed, because the depression is always covered with sediment. The central axis and the shafts of the laterals were obviously not calcified and are therefore not preserved.

The surface of the skeleton exhibits a very regular pattern of cup-like depressions with hexagonal outline (Fig. 2a) corresponding to the proximal part of the heads. They are arranged in horizontal rows alternating in position from one row to the next (Fig. 2b). Generally, the hexagons are wider than high becoming, however, more and more isometric towards the apical region of the skeleton (Fig. 2c). Their dimensions depend on the size of the thallus. In the large holotype (SM.B 20857) they are 1.2 mm wide and 0.65-0.75 mm high, with a diameter of 0.8 mm in the apical region. The hexagons of the smallest specimen (SM.B 20855), however, are only 1.0 mm wide and 0.6 mm high; in the apical region they have a diameter of 0.65 mm. In somewhat deeper sections parallel to the surface of the skeleton, the depressions show an irregularly oval outline (Fig. 3c). The bottom of the depressions is evenly vaulted merging into the clearly thicker lateral walls (Fig. 3b). A small circular hole in the centre of the bottoms (Fig. 3a) indicates the insertion of an uncalcified and therefore not observed shaft of a lateral branch.

MORPHOLOGICALLY SIMILAR DASYCLADS

The weak calcification of the thallus of *Landereria decastroi* allows us to compare this new taxon with other morphologically similar and more completely preserved dasyclads, with the aim to get further

structural information. As a model of Ordovician-Silurian cyclocrinitids we have chosen the genus *Cyclocrinites*, whose type species *C. spaskii* Eichwald was carefully described by Nitecki & Spjeldnaes (1992). As an example of Jurassic spherical or claviform dasyclads (Fischer & Thierry, 1971; Bassoullet et al., 1978) we discuss *Goniolina hexagona* d'Orbigny (middle Oxfordian-Kimmeridgian). Finally, *Bornetella sphaerica* (Zanardini) gains an insight into the architecture of a recent spherical dasyclad.

Cyclocrinites spaskii Eichwald, 1840

The reconstruction of this species presented by Nitecki & Spjeldnaes (1992) shows a globular or somewhat ovate thallus, which is attached to the substrate by a peduncle (Fig. 4a). The thallus consists of a short and vertically directed central axis, around which unbranched laterals are regularly arranged in whorls (Fig. 4c). Each lateral shows a thin, tubular shaft, which suddenly expands at its distal end (Fig. 4b) to form a head with more or less hexagonal outline, for which Spjeldnaes & Nitecki (1990) have introduced the term "globellum". The distal surface of a globellum, named "cribellum" by Nitecki & Spjeldnaes (1992), is characterized by a complex system of pores and ribs.

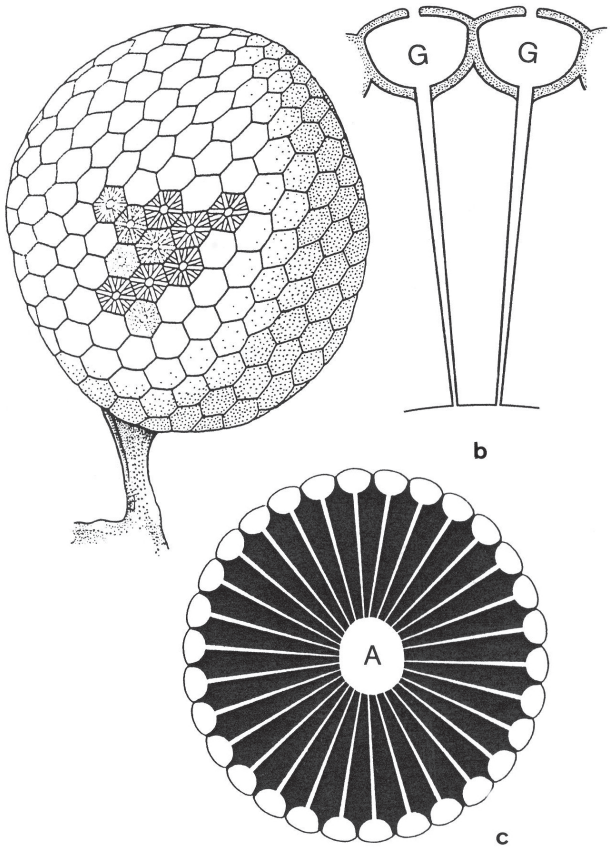

Fig. 4 - Diagrammatic reconstruction of *Cyclocrinites spaskii* Eichwald, 1840.
a) Shape of thallus. b) Two lateral branches consisting of thin shaft and globellum (G) with a cribellum (calcification shown by shaded areas). c) Transversal section through a thallus (A: main axis). From Nitecki & Spjeldnaes (1992, fig. 1), slightly modified.

The position of the gametophores is unknown: Nitecki & Spjeldnaes (1992) assumed that they were located in the globella.

Just as in *Landereria decastroi*, also the thallus of *Cyclocrinites* is generally incompletely calcified. The central axis is very rarely preserved and the shafts of the laterals are only occasionally calcified (e.g. Beadle, 1991, fig. 2c; Nitecki & Spjeldnaes, 1992, fig. 15). The distal parts of the heads (resp. globella) are normally lacking, but the proximal parts are always preserved and form in their entirety a very regular pattern of cuplike depressions, frequently showing an aperture at their bottoms.

Goniolina hexagona d'Orbigny, 1850

For a long time, this taxon was described and cited under the name *Goniolina geometrica* (e.g. Bassoullet et al., 1978). However, Cherchi & Schroeder (1992) demonstrated that the holotype of the latter species, established by Roemer (1839) under the name "*Chama* (?) *geometrica*", is the upper valve of an oyster encrusting a *Goniolina* thallus and showing as a xenomorphic sculpture the hexagonal pattern of the surface of the dasyclad.

The thallus of *G. hexagona* is ovoidal (Fig. 5a) with a diameter up to 28 mm (lectotype; Cherchi & Schroeder, 1993, fig. 3). It is attached to the substrate with a well-developed peduncle (von Seebach, 1864, pl. 2, fig. 1), whose proximal end is visible at the base of the specimens depicted in Figs. 5a and 5c.

The diagrammatic reconstruction of the architecture of this species, presented by Pia (1920, fig. 21; 1927, fig. 58) and adopted in several treatises (e.g. Bassoullet et al., 1978, pl. 11, fig. 7; Berger & Kaever, 1992, fig. 2.19a:f) is based upon a drawing of a fragment, made by de Saporta (1891, pl. 258, fig. 3). This sketch shows a group of broad tubes with circular outline, which are separated one another by thin walls. Pia (1920) took the view that the tubes represent very voluminous laterals in the form of elongated ampoules containing the gametes (cladospore gamete production). On the contrary, our revision of the type material of *G. hexagona* stored in the Muséum d'Histoire Naturelle (Paris) has shown (Cherchi & Schroeder, 1993) that the "walls" (in the sense of Pia) correspond to very thin and hollow laterals, whereas the large "tubes" represent the spaces between the laterals, filled with muddy sediment (Fig. 5b).

The scars observed on the surface of a fragment of the central axis (Cherchi & Schroeder, 1993, fig. 8) represent the insertion points of the laterals, which are arranged in whorls (euspondyl type) and in alternating position from one whorl to the next (as in a schematic drawing published by de Castro, 1997, fig. 12D). Branching into secondary laterals was not directly observed; this point needs further studied. The heads of the laterals exhibiting a hexagonal outline are delimited in the specimens from Pomerania (Cherchi & Schroeder, 1992) by a very thin (0.02 mm) calcareous wall (Fig. 5d).

Each lateral is surrounded by a layer of densely packed and irregularly distributed small globular hollows (Fig. 5b) representing without doubt the gametophores

(choristospore gamete production), which communicate with the laterals by a simple aperture.

Bornetella sphaerica (Zanardini, 1878)

This recent species, living in the Indian and Pacific Ocean (Berger & Kaever, 1992), exhibits a spherical to subspherical thallus with a diameter of 6-10 mm (Fig. 6a). 10-14 successive whorls of long and slim primary laterals originate from a relatively short axis, which is sharp on both ends. The somewhat swollen distal ends of these laterals branch into 4-7 very short secondary laterals (Fig. 6a, upper right quadrant), which expand to form a cortex of heads with hexagonal outer surface (Fig. 6a, lower right quadrant). 4-12 gametophores

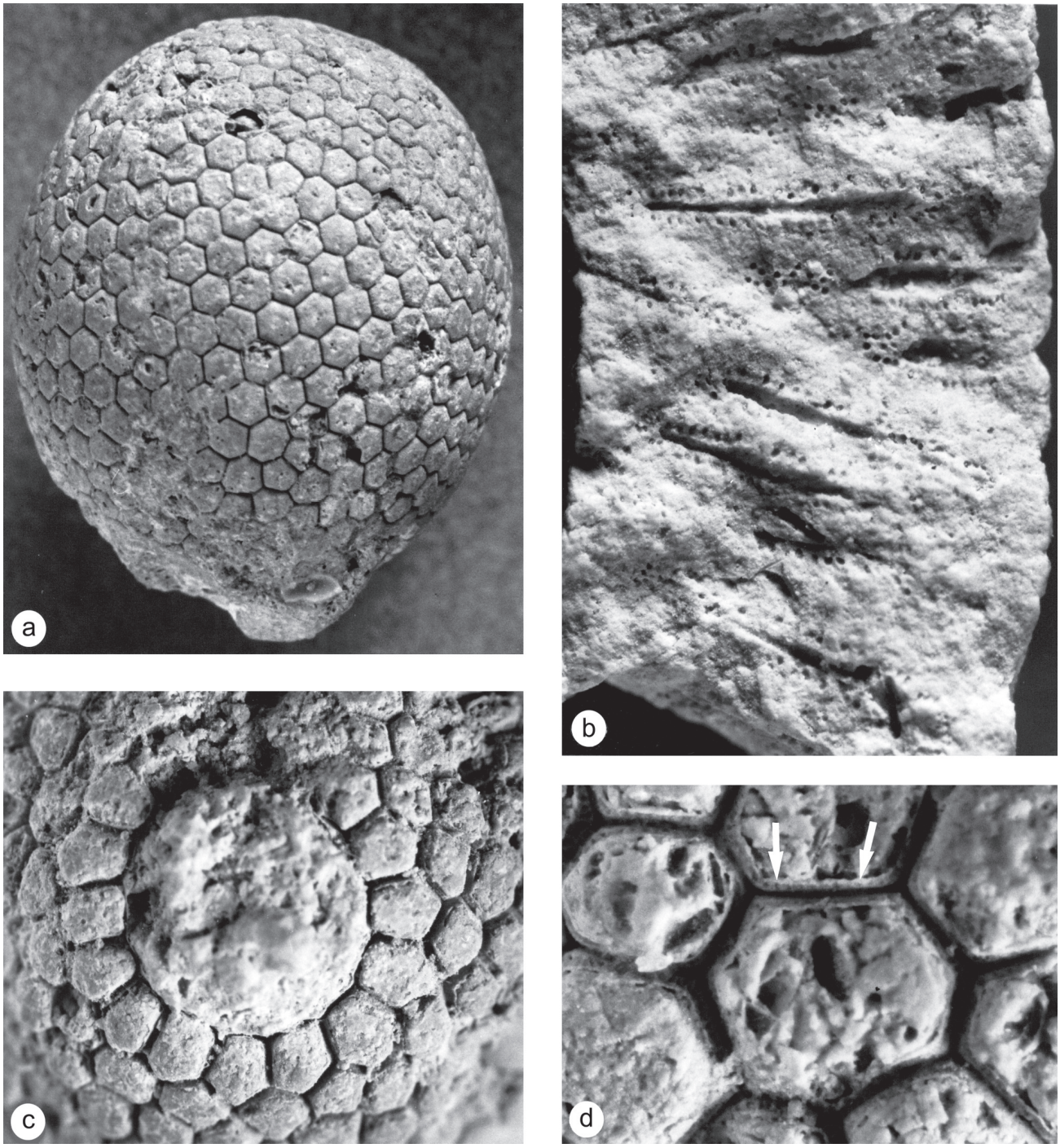

Fig. 5 - *Goniolina hexagona* d'Orbigny, 1850. Kimmeridgian.
a) Shape of thallus, lateral view, x 8. Trzebieszewo (Tribsow), Pomerania, NW Poland. Geological Institute, University of Greifswald, Germany. b) Laterals with attached gametophores (right border: surface of the thallus; left border: surface of the central axis), x 9.7. Pointe du Ché (Charente Maritime, SW France). Laboratoire de Paléobotanique, Muséum d'Histoire Naturelle, Paris (d'Orbigny collection, no. 4569). c) Base of a thallus showing the insertion of the peduncle, x 12. Wrzosowo (Fritzow) Pomerania, NW Poland. Geological Institute, University of Greifswald, Germany. d) Eroded surface of some heads (the arrows point to the very thin outer wall of a head), x 31. Wrzosowo (Fritzow) Pomerania, NW Poland. Geological Institute, University of Greifswald, Germany.

sitting on small stalks are attached to each primary lateral (Fig. 6b). Outside of the cortex, a bunch of rhizoids originates from the lower end of the central axis (Fig. 6a, lower left quadrant).

The ontogenetic development of subspheric forms of *Bornetella* was studied by Valet (1968).

CONCLUSIONS

The foregoing short description of morphological similar and sometimes more completely calcified dasyclads allows to draw some conclusions with regard to the structure of *Landereria decastroi.*

Apparently, there are relationships between the shape of the thallus and the mode of attachment to the substrate. Adult specimens of spherical forms like *Cyclocrinites spaskii* or ovoidal species similar to *Goniolina hexagona* exhibit a well-developed peduncle with probably short rhizoids at their lower end. On the contrary, adult specimens of *Bornetella sphaerica* showing a slight central morphological depression on their flattened base (Fig. 6a; Berger & Kaever, 1992, fig. 3.30a) develop only a bunch of rhizoids. It is

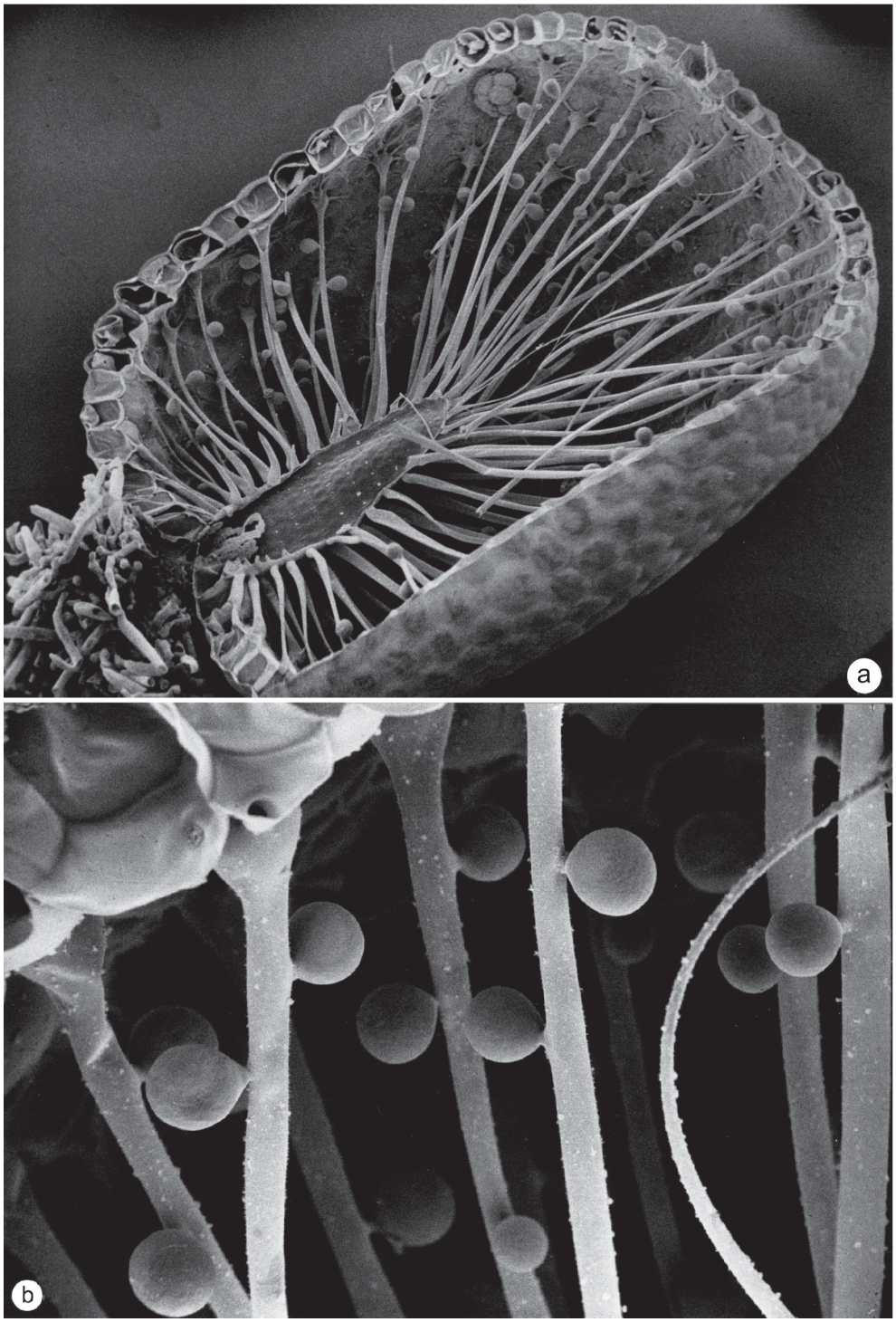

Fig. 6 - *Bornetella sphaerica* (Zanardini, 1878). Laboratory culture of the Max-Planck-Institute for Cell Biology, Ladenburg/Heidelberg, Germany.
a) Longitudinal section, x 16; b) Gametophores sitting on small stalks attached to the laterals, x 125. Photographs made available by Dr. Sigrid Berger, Ladenburg.

therefore very probable that also the cushion-like thallus of *Landereria decastroi* did not develop a peduncle, but was directly lying with its flattened base on the bottom and anchored with rhizoids in the sediment. Nitecki (1970) came to similar conclusions for the mode of life of cushion-shaped cyclocrinitids.

According to the shape of the thallus, the central axis of *Landereria decastroi* was relatively short and generally uncalcified. Corresponding to the arrangement of the heads, being visible on the surface of the thallus, the uncalcified laterals were arranged in whorls (euspondyl type) alternating from one whorl to the next as in *Goniolina hexagona*. The gametophores were probably attached to the laterals (choristophore gamete production) as in *Bornetella sphaerica* and *Goniolina hexagona*. It is uncertain, whether the laterals distally branched into shorter secondary laterals, but in view of the high number of relatively small heads such a branching seems possible.

The absence of a calcareous wall bordering outwards the heads of *Landereria decastroi* could be explained either by subsequent erosion or as an original character. In this respect, it is noteworthy that in the recent genus *Bornetella* only the sidewalls of the heads are calcified (Valet, 1969; Berger & Kaever, 1992). Thread-like bryozoans encrusting the open heads of the holotype of *Landereria decastroi* (Fig. 2a, upper left quadrant) suggest that also the heads of this species were limited outwards by an uncalcified membrane.

ACKNOWLEDGEMENTS

We thank Dr. Xavier Querol and Dr. Carles Martín-Closas (University of Barcelona), which made some specimens of *Landereria decastroi* available to us, resp. informed us on the discovery of this species west of Morella. We thank Prof. Filippo Barattolo (University of Napoli) and Dr. Marc Conrad (Genève) for the review of the text.

REFERENCES

Bassoullet J.P., Bernier P., Conrad M.A., Deloffre R. & Jaffrezo M. (1978). Les Algues Dasycladales du Jurassique et du Crétacé. *Géobios*, *Mémoire spécial*, 2: 1-330.

Berger S. & Kaever M.J. (1992). Dasycladales. An illustrated monograph of a fascinating algal order. 247 pp. Georg Thieme Verlag, Stuttgart, New York.

Canérot J., Cugny P., Pardo G., Salas R. & Villena J. (1982). Ibérica Central-Maestrazgo. *In* Grupo Español de Trabajo. Proyecto no. 58. Mid Cretaceous Events (ed.), El Cretácico de España: 273-343. Universidad Complutense de Madrid.

Castro P. de (1997). Introduzione allo studio in sezione sottile delle Dasicladali fossili. An approach to the thin-section study of fossil Dasycladales. *Quaderni dell'Accademia Pontaniana*, 22: 1-261.

Cherchi A. & Schroeder R. (1992). *Goniolina hexagona* d'Orbigny [Dasycladaceae] aus dem Kimmeridge vom Südrand der Pommerschen Bucht. *Zeitschrift für geologische Wissenschaften*, 20 (1-2): 3-26.

Cherchi A. & Schroeder R. (1993). Nouvelles observations sur *Goniolina hexagona* d'Orbigny. Algue Dasycladale du Kimméridgien. *Paläontologische Zeitschrift*, 67 (3-4): 239-244.

Fischer J.-C. & Thierry J. (1971). Révision de quelques Dasycladacées jurassiques et proposition d'un nouveau genre: *Coniporella*. *Bulletin du Muséum national d'Histoire naturelle de Paris*, 3ième série, section 3 (Sciences de la Terre), 19: 25-34.

Gozalo Gutiérrez R. & Navarro Brotons V. (1995). Geología y Paleontología en la obra de José Joaquín Lánderer. *In* Actes de les III trobades d'història de la ciència i de la tècnica als paisos catalans. Barcelona: 163-171.

Instituto Geológico y Minero de España (1973). Mapa Geológico de España 1:50.000. Sheet Morella (no. 545).

Landerer J.J. (1874). El piso tenéncico ó urgo-áptico y su fauna. *Anales de la Sociedad Española de Historia Natural*, 3 (3): 345-386.

Marie J. (1964). Étude stratigraphique et micropaléontologique de la région de Morella (Province de Castellon Espagne). Diplôme d'études supérieures (unpublished), Université de Dijon, Faculté des Sciences. 108 pp.

Marin P. & Sornay J. (1971). Précisions sur l'âge des formations aptiennes aux confins de l'Aragón et du Maestrazgo (Provinces de Teruel et Castellón de la Plana, Espagne). *Compte rendu sommaire des Séances de la Société géologique de France*, 1971 (3): 165-167.

Martín-Closas C. & Salas R. (2003). XIX Jornadas de la Sociedad Española de Paleontología (Morella, 16-18 de Octubre de 2003). Guía de la excursión. 31 pp.

Martínez R., Grauges A. & Salas R. (1994). Distribución de los ammonites del Cretácico inferior de la Cordillera Costera Catalana e Ibérica Oriental. *In* Salas R. & Martín-Closas C. (eds.), Estratigrafía del Cretácico de la Península Ibérica II. *Cuadernos de Geología Ibérica*, 18: 337-394.

Nitecki M.H. (1970). North American cyclocrinitid algae. *Fieldiana Geology*, 21: I-XIII, 1-128.

Nitecki M.H. & Spjeldnaes N. (1992). *Cyclocrinites spaskii*. A model of cyclocrinitid morphology. *Institutt for Geologi Universitetet i Oslo, intern skriftserie*, 63: 1-69.

Pia J. von (1920). Die Siphoneae verticillatae vom Karbon bis zur Kreide. *Abhandlungen der zoologisch-botanischen Gesellschaft Wien*, 11: 1-263.

Pia J. (1927). Thallophyta. *In* Hirmer M. (ed.) Handbuch der Paläobotanik, 1 (Thallophyta-Bryophyta-Pteridophyta), Verlag Oldenbourg, München, Berlin: 31-136.

Roemer F.A. (1839). Die Versteinerungen des norddeutschen Oolithen-Gebirges. Ein Nachtrag. 59 pp., Hannover.

Salas R. & Guimerà J. (1997). Estructura y estratigrafía secuencial de la Cuenca del Maestrazgo durante la etapa de rift jurásica superior-cretácica inferior (Cordillera Ibérica oriental). *Boletín geológico y minero*, 108 (4): 393-402.

Salas R., Guimerà J., Mas R., Martín-Closas C., Meléndez A. & Alonso A. (2001). Evolution of the Mesozoic Central Iberian Rift System and its Cainozoic inversion (Iberian Chain). *In* Ziegler P.A., Cavazza W., Robertson A.H.F. & Crasquin-Soleau S. (eds.), Peri-Tethys Memoir: Peri-Tethyan Rift/Wrench Basins and Passive Margins. *Mémoires du Muséum national d'Histoire naturelle*, 186: 145-185.

Salas R., Martín-Closas C., Querol X., Guimerà J. & Roca E. (1995). Evolución tectonosedimentaria de las Cuencas del Maestrazgo y Aliaga-Penyagolosa durante el Cretácico inferior. *In* Salas R. & Martín-Closas C. (eds.), El Cretácico inferior del nordeste de Iberia. Guía de campo de las excursiones científicas realizadas durante el III Coloquio del Cretácico de España. Morella, 1991: 13-47, Publicacions Universitat Barcelona.

Saporta G. de (1891). Plantes jurassiques. *In* Paléontologie française ou description des fossiles de la France, série 2 (Végetaux), 4: 1-547.

Seebach K. von (1864). Der Hannoversche Jura. 158 pp. Wilhelm Hertz, Berlin.

Spjeldnaes N. & Nitecki M.H. (1990). Anatomy and relationship of the Ordovician algal genus *Apidium*. *Institutt for Geologi Universitetet i Oslo*, *intern skriftserie*, 61: 1-37.

Valet G. (1968). Contribution à l'étude des Dasycladales. 1. Morphogenèse. *Nova Hedwigia. Zeitschrift für Kryptogamenkunde*, 16 (1-2): 21-82.

Valet G. (1969). Contribution à l'étude des Dasycladales. 2-Cytologie et reproduction, 3- Révision systématique. *Nova Hedwigia. Zeitschrift für Kryptogamenkunde*, 17: 551-644.

Manuscript received 15 January 2006
Revised manuscript accepted 13 May 2006