

**COSMARIUM, ACTINOTAENIUM AND COSMOCLADIUM (DESMIDIACEAE,
CHLOROPHYTES) ASSOCIATED TO GRAMINEAE, WITH THE
PROPOSITION OF FOUR NEW TAXA FOR SCIENCE**

**COSMARIUM, ACTINOTAENIUM Y COSMOCLADIUM (DESMIDIACEAE,
CHLOROPHYTA) ASOCIADAS A GRAMINEAS, CON LA PROPOSICION
DE CUATRO NUEVOS TAXA PARA LA CIENCIA**

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RESUMEN

En el presente estudio se presenta la descripción de 35 taxa de Desmidiaceae (3 *Actinotaenium*, 31 *Cosmarium* y 1 *Cosmocladium*) asociados a raíces, tallos y hojas sumergidas de *Hymenachne amplexicaulis* (Gramineae) colectadas en una sabana inundable de Venezuela- Edo. Apure (07° 33' Lat. N, 69° 10' Long. O). El ambiente está caracterizado por ser de aguas ácidas, con baja salinidad y una alta densidad de macrofitas. De los 35 taxones reportados 26 corresponden a nuevas citas para Venezuela (2 *Actinotaenium*; 23 a *Cosmarium* y 1 a *Cosmocladium*) y 4 se proponen como nuevos para la ciencia: *Actinotaenium venezuelense* Salazar, C. sp. nov.; *Cosmarium protuberans* var. *semicircularis* Salazar C. var. nov. y *C. regnellii* var. *scrobiculosum* Salazar C. var. nov.

ABSTRACT

This study presents the description of 35 Desmidiaceae-Chlorophytes (3 *Actinotaenium*, 31 *Cosmarium* and 1 *Cosmocladium*) found on roots, shoots and leaves of *Hymenachne amplexicaulis* (Gramineae) collected in a flooded savanna of Venezuela (Apure State, 07° 33' N, 69° 10' W). The aquatic environment is acidic, with low salinity and high macrophyte density. Of the 35 taxa reported in this work 26 are new for Venezuela (2 *Actinotaenium*; 23 *Cosmarium* and 1 *Cosmocladium*) and 4 are propous new to science: *Actinotaenium venezuelense* Salazar sp. nov.; *Cosmarium protuberans* var. *semicircularis* Salazar C. var. nov. y *C. regnellii* var. *scrobiculosum* Salazar C. var. nov.

Palabras clave: Perifiton, Clorophyta, Desmidiaceae, *Actinotaenium*, *Cosmarium*, *Cosmocladium*, sabana inundable.

Keywords: Periphyton, Chlorophytes, Desmidiaceae, *Actinotaenium*, *Cosmarium*, *Cosmocladium*, flooded savanna.

INTRODUCTION

Phycofloristic studies of microalgae in freshwater environments in Venezuela are very scarce. In this regard, we only can mention the studies by Deflandre (1928); Drouet (1957); Gessner (1956); Krieger & Bourrelly (1956); Margalef (1961); Yacubson (1969, 1977, 1980, 1984-85); Yacubson & Bravo (1982-83); Förster (1972a); Riehl *et al.*

(1987); Blanco & Sánchez (1986); Carvajal-Chitty (1988), that took into consideration only the planktonic community. Matos & Parra (1986); Salazar (1984,1989); Salazar & Guarrera (1998) performed a number of ecological and taxonomical studies that included the periphytic community. Periphytic material collected from previous research by Salazar indicates the existence in this microhabitat of a wide variety of algae of several

groups, but mainly Desmidiaceae (Chlorophytes). In this paper we report 35 taxa of Desmidiaceae (3 *Actinotaenium*, 31 *Cosmarium* and 1 *Cosmocladium*), including 4 new taxa (1 new species of *Actinotaenium* and 3 new variety of *Cosmarium*) and 26 new reported for Venezuela.

MATERIALS AND METHODS

The material analyzed (periphyton), associated with the roots, stems and submerged leaves of *H. amplexicaulis* was collected in a floodable savanna in the State of Apure, Venezuela (07° 33' N, 69° 10' W). This periphyton was removed from the plant (substrate) by washing, followed by soft brushing. The material obtained after this process was preserved in a Transeau solution. Specimens were observed using a Wild M-20 microscope with a camera lucida. An alternative method used was scanning electron microscopy after dehydration of the material by the critical point method, Gough et al. (1976). All species recorded are illustrated, and the species which had not previously been recorded from Venezuela freshwater algal flora are marked with an asterisk. The samples, marked CPHaM, followed by a number, are kept at the Herbario Nacional de Venezuela (VEN) and the Instituto de Zoología Tropical, Facultad de Ciencias, Universidad Central de Venezuela (private collection, Cruz Salazar). All dimensions are expressed in microns, and the following abbreviations are used: L = Length; W = Width; T = Thickness; Ap = Apex; I = Isthmus; D = Diameter.

RESULTS

**Actinotaenium cucurbitinum* var. *cucurbitinum*
f. *minus* (West & West) Teiling, Bot. Not. 4:
399. 1954

Figure 1

Cells small, L:W = 2.85-3.41. Sinus a shallow notch. Margins almost parallel, converging towards the apex. Apex rounded. Cell walls with disperse puncta. Axial chloroplast (stelloid) with 8 lamellae and one pyrenoid. L = 41.5-45.5 µm; W = 12-16 µm.

**Actinotaenium cucurbitinum* var. *longum*
(Scott & Grönbl.) Croasdale, in Prescott et al.,
A Synopsis of North American Desmids Part
II, Sec. 3:12 1981

Figure 2

Cells small, L:W = 4.4. Sinus a shallow notch. Margins slightly converging towards the apex. Apex rounded. Cell wall with disperse puncta. Axial chloroplast (stelloid) with six lamellae and one axial row of three pyrenoids. L = 63 µm; W = 15.4 µm.

Actinotaenium venezuelense Salazar C. sp. nov.

Figure 3

Cellula magna, longitudo:latitudo = 3.56, sinu levi, marginibus leviter convexis, apice late rotundato, pariete cellulari laevi. Hemicellula adspectu frontali elliptica. Chloroplastus axialis (stelloides) magnoque pyrenoide axiali praeditus, 8-10 lamellis. Longitudo = 204.5 µm; latitudo = 57.5, istmi latitudo = 41 µm

Holotipus: Figure 3

Origo: In periphyto foliorum *Hymenachnae amplexicaulis*.

Cells large, L:W = 3.56. Sinus a shallow notch. Semicell subelliptical in front view. Margins slightly convex. Apex broadly rounded. Cell wall smooth. Axial chloroplast (stelloid) with large axial pyrenoid, and 8-10 lamellae.

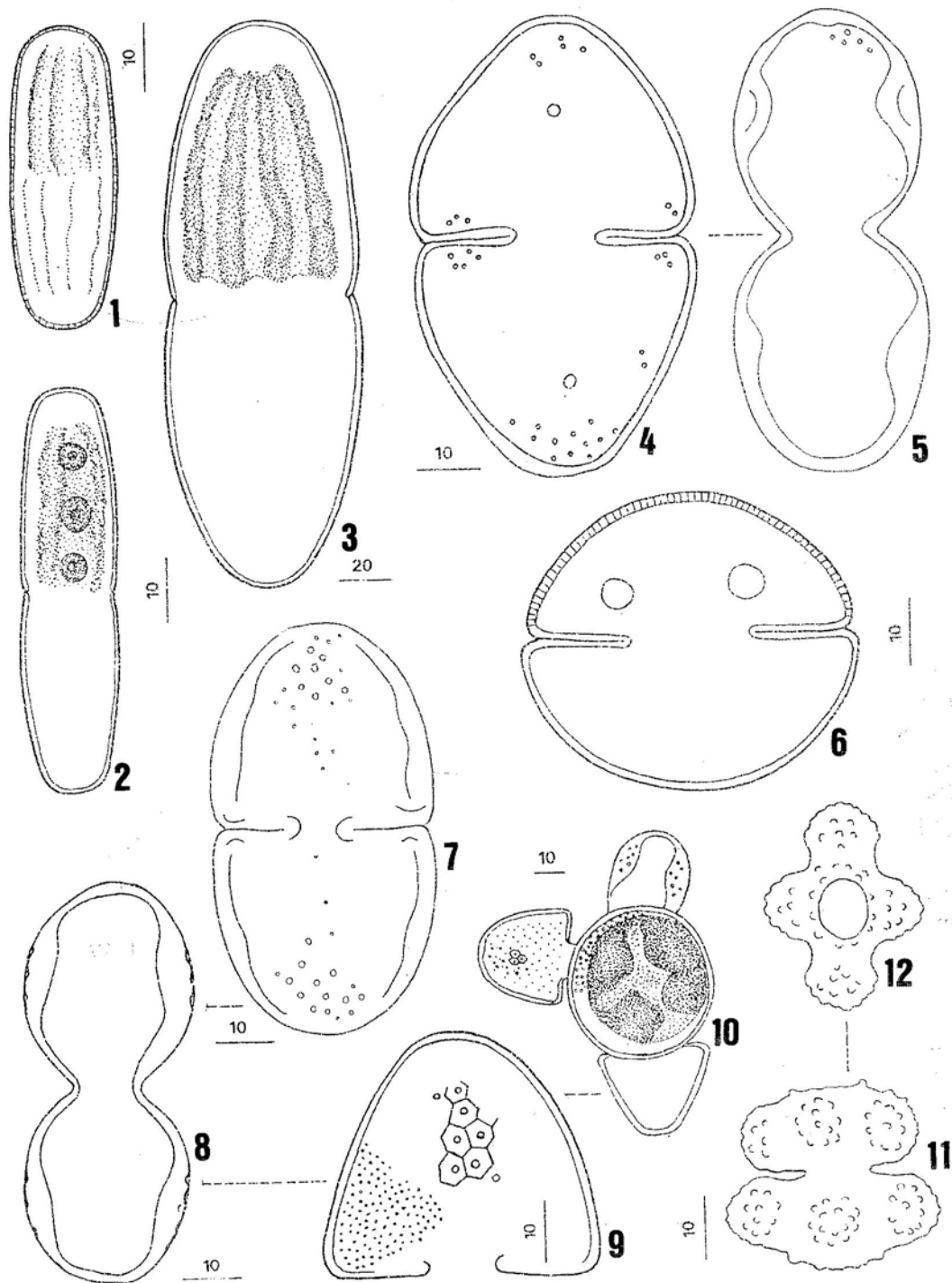
Dimensions: L = 207.5 µm; W = 72.5 µm; I = 65 µm

Comments: Closest taxon is *A. cucurbitinum* var. *grande* (Grönbl.) Teiling 1954, which has smaller dimensions (L = 85-118 µm; W = 32-50 µm) and the L:W ratio is also different (L:W = 2.5).

**Cosmarium ambadiense* Grönbald & Scott, in
Grönbald et al., Acta Bot. Fennica 58: 23.
1958

Figs. 4-5

Cells of medium size, L:W = 1.57 - 1.58. Sinus deep and linear. Semicell in front view



Figures. 1-12. 1. *Actinotaenium cucurbitinum* var. *cucurbitinum* f. *minus*; 2. *A. cucurbitinum* var. *longum*; 3. *A. venezuelense*; 4-5. *Cosmarium ambadiense* (4: frontal view, 5: lateral view). 6. *C. baileyi*; 7-10. *C. callosissimum* var. *americanum* (7: frontal view, 8: lateral view, 9: detail of wall ornamentation, 10: zygospore); 11-12. *C. commisurale* var. *cruciforme* (11: frontal view, 12: end view). Bars in figures correspond to 10 μ m

approximately pyramidal, with basal angles close to 90° and slightly convex and converging margins. Apex narrow, rounded, truncate. Cell wall scrobiculate, with a conspicuous central pit. Lateral view oval. Chloroplast furcoid and monocentric with 8 longitudinal ridges. L = 71-72 µm; W = 42-45 µm; I = 15.5 µm; T = 30.5-31 µm.

Cosmarium baileyi Wolle, Desm. U.S.,:64. 1884
var. *baileyi*

Figure 6.

Cells of medium size, in front view subcircular. L:W = 0.86-0.87. Sinus deep and linear. Semicell with rounded basal angles. Cell wall finely punctate. Chloroplast furcoid and dicentric. L = 43-45 µm; W = 49.7 - 51.5 µm; I = 14-18 µm.

**Cosmarium callosissimum* var. *americanum*
Scott & Grönblad, Acta Soc. Sci. Fennica, B,
2(8): 15. 1957.

Figures 7-10.

Cells of medium size, L:B = 1.70-1.78. Sinus deep and linear. Semicell in front view semioval, with rounded and slightly swollen basal angles. Apex dome-shaped. Lateral view broadly oval. Cell wall dilated in its median part, easily noticeable in side view, ornamented with scrobiculations of different sizes, large in the central area of the semicell and small in the rest. L = 62-70.6 µm; W = 36-41 µm; I = 10 - 12.5 µm; T = 28 µm. Zygospore globose, wall scrobiculate, 53 µm in diameter.

Comments: In some specimens, the scrobiculations in the central area form small hexagons. The zygospore of this species is cited and described for the first time.

Cosmarium commissurale var. *crassum* f.
cruciforme Förster ex Förster, Arch.
Hydrobiol Suppl. Bd. 60 (Algol. Stud.28). 1981
in Förster, Die Binnengewasser, Bd. 16,
8(1):181. 1982.

Figures 11-12

Cells small, L:W = 0.86. Sinus deep and slightly open. Semicell in front view with rounded sides, apex slightly elevated, with straight margin. Cell

wall ornamented with verrucae arranged in a small rose at the end of the lobes and around the apex. End view cruciform. L = 25 µm; W = 29 µm; T = 22.5 µm; I = 9 µm.

**Cosmarium connatum* var. *minus* Wolle, Bull.
Torr. Bot. Club 6: 122. 1876

Figures 13, 69

Cells small, L:W = 1.1-1.3, broadly elliptical contour. Sinus a shallow notch. Semicell in front view vaulted. End view circular. Chloroplast furcoid dicentric. L = 36-49.5 µm; W = 30.6-38 µm; I = 39.5 µm.

**Cosmarium contractum* Kirchner, in Kryptog.-
Fl. Schles Alg.: 147. 1878. var. *contractum*.

Figures 14-16

Cells of medium size, L:W = 1.48-1.60. Sinus deep and abruptly open at an acute angle. Semicell in front view subelliptic. Lateral view circular. End view elliptic. Cell wall smooth or finely punctate. Chloroplast furcoid monocentric. L = 34-47 µm; W = 19-31 µm; T = 16-21 µm; I = 6-9 µm. Zygospore globose, wall smooth, 30.7 µm in diameter.

**Cosmarium contractum* var. *incrassatum* Scott
& Prescott, Rec. American-Australian Sci.
Exped. to Arnhem Land 3: 44. 1958.

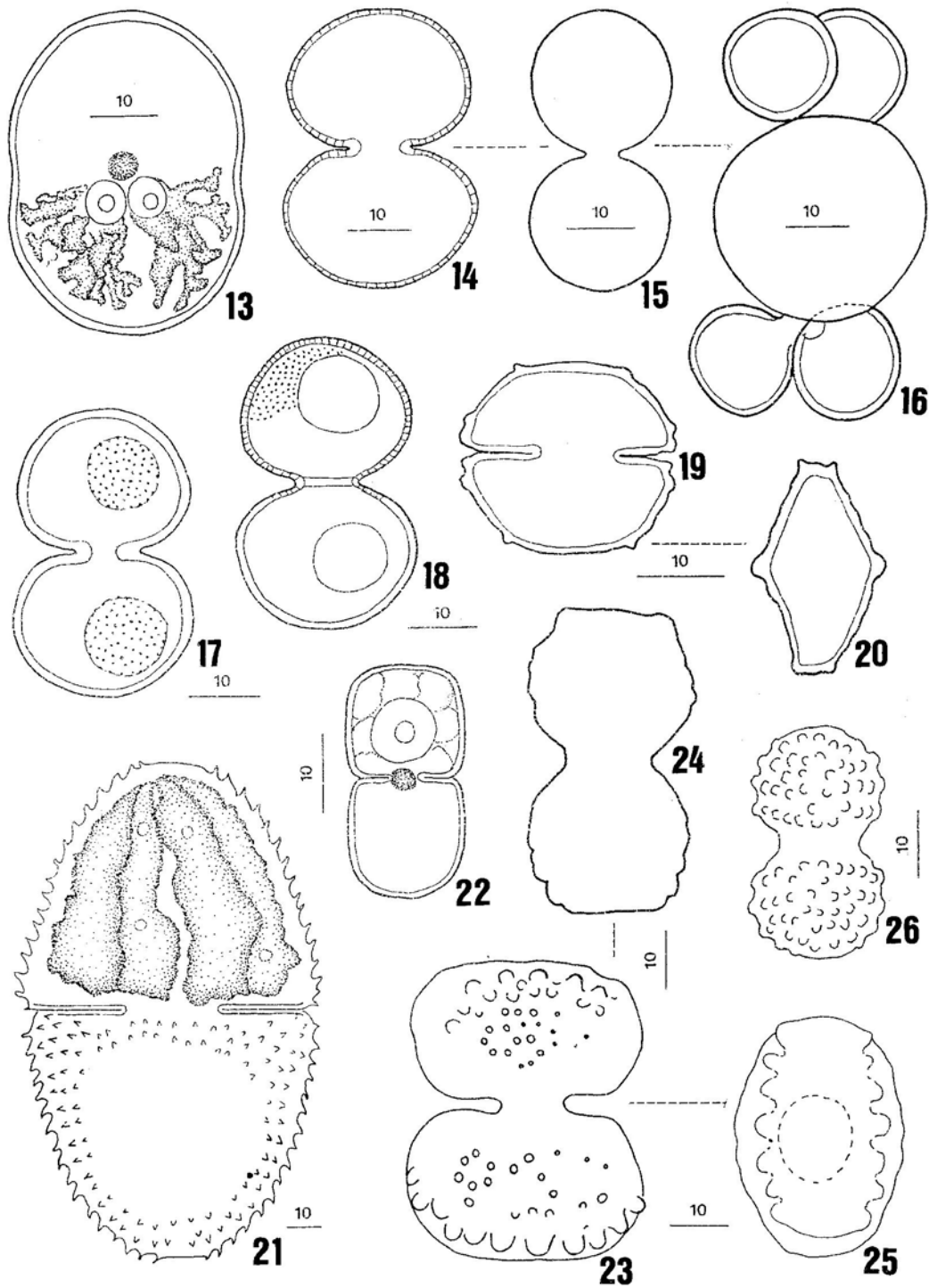
Figure 17

Cells of medium size L:W = 1.57. It differs from the typical species in that it has an internal brown-golden lenticular thickening with thick scrobiculations in the center of the semicell, the rest of the cell wall is colorless and smooth. L = 40.5 µm; W = 27.5 µm; I = 8 µm; T = 20 µm.

**Cosmarium contractum* var. *subtrapeziforme*
Förster, Nova Hedwigia, 23 (2+3): 548. 1972 ab

Figure 18

Cells of medium size. It differs from the typical species in that it has an internal brown-golden lenticular thickening at the center and displaced towards the upper part of the semicell, without scrobiculations. The rest of the wall is colorless and scrobiculate. L = 44.6 µm; W = 27.4 µm; I = 8.64 µm; L:W = 1.63.



Figures 13-26. 13. *Cosmarium connatum* var. *minus*; 14-16. *C. contractum* var. *contractum* (14: frontal view, 15: lateral view, 16: zygospore); 17. *C. contractum* var. *incrassatum*; 18. *C. contractum* var. *subtrapeziforme*; 19-20. *C. dimaziforme* var. *floridanum* (19: frontal view, 20: end view); 21. *C. denticulatum* var. *denticulatum* f. *denticulatum*; 22. *C. exiguum* var. *exiguum* f. *exiguum*; 23-25. *C. hexagonum* (23: frontal view, 24: lateral view, 25: end view); 26. *C. itsmium*. Bars in figures correspond to 10 μ m

**Cosmarium dimaziforme* var. *floridanum* Scott
& Grönblad, *Acta Soc. Sci. Fennica*, B,2 (8):
17. 1957

Figures 19-20

Cells small, L:W = 0.88. Sinus deep, irregularly open at an acute angle. Semicell in front view approximately semicircular, basal angles with a bipapillate projection and apex with a small denticulation on each side. Cell wall with a prominent emarginate central protuberance on each semicell. These protuberances face each other above the isthmus. End view elliptical, with truncate poles and a small projection at each angle and a central protuberance on each side. Chloroplast furcoid dicentric. L = 21.6 μm ; W = 24.3 μm ; I = 9.5 μm ; T = 15.5 μm .

**Cosmarium denticulatum* Borge, Bih. Kongl.
Svenka Vet.-Akad. Handl. 22, III: 19. 1896.
var. *denticulatum* f. *denticulatum*

Figure 21

Cells large, L:W = 1.55. Sinus deep and slightly open. Semicell in front view pyramidal. Basal angles rounded and slightly flattened apex. Cell wall ornamented with four rows of intramarginal tooth arranged concentrically. Central region without tooth, ornamented with pores that are evenly distributed. End view elliptical. L = 177 μm ; W = 117 μm ; I = 40 μm .

**Cosmarium denticulatum* var. *denticulatum* f.
borgei Irénée-Marie, 1938, in Prescott *et al.* A
synopsis of North American Desmids, Part II,
Sec 3:123. 1981.

Figures 62-63

Cell large, L:W = 1.9. Lateral margins convexa, with 40 teeth. In lateral view 6-9 rows of teeth within the sides of the semicells decreasing in size toward the mid region of the semicell. Cell wall with irregular rows of teeth across the base of the semicell immediately beyond the sinus. L = 210 μm ; W = 110 μm ; I = 45 μm ; T = 40 μm .

**Cosmarium elegantissimum* Lundell, Nova
Acta Reg. Soc. Sci. Upsaliensi, ser III, 8 (2):
53. 1871 var. *elegantissimum* f. *elegantissimum*

Figure 31

Cells large, cylindrical, just slightly constricted, L:W = 2.17. Semicell in front view with parallel margins, ornamented with a series of emarginate verrucae, nine horizontal rows and nine vertical rows. Apex rounded. End view circular. Chloroplast furcoid dicentric. L = 63 μm ; W = 29 μm ; I = 3 μm .

**Cosmarium elegantissimum* var.
elegantissimum f. *minor* West & West, Linn.
Soc. Jour. Bot. 29 (199/200): 164. 1892

Figure 30

Cells cylindrical, just slightly constricted, of medium size, L:W = 2.8. Sinus a shallow notch. Semicell in front view cylindrical. Cell wall ornamented with emarginate verrucae (7 longitudinal series, 7 horizontal series). Apex rounded. End view circular. L = 41.5 μm ; W = 15 μm ; I = 11.5 μm .

Cosmarium exiguum Archer, Proc. Dublin Nat.
Hist. Soc. 4 (1): 49. 1864 var. *exiguum* f.
exiguum

Figure 22

Cells small, L:W = 1.95. Sinus deep and linear. Semicell in front view subquadrangular, with rounded angles. Apex straight or slightly convex. Lateral view broadly elliptical. Cell wall smooth. Chloroplast axial with one large central pirenoid. L = 30 μm ; W = 15.5 μm ; I = 4.6 μm .

Cosmarium hexagonum Nordstedt, Vidensk.
Medd. Nat. Hist. Foren, Kjobenh. (14-15):
208. 1869/1870

Figures 23-25

Cells of medium size, L:W = 1.31. Sinus deep, dilated in the proximal end and slightly open in the distal end. Semicell in front view elliptic-hexagonal. Cell wall ornamented with a series of large verrucae in subapical position and with scrobiculations in the central area, arranged in a hexagon around a central verruca. Side view hexagonal, with flat apex. End view elliptic, with two parallel series of verrucae close to the borders and with the central area finely punctate. L = 51-52 μm ; W = 39-44 μm ; I = 28 μm ; T = 28 μm .

****Cosmarium isthmium* var. *brasiliense* Grönblad,
Acta Soc. Sc. Fennicae. B 2 (6): 19. 1945**

Figure 26

Cells of medium size, slightly constricted. L:W = 1.5. Sinus deep and linear. Semicell in front view approximately semicircular. Cell wall ornamented with tooth-like projections, arranged in eight vertical series with 4-5 projections in each series. End view circular with approximately 16 granules along the margin. Chloroplast furcoid with one prominent axial pyrenoid. L = 32 μ m; W = 21 μ m; I = 12 μ m.

****Cosmarium isthomochondrum* Nordstedt, Act.
Univ. Lund 9: 12. 1873 var. *isthomochondrum***

Figures 27-28

Cells of medium size, L:W = 1.3. Sinus deep and linear. Semicell in front view approximately semicircular, with rounded basal angles ending at a small tubercle. Lateral margins crenulate and convex. Apex flat and smooth. Face of the semicell with an intramarginal row of granules, the two central ones are more prominent. One prominent tubercle like granule at the base of the semicell in the isthmal region. Lateral view rhomboid, with two verrucae at the sides of the apex and two verrucae close to the isthmus. End view elliptical, with two verrucae in the center of the sides. L = 38 μ m; W = 29 μ m; I = 10 μ m.

****Cosmarium lagoense* var. *borgei* Tell &
Couté, Protistológica, 25, Fasc. 4: 634. 1979**

Figure 29

Cells of medium size, L:W = 0.77. Sinus deep with a dilated proximal end and a generally closed distal end. Semicell in front view laterally extended, with slightly elevated apex and dilated ends. Cell wall ornamented in the central area and in the end, with simple spines and verrucae. The spines at the base are facing the isthmus, while the spines on the apex are facing the exterior. Apex smooth. L = 32 μ m; W = 42 μ m; I = 12 μ m.

****Cosmarium obtusatum* (Schmidle) Schmidle,
Engler's Bot. Jahrb 26 (1):38. 1898 var. *obtusatum***

Figure 32

Cells of medium size, L:W = 1.1. Sinus deep and linear. Semicell in front view truncate-pyramidal, basal angles slightly rounded. Cell wall coarsely punctate and ornamented with two series of papillae that are parallel to the margins. Lateral view broadly elliptical. End view oblong-elliptical. Apex punctate with parallel rows of papillae. Chloroplast furcoid dicentric. L = 40-41, 5 μ m; W = 35-37 μ m; I = 12-12.5 μ m; T = 17-18 μ m.

****Cosmarium ordinatum* (Börger.) West &
West, Trans. Linn. Soc. London, Bot. II, 5:
251. 1896 var. *ordinatum* f. *ordinatum***

Figure 33

Cells small, L:W = 1.08. Sinus deep, open in the distal end at an acute angle. Semicell in front view approximately elliptical. Margin granular-undulate. Cell wall ornamented with three horizontal rows of verrucae, located in the upper part of the semicell. Basal zone without ornamentation. End view elliptic with granular-undulate border. L = 25 μ m; W = 23 μ m; T = 15 μ m; I = 9 μ m.

***Cosmarium ornatum* var. *pseudolagoense*
Förster, Hydrobiol. 23 (3-4): 399. 1964**

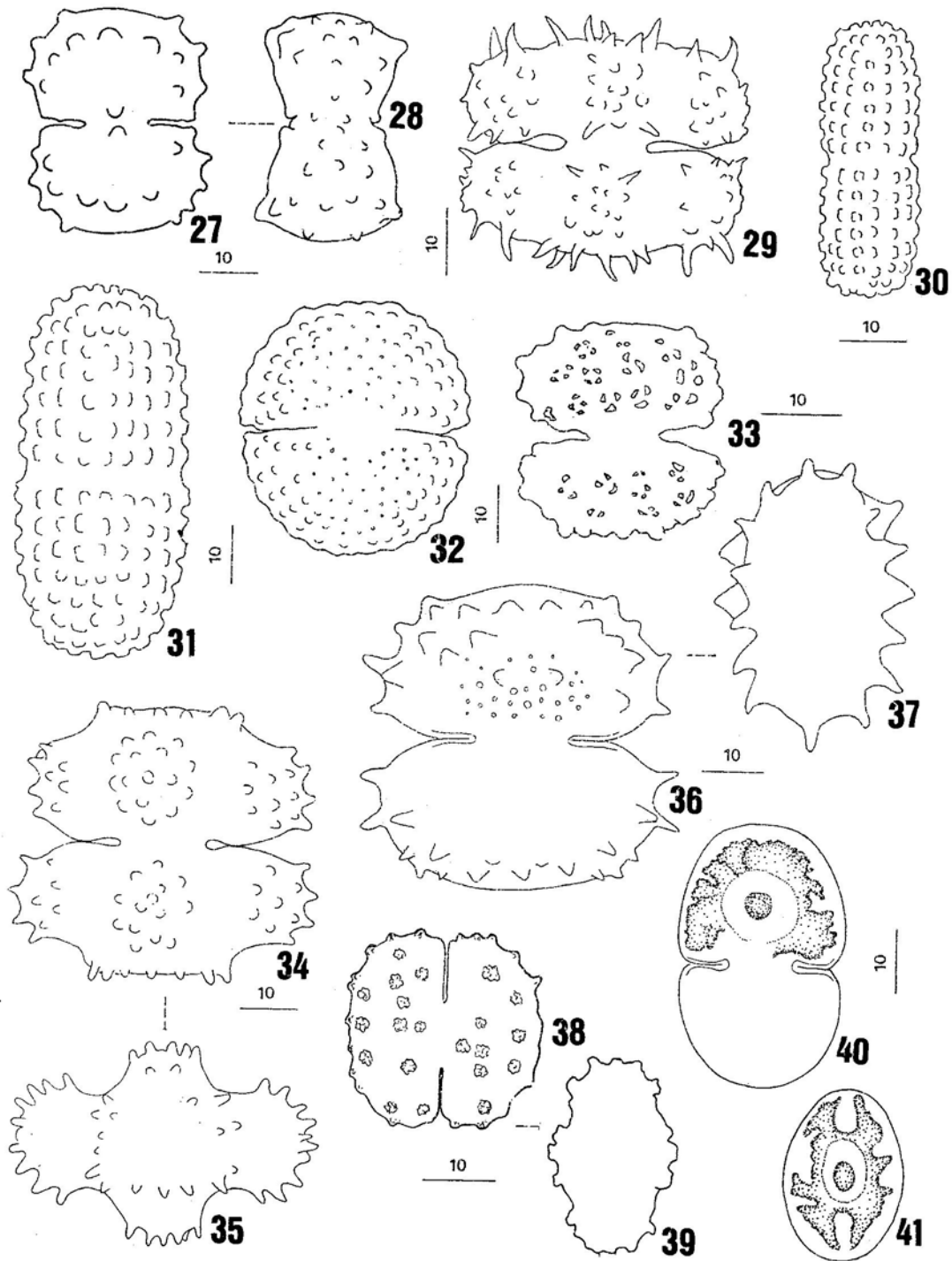
Figures 34-35

Cells of medium size, L:W = 0.89. Sinus deep and slightly opening outward in acute angle. Semicell in front view laterally extended, with broadly rounded sides and slightly elevated and flat apex, margins ornamented with stout spines. Face of semicell with a central protuberance, ornamented with spines arranged in a small rose and lobes with similar ornamentation. End view approximately cruciform. L = 44.5 μ m; W = 50 μ m; I = 15 μ m; Ap = 24.5 - 25 μ m; T = 31.5 μ m.

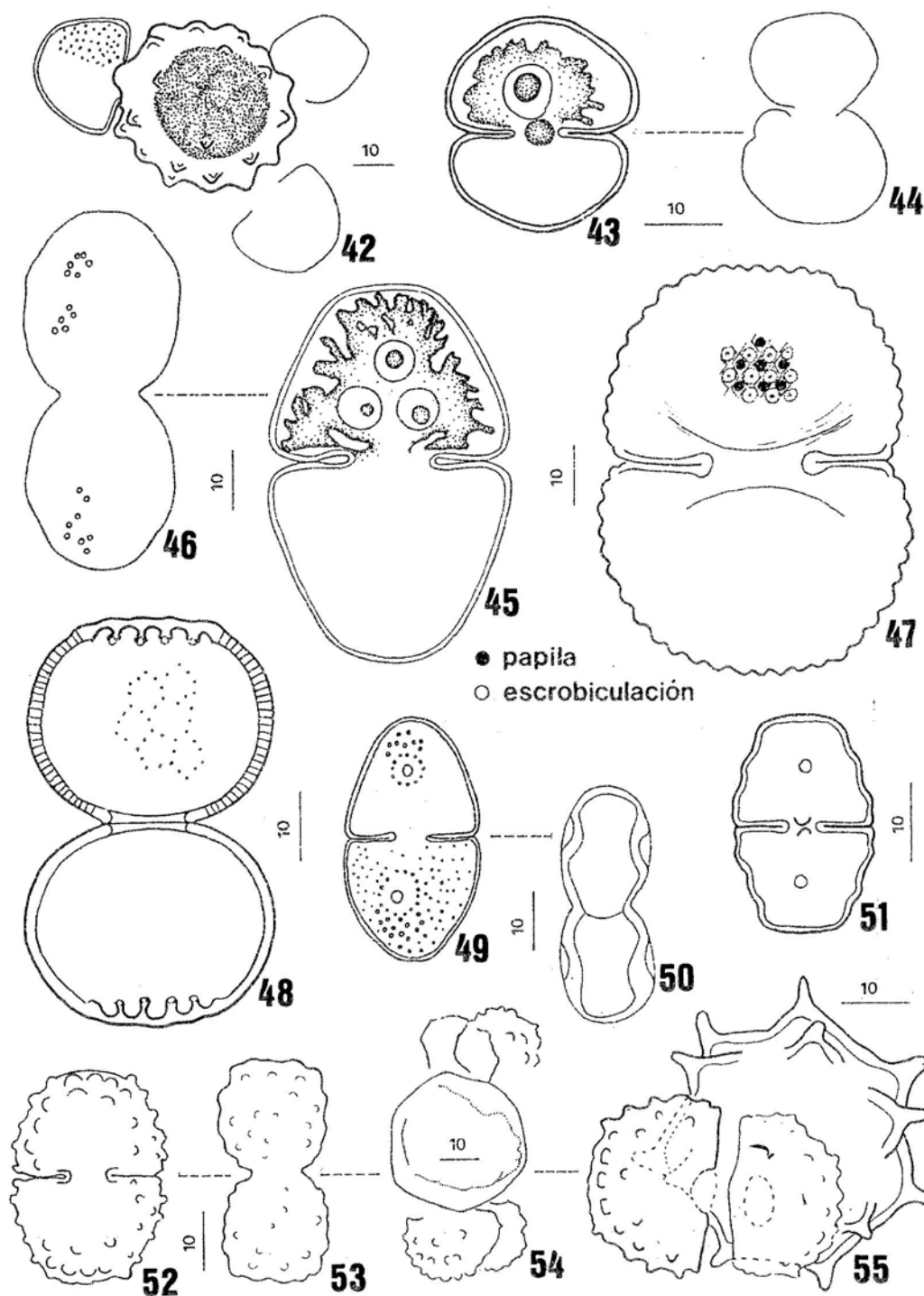
****Cosmarium paraguayense* Borge, Ark. f. Bot.
1: 88. 1903**

Figures 36-37

Cells of medium size, L:W = 1.1 - 1.2. Sinus deep and open at an acute angle. Semicell in front view crenate-elliptical and smooth apex. Cell wall with a row of stout spines arranged intramarginally, with two central spines and large scrobiculations in the center and small scrobiculations towards the periphery. End view elliptical, with sinuate margins. L = 49-52 μ m; W = 41-46 μ m; I = 15 - 16.5 μ m.



Figures 27-41.-27-28. *Cosmarium isthomocondrum* (27: frontal view, 28: lateral view); 29. *C. lagoense* var. *borgei*; 30. *C. elegantissimum* var. *elegantissimum* f. *minor*; 31. *C. elegantissimum* var. *elegantissimum* f. *elegantissimum*; 32. *C. obtusatum*; 33. *C. ordinatum*; 34-35. *C. ornatum* var. *pseudolagoense* (34: frontal view, 35: end view); 36-37. *C. paraguayense* (36: frontal view, 37: end view); 38-39. *C. paulense* (38: frontal view, 39: end view); 40-41. *C. pseudopyramidatum* var. *rotundatum* (40: frontal view, 41: end view). Bars in figures correspond to 10 μm.



Figures 42-55. 42. *Cosmarium pseudopyramidatum* var. *rotundatum* (zygospore); 43-44. *C. pseudoprotuberans* (43: frontal view, 44: lateral view); 45-46. *C. pyramidatum* var. *borgei* (45: frontal view, 46: lateral view); 47. *C. scrobiculosum*; 48. *C. redimitum*; 49-50. *C. variolatum* (49: frontal view, 50: lateral view); 51. *C. venustum* var. *basichondrum*; 52-55. *C. vitiosum* (52: frontal view, 53: lateral view, 54: immature zygospore, 55: mature zygospore). Bars in figures correspond to 10 µm.

**Cosmarium paulense* Børgesen, Vidensk. Medd. Naturh. Foren, Kjöbenh.: 39. 1890

Figures 38-39

Cells small, L:W = 1. Sinus deep and linear. Semicell in front view trapeziform-elliptical, with convex and dentate margins. Apex truncate. End view elliptical, with dentate margins and a central protuberance on each side. Cell wall with verrucae of irregular texture, some of them in an intramarginal row and others towards the center of the semicell. L = 26.5 μ m; W = 26.5 μ m; I = 9 μ m; T = 18 μ m.

Cosmarium protuberans var. *semicircularis*
Salazar C. var. nov.

Figures 60-61

Varietas haec a reliquis varietatibus forma frontalter semicirculari et scrobiculationibus crassis praesentibus diversa. Longitudo = 18.5 μ m; latitudo = 18.5 μ m, istmi latitudo = 4-5 μ m

Holotypus: Figs. 60-61

Origo: In periphyto foliorum *Hymenachnae amplexicaulis*.

Cells small, L:W = 1. Sinus deep and linear. Semicell in front view approximately semicircular (Fig. 62), with very rounded basal angles and flat apex, slightly depressed, with conspicuous central

protuberance. Cell wall ornamented with thick scrobiculations in the central protuberance and the sides, and thinner in the rest of the semicell. End view cruciform (Fig. 63). It differs from the typical form in that this new taxon is semicircular in front view and has heterogeneous scrobiculations (thick in the central protuberance and thin in the rest of the semicell). L = 18.5 μ m; W = 18.5 μ m; I = 4-5 μ m; T = 14.5 μ m.

**Cosmarium pseudopyramidatum* var. *rotundatum* Krieger & Gerloff, Die Gattung *Cosmarium* 2: 129. 1965

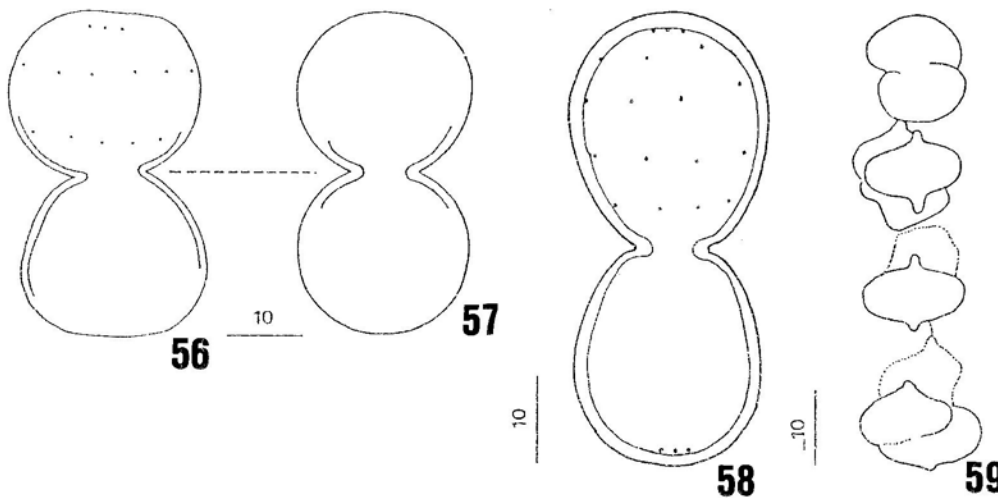
Figures 40-42

Cells of medium size, L:W = 1.55. Sinus deep and linear. Semicell in front view semicircular, with rounded angles and convex sides. Apex rounded. Lateral view and end view elliptical. Cell wall finely punctate. Chloroplast furcoid monocentric. L = 42-43 μ m; W = 27-29 μ m; I = 9.5 - 11.5 μ m; T = 20 μ m. Zygospore globose with mammillate wall, 42-48 μ m in diameter.

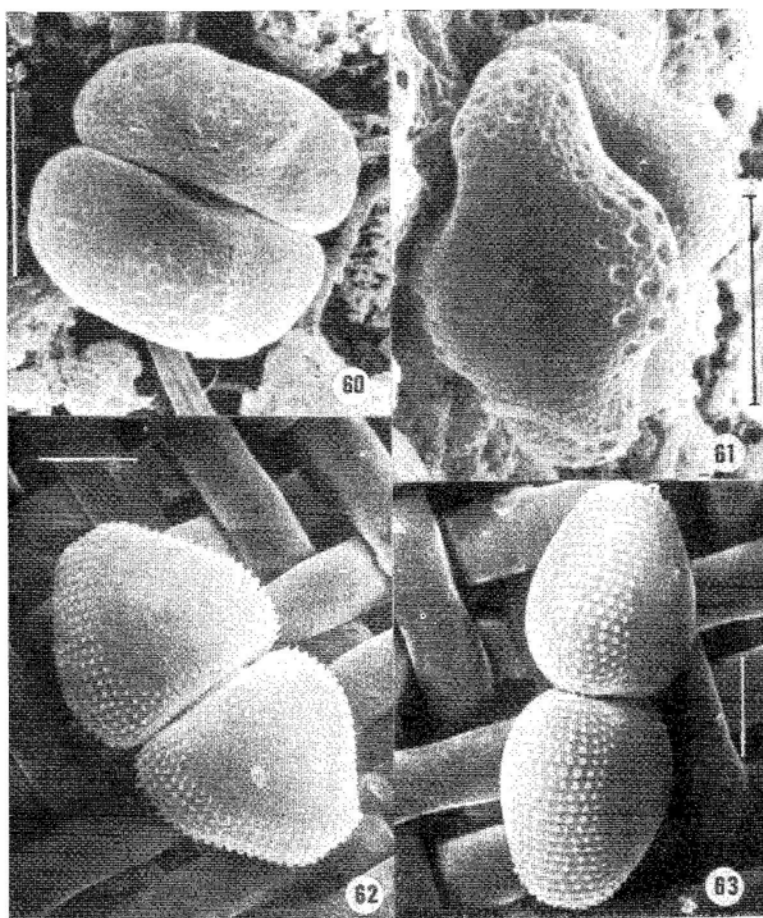
**Cosmarium pseudoprotuberans* var. *tumidum*
Borge, Bot. Notiser.: 200. 1911

Figures 43-44

Cells small, L:W = 1.09. Sinus deep and linear. Semicell in front view subhexagonal, with rounded



Figures 56-59. 56-57. *Cosmarium zonatum* var. *obversum* (56: frontal view, 57: lateral view); 58. *C. zonatum* var. *obovoide*; 59. *Cosmocladium tumidum* var. *evolutum*. Bars in figures correspond to 10 μ m.



Figures 60-63. 60-61. *Cosmarium protuberans* var. *semicircularis* (60: frontal view, 61: end view). 62-63. *C. denticulatum* var. *denticulatum* f. *borgei* (62: frontal view, 63: lateral view). Bar corresponds to 10 μm in Figs. 60-61 and 50 μm in Figs. 62-63.

angles, convex lateral margins and prominent truncate apex. End view with a protuberance on each side of the semicell. Axial chloroplast (stelloid), with a central pyrenoid. L = 27 μm ; W = 24.5 μm ; I = 6 μm ; T = 17 μm .

****Cosmarium pyramidatum* var. *borgei* Krieger & Gerloff, Die Gattung *Cosmarium* 2: 123. 1965**

Figures 45-46, 67-68

Cells of medium size, L:W = 1.5-1.8. Sinus deep and linear, dilated in the proximal end. Semicell in front view trapeziform, rounded basal and apical angles. Apex truncate or very slightly retuse. Lateral view broadly elliptic, with a small protuberance in the upper third on both sides of the semicell. Cell wall scrobiculate. L = 55-64 μm ; W = 30-41 μm ; I = 8-14 μm ; T = 26-27 μm .

****Cosmarium redimitum* Borge, Bih. till Kongl. Svenka Vet.-Akad. Handl. 24, III (12): 18. 1899**

Figure 47

Cells of medium size, L:W = 1.64. Sinus deep and opening abruptly. Isthmus slightly elongate. Semicell in front view subcircular. Apex flattened, ornamented with a crown of 14 slightly prominent mammillae and 14 scrobiculations arranged alternately. Cell wall ornamented with scrobiculations arranged in a hexagon. Chloroplast furcoid tetra-centric. L = 58 μm ; W = 36.6 μm ; I = 13.5 μm .

***Cosmarium regnellii* Wille var. *scrobiculosum* Salazar C. var. nova.**

Figures 64-65

A varietate typica scrobiculationibus praesentibus et forma lateraliter elliptica

cellulae differt. Longitudo = 19 μm ; *latitudo* = 17,5 μm ; *istmi latitudo* = 5 μm

Holotypus: Figs. 66-67.

Origo: *In periphyto foliorum Hymenachnae amplexicaulis.*

Cells small, L:W = 1.08. Sinus deep and linear. Semicell in front view subhexagonal (Fig. 66), with rounded angles and lateral margins somewhat depressed. The upper half is more prominent than the lower half, central angle projecting outward as mucro. Apex smooth and slightly convex. Side view elliptic (Fig. 67). Cell wall uniformly scrobiculate. It differs from the typical form in that it has scrobiculations and is elliptic in side view. L = 19 μm ; W = 17.5 μm ; I = 5 μm ; Ap = 13.5 - 14 μm .

***Cosmarium scrobiculosum** Borge, *Ark. f. Bot.* 1 (4): 87. 1903

Figure 48

Cells large. Sinus deep and linear, with dilated proximal end. Semicell in front view subcircular. Apex almost flat. Cell wall ornamented with verrucae and scrobiculations of circular or rhomboidal contour and a central pore. Each verruca is equidistant from 4 scrobiculations. End view elliptical, with central portion scrobiculate. L = 60-76 μm ; W = 47-53 μm ; I = 15-21 μm .

***Cosmarium variolatum var. incrassatum** Scott & Grönblad, *Acta Soc. Sci. Fennica, B*, 2(8): 23. 1957

Figures 49, 50

Cells of medium size, L:W = 1.8. Sinus deep and linear. Semicell in front view subpyramidal. Cell wall very thick, with a large central scrobiculation, surrounded by a very refringent smooth zone. Other scrobiculations of smaller diameter cover most of the semicell, except the apex, where there are other, less numerous scrobiculations that have an intermediate diameter. Lateral view subelliptical. L = 40.5 μm ; W = 22 μm ; I = 4 μm ; T = 15 μm .

***Cosmarium venustum var. basichondrum** (Nordstedt) Krieger & Gerloff, *Die Gattung Cosmarium* 22: 197. 1965.

Figures 68-70

Cells small, L:W = 1.4 - 1.55. Sinus deep and linear, slightly dilated in the proximal end. Semicell in front view pyramidal-truncate, lateral margins tri-undulate and basal angles with a small projection. Apex broad, truncate, slightly depressed in the center. Face of the semicell with a pre-isthmal verruca and two large pores, located above the verruca. End view elliptical. L = 21-25 μm ; W = 15-17 μm ; I = 4-3.5 μm .

Cosmarium vitiosum Scott & Grönblad, *Acta Soc. Sci. Fennica, B*, 2(8): 24. 1957

Figures 52-55

Cells small, L:W = 1.3. Sinus linear. Semicell in front view trapeziform. Rounded apical and basal angles, with a small denticulation. Lateral margins convex, with 5 denticulations. Apical margin undulate. Cell wall ornamented with 4-6 subapical and 3-4 lateral granules. Central area with 3-5 granules arranged irregularly. End view broadly oval. Lateral view approximately circular. L = 35.5 μm ; W = 26 μm ; I = 6 μm ; T = 19 μm . Zygospore globose, 32-24 μm in diameter, ornamented with 7 stout spines that are visible around the margin.

***Cosmarium zonatum var. obversum** Grönblad & Scott, in Grönblad, Prowse & Scott, *Acta Bot. Fennica* 58: 35. 1958

Figures 56-57

Cells of middle size, L:W = 1.69. Sinus deep and open at an acute angle. Semicell in front view subpyriform. Apex flat with rounded borders. Cell wall with 3-4 horizontal rows of small pores. Lateral view approximately circular. Chloroplast furcoid monocentric. L = 43 μm ; W = 25.5 μm ; I = 8.5 μm ; T = 25 μm .

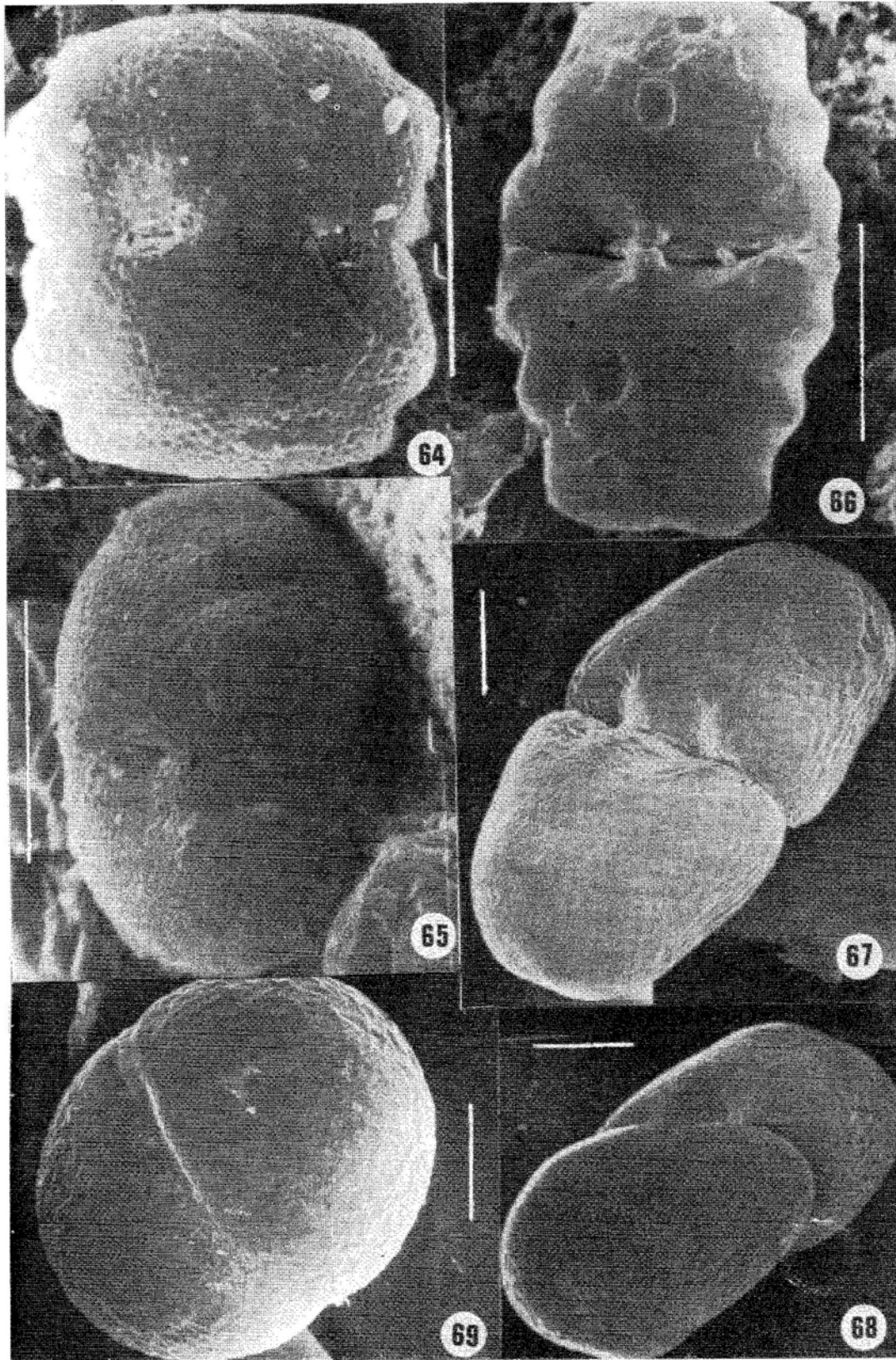
Cosmarium zonatum var. obovoide Salazar C. **var. nov.**

Figure 58

A varietate typica forma obovoidei hemicellulae diversa. Longitudo = 51.5-52.5 μm ; *latitudo* = 2.5-25.5 μm ; *istmi latitudo* = 7.5-8 μm

Holotypus: Fig. 58

Origo: *In periphyto foliorum Hymenachnae amplexicaulis.*



Figures 64-69. 64-65. *Cosmarium regnellii* var. *scrobiculosum* (64: frontal view, 65: lateral view). 66. *C. venustum* var. *basichondrum*. 67-68. *C. pyramidatum* var. *borgei* (67: frontal view, 68: lateral view). 69. *C. connatum* var. *minus*. Bars in figures correspond to 10 μ m.

Cells of medium size, L:W = 2.05-2.08. Sinus deep and opening abruptly at sharp angle. Semicells ovoid in front view. End view circular. Cell wall with 4-5 horizontal rows of small pores. It differs from the other varieties in the shape of the semicell. L = 51.5-52.5 μm ; W = 24.5-25.5 μm ; I = 7.5 - 8 μm .

Comments: The closest taxon to this variety is *C. zonatum* var. *pyriforme*, Scott & Prescott 1961. The difference between them lies in the shape of the semicell.

****Cosmocladium tumidum* var. *evolutum* Scott & Grönblad, Acta Soc. Sci. Fennica, B, 2(8): 48. 1957**

Figure 59

Cells small, L:W = 1.12. Sinus deep and linear. Semicell in front view hexagonal with rounded basal and apical angles. Apex straight. In end view elliptical, with one papilla in the center of each side. Cells in groups of 2-4 cells connected by two parallel gelatinous strands. L = 13 μm ; W = 11.5 μm ; I = 4-5 μm ; T = 10-11 μm .

ACKNOWLEDGMENTS

We are indebted to Consejo de Desarrollo Científico y Humanístico of the Universidad Central of Venezuela for financial support (CDCH N° 03.31.2964-95). Also to Prof. Bruno Manara for the Latin diagnoses.

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