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Morphological, karyological and phytogeographic observations on *Entosthodon curvisetus* (Schwager.) C. Müll. as a basis for a new genus, *Funariella* Sérgio (Funariaceae: Musci)

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Abstract. Based on comparative studies of sporophyte characters such us capsule morphology, seta length, arrangement of cells in the operculum, absence of peristome, spore morphology and chromosome number (n=5) a new genus has been proposed, *Funariella* Sérgio for the Funariaceae. The european material of *F. curviseta* has been revised and the ecology and general distribution are discussed briefly.

Resumen. *Observaciones morfológicas, cariológicas y fitogeográficas sobre* Entosthodon curvisetus *(Schwaegr.) C. Müll. como base para la descripción de un género nuevo* Funariella *Sérgio (Funariaceae: Musci).* Se propone un nuevo género, *Funariella* Sérgio, en base al estudio comparativo de los caracteres del esporófito tales como la morfología de la cápsula, longitud de la seta, disposición de las células del opérculo, ausencia de peristoma, morfología de las esporas y número cromosómico.

Introduction

In connection with the revision of some Mediterranean species of bryophytes for preparing distribution maps to be included in «Workgroup for mapping the bryophytes in Europe», approximately 50 specimens of *Entosthodon curvisetus* (Shwaegr.) C. Müll, from the following herbaria (LISU, LISFA, INA, G, BM, PC, BCB, MA, FI, DUIS, HÉBRARD) have been examined. Additionally, as a result of several bryological explorations in calcareous areas of Portugal (Sérgio et. al. 1984, Sérgio & Sim - Sim 1985), many samples of this interesting Funariaceae, always considered a rare species, were collected. For these reasons, a short revision of this taxon has been undertaken.

Generic concept

A generic revision of the Funariaceae was recently published (Fife 1985) based especially on numerical phenetics studies, spore morphology and evolutionary trends. In this work *E. curvisetus* was provisionally placed in *Entosthofdon* section *Entosthodon* with some reservations, althougt this taxon presents phenetic similarities in sporophytic characters nearer the subgenus *Plagiodus* Fife.

The majority of the distinctive characters of the Funariaceae are in sporphytes (Fife 1985) and the morphological features of *E. curvisetus* show that this taxon had some intermediate characteristics between the subg. *Entosthodon* and the subg. *Plagiodus*, and presents a similarity coeficient considered by Fife as a monotypic genera or subgenera.

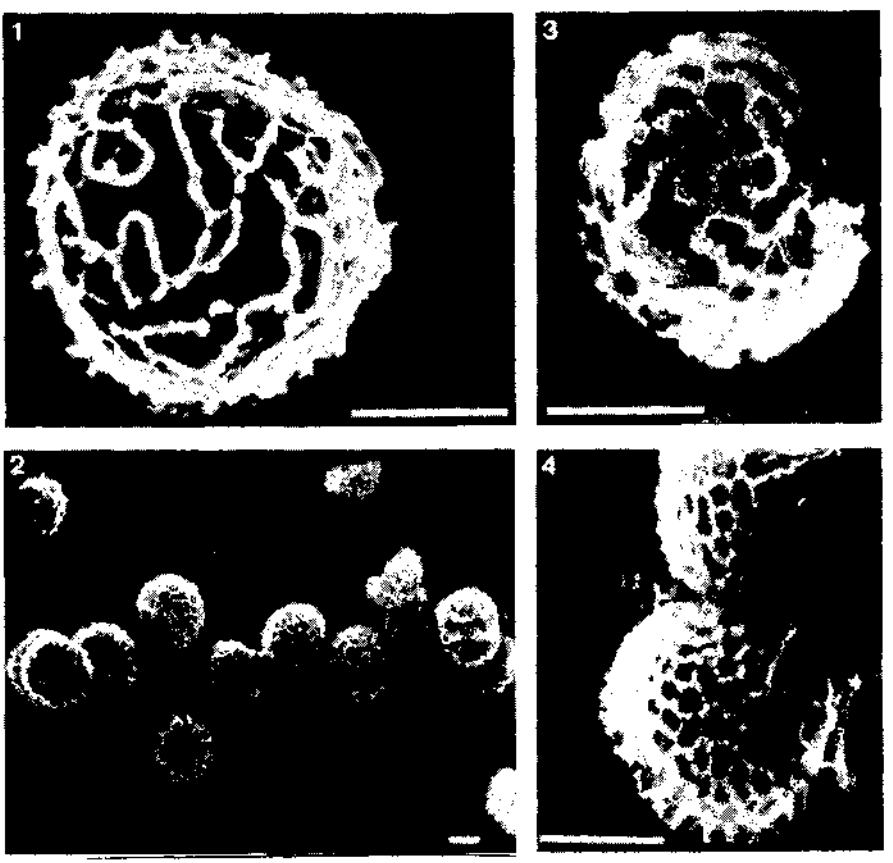

Figure 1. Spores of *Funariella curviseta* (Schwaegr.) Sérgio comb. nov. Scanning electron micrographs. Specimens 1.2 Algeria, 1904, Dixon (BM); 3.4 Italy, Sardinia, 1832, Müller (BM). Scale bar = 10 μm.

I have been studing this taxon since 1980, particulary the spore ornamentation, that shows considerable differences from other Funariaceae by having a distinct reticulum whit minutely verrucate-baculate perine processes that border more or less regular alveoli (Fig. 1.). Limpricht (1885-1903) first mentioned the presence of «dicht mit klein Netzfalten» in these spores, and Roth (1904) also mentioned «netzfalting oder locker warzig und durchscheinend».

Recently Fife (1985), studing 53 taxa if the Funariaceae with electron

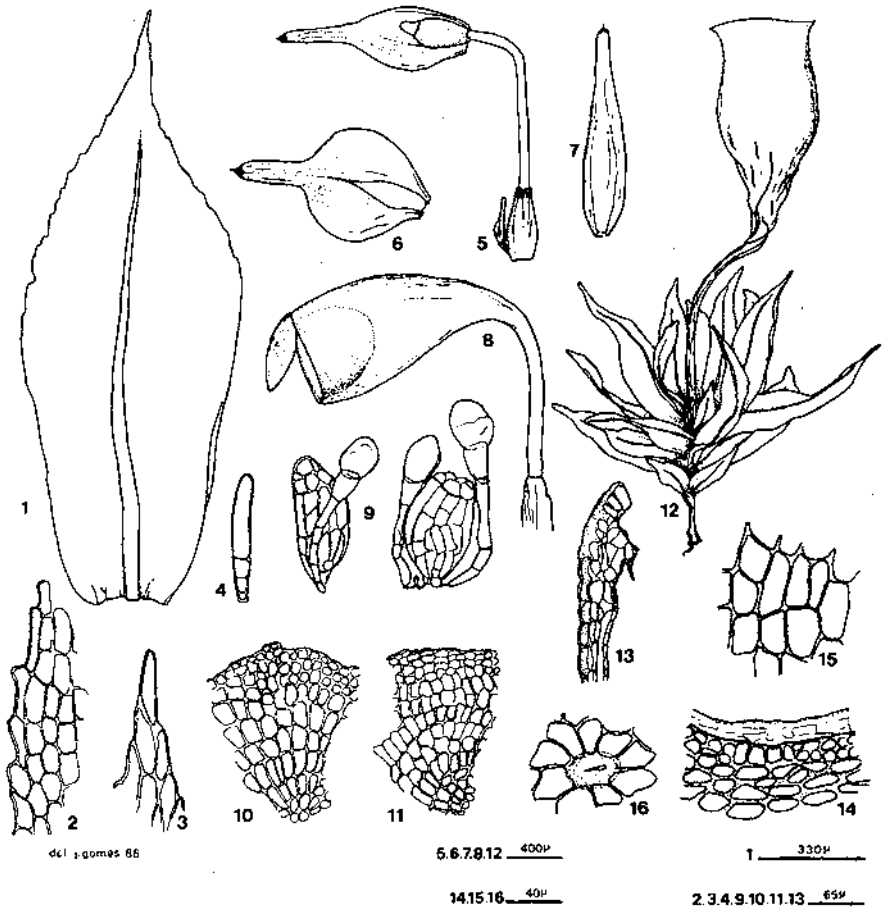

Figure 2. *Funariella curviseta*. (Schwaegr.) Sérgio comb. nov. 1 Leaf; 2 Leaf median margin; 3 Leaf apice; 4 Axillary hair; 5 Immature sporophyte; 6-7 Calyptra; 8 Mature capsule; 9 Paraphyses and antheridia; 10-11 Arrangement of operculum cells; 12 Dry plant with empty capsule; 13 Longitudinal cross section of capsule mouth; 14 Capsule mouth; 15 Exothecial cells; 16 Stoma. Specimens: 1-16 Portugal: Serra da Arrábida, Alpertuche, C. Sérgio & M. Sim-Sim 4769 (LISU); 11 Corsica: Cap. Corse, J.P. Hébrard; 916.4.76 (LISU).

microscopy, showed that *E. curvisetus* spores presents an ornamentation that occurs in no other species of this genus.

In addiction there is no infraspecific variation in this taxon and the sporophyte characters are stable. Also, *E. curvisetus* is easily distinguished from others species of the genus by the seta length (1.2 to 2 mm), its ratio with the capsule (from 0.8:1 to 1:0.8), the asymmetric, inclined to pendent capsule before dehiscence, the absence of peristome and the marked spiral arrangement of cells in the operculum (Fig. 2).

The spiral arrangement of the operculum cells occurs only in *Entoshodon* in the subg. *Plagiodus* sensu Fife and this Mediterranean species has an operculum with this character (Fig. 2). Schimper (1856) has described the operculum of *E. curvisetus* as having *series cellularum oblique versus centrum convergentes*. On the other hand the species of this subg. *Plagiodus* have the capsule with double peristome or a well developed exostome, while *E. curvisetus* has no peristome. The operculum on the species of the subg. *Entosthodon* presents irregularly arranged cells. The capsules are erect and more or less symmetric.

In Bryologia Europaea, Bruch et al. (1836-1851) referred to an other interesting characteristic of the sporophyte. The calyptra when young is *fusiformis tetragona*, related to the genus *Pyramidula* or *Gonimitrium* that have a persistent and distinctly 4-8 angled calyptra. However in *E. curvisetus* this feature is observed only in the first phase of development of the sporophyte and is not a constant calyptra characters of *E. curvisetus* in herbarium specimens.

Karyology

As the sporophyte morphology suggests a possible segregation of *E. curvisetus* from others species of this genus, chromosome studies were caried out on this taxon in 1983 and 1984, with fresh material from Portugal to try to confirm these differences.

Chromosomes were counted at meiosis and the number of bivalents determined. Only 5 could be discerned, with apparent size *ca.* 2.5-4μm (Fig. 3).

Chromosome studies have been made on all classes of bryophytes but the number of species has been small (about 3 % to 14 % in different groups, after Smith 1978). However, a detailed treatment of bryophyte karyology was made by Fritsch (1982) and studies of cytogenetics and evolution in the more important groups, genera and also species, have been published recentiy (Iwatsuki & Inoue 1984, Mc Adam 1982, Ramsay 1983a, Smith 1978, Steere 1972).

A remarkable diversity in chromosome numbers in moss species was found with the lowest value n=4 (Ramsay 1983b). Species with n=5 are rare with some examples in *Fissidens* (Iwatsuki & Inoue 1984) while high

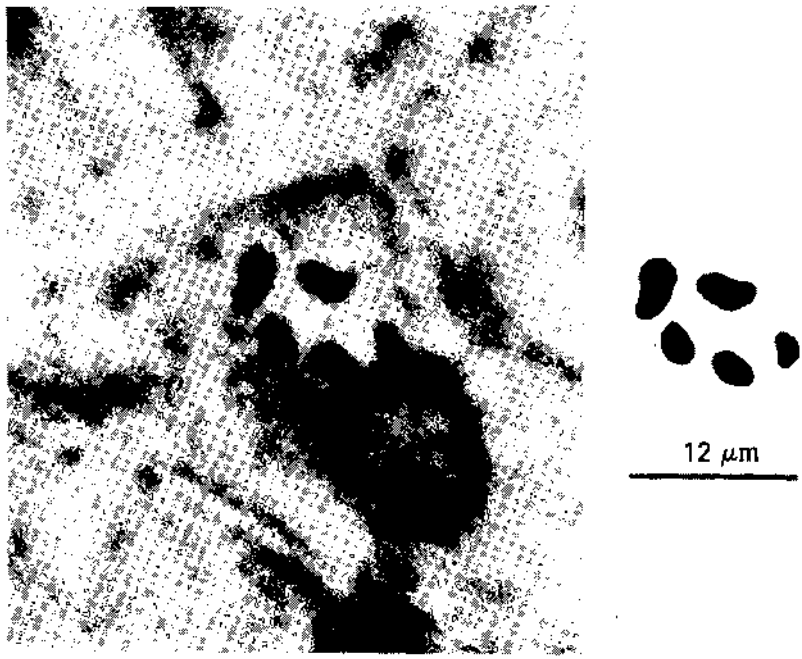

Figure 3. Photomicrographs of sporocystes of *Funariella curviseta* at meiosis (acetato-orcein stein, with Geimsa's 6-8 pH method). Bivalents 5 →n=5. Specimen Portugal, Serra da Arrábida, Alpertuche, 2.03.1983, C. Sérgio & M. Sim-Sim 4769 (LISU).

numbers of n =10 to n=13 are more frequent in the Bryopsida (Smith 1978).

A large part of the Funariaceae species still remain totally unknown in terms of their chromosome numbers (Fife 1985), and the tropical and mediterranean taxa have not yet been studied. However, Steere (1972) considered the basic numbers n=9, n=12, n=13 or n=14 for this family, while Smith (1978) refered to the haploid number of the Funariaceae as n=7 or n=9. This author suggests that the elements of this family evolved from an earlier stock than other Diplolepideae, before the chromosome number of 6 had been derived.

A species of *Nanomitrium*, an element of a family related to the Funariaceae, has a haploid chromosome number n=10, being the basic number of a large series of Bryaceae (Steere 1972) and Fissidentaceae (Iwatsuki & Inoue 1984).

Based on the acquisition of this detail of *E. curvisetus* I think that this species has a different karyological base to segregate it from the rest of the *Entosthodon* genus, that has n=14, n=9 or its multiples (Fife 1985).

It is possible that in this taxon karyological changes were involved in its evolution, which agrees with the cytological phylogenies suggested by Smith in the Diplolepideae-Acrocarpae group (n=6 → n=5 → n=10). Then spe-

cies with n=5 where derived from the ancestral stock which has n=6.

On the other hand, with the principles of moss systematics of Miller (1979) it is concluded that the sporophyte of *E. curvisetus* may involve an evolutionary advance with short seta and peristome absent. The monoecious condition of this moss also represents phylogenetic evolution.

Funariella gen. nov.

Capsula subpendula longicolla subgibbosa in pedicello breviore arcuato horizontalis; sicca vacua macrostoma. Operculum plano-convexum. Operculi series cellularum oblique versus centrum convergentes. Peristomium nullum. Sporae ferruginae 20-24 μm diam., manifeste reticulata, muri verrucoso-baculatae. Chromosomatum numerus n=5.

Type species: *Funariella curviseta* (Schwaegr.) Sérgio comb. nov.

Basionym: *Gymnostomum curvisetum* Schwaegr., Spec. Musc, Suppl. 2 (1): 17, Tab. 105 (1823).

Main synonymy: *Physcomitrium curvisetum* Brid., Bryol. Univ. II: 815 (1827). *Entosthodon curvisetus* (Schwaegr.) C. Müller, Syn. I:121 (1848). *Funaria curviseta* Milde, Bryol. siles.: 196 (1869).

Illustrations: Schwaegrichen. 1823. Tab. 105. Bruch, P., W. Ph. Schimper & T. Gümbell. 1836-1855. Tab. 301. Husnot, T. 1884-1890. Tab. 58. Roth, G. 1904. Tab. 44.2. Brotherus, V. F. 1924-1925.: 329 fig. 278.

Ecology and habitat

Funariella curviseta has a termophytic character and is found mostly on wet sites with maritime influence. It prefers saxicolous substrata in fissures of rocks and grows frequently on calcareous areas.

In Portugal, this species is usually found mixed with Mediterranean elements, sometimes with rare species such as *Fissidens intralimbatus* (Sérgio & Sim-Sim 1985) and in the same communities reported by Hébrard (1984) from Corsica.

The great majority of the European records of this Funariaceae are in areas whit mean annual temperatures 15° C or more.

Distribution

The Funariaceae, which is a world-wide family consisting of about 276 species in 13 genera, has the great majority of its taxa restricted to the northern temperate zones, althougth there is a great diversification in tropical Africa with 11 genera (Ochyra 1983), while Europe has only 6 genera.

F. curviseta has a Mediterranean-macaronesian distribution pattern. Most european records are in areas near the coast or in islands (Fig. 4). It is distributed from the eastern part of the Mediterranean basin (Syria, Crete, Eggypt and Cyprus) to the Iberian Peninsula and Canary Islands

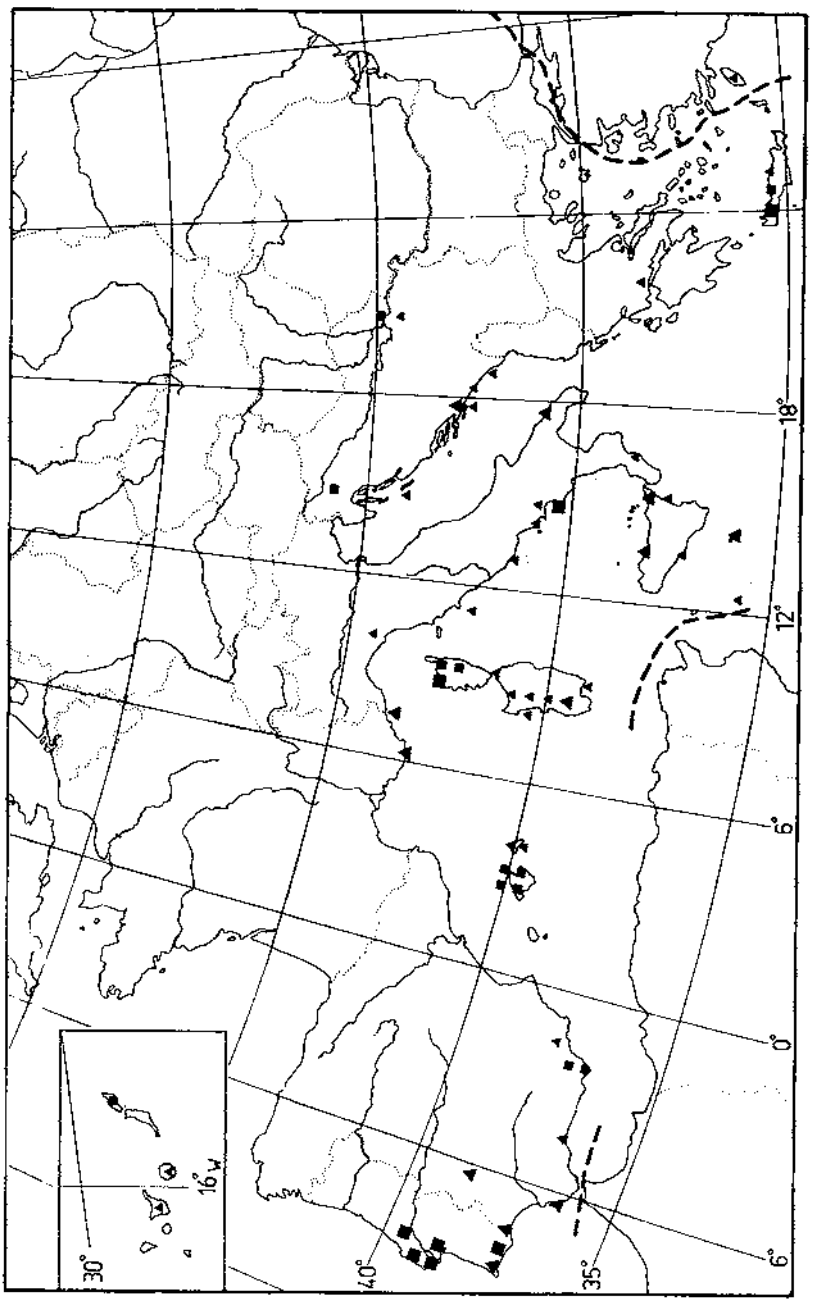

Figure 4. Distribution of *Funariella curviseta* (Schwaegr.) Sérgio in Europe Macaroneia. Herbarium material: ▲ before 1950, ■ after 1950; literatura data: ▲ before 1950, ■ after 1950. The Madeira reference actually belongs to a portuguese locality: Cacilhas, Mandon (BM).

(During 1981, Eggers 1982). Nevertheless, it always a restricted occurence, and more than 40 % of all its collections were made in the last century.

In the Mediterranean region, many monotypic bryophyte genera are present and endemic species are included in some Funariaceae such as in *Gonimitrium* and *Pyramidula* that are also a strongly isolated group in this family, and exhibit many morphological features which can be considered allied to the Gigaspermaceae (Fife 1982) which also has endemic Mediterranean taxa.

The isolation of *F. curviseta* from its congeners confirms its recognition as a monotypic genus.

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