MICROSCLERE VARIATIONS OF *Dosilia pydanieli* (PORIFERA, SPONGILLIDAE) IN CARACARANÃ LAKE (RORAIMA – BRAZIL). PALAEOENVIRONMENTAL IMPLICATION

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ABSTRACT

TLM and SEM analysis of spicules in a sediment core from lake Caracaranã, at the northern Brazilian savanna disclosed the past occurrence in the lake of the freshwater sponges *Metania spinata, Radiospongilla amazonensis, Trochospongilla variabilis* and *Dosilia pydanieli*, the last one with normal and modified microscleres. The study of the microsclere modification, which took place from second phase of lake recover (0-75cm; 4.770 ± 60 years ^{14}C to present), and its comparison with modern material of *D. pydanieli* confirmed the specific identification. This study has also contributed to the species habitat characterization as well as to the knowledge of the paleoenvironmental changes during the Holocene.

Key words: Brazilian savanna, lake sediments, freshwater sponges, *Dosilia pydanieli*, Holocene, paleoenvironments.

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RESUMO

Variações das microscleras de *Dosilia pydanieli* (Porifera: Spongillidae) no Lago Caracaranã (Roraima – Brasil). Implicações paleoambientais

A análise em MLT e MEV das espículas presentes em coluna de sedimentos do Lago Caracaranã, em região de cerrado no extremo norte do Brasil, evidenciou a ocorrência pretérita, no lago, das esponjas dulciaqüícolas *Metania spinata, Radiospongilla amazonensis, Trochospongilla variabilis* e *Dosilia pydanieli*, esta última com microscleras normais e modificadas. O estudo das modificações dessas microscleras, que tiveram lugar a partir da segunda fase de recuperação do lago (0-75cm; 4.770 ± 60 anos ^{14}C ao presente), e sua comparação com material atual de *D. pydanieli* confirmaram a identificação específica. Este trabalho também contribuiu para a caracterização do habitat dessa espécie, assim como para o entendimento das mudanças paleoambientais durante o Holoceno.

Palavras-chave: Cerrado, sedimentos lacustres, esponjas de água doce, *Dosilia pydanieli*, Holoceno, paleoambientes.

INTRODUCTION

The taxonomy of freshwater sponges relays mostly on the shape and size of their spicules. Because of their siliceous composition such spicules resist to the decaying processes after death of the sponge body and fall apart on the bottom sediments. The study of the spicular remains from cored sediments of lakes, ponds and bogs, particularly when spicules which invest the gemules are detected, allow for the identification of the sponge species which lived in such habitats (Harrison, 1988; Harrison et alii., 1979; Harrison & Warner, 1986; Sifedine et alii., 1994; Turcq et alii., 1998). Particular modifications of size and shape of the spicules may be considered as ecomorphic variations (Poirrier, 1974) thus also handling significant clues to the habitat in wich the specimens were thriving . It was recently demonstrated that the SEM study of modifications of the size and shape of fresh water sponge spicules may be a helpful tool in paleoenvironmental interpretations (Volkmer-Ribeiro & Turcq, 1996). A 2 m long sediment column was recovered from Lake Caracaranã, at the savanna of Roraima State, northern Brazil. Analysis of the spicules found in that column aimed to: 1) identify the freshwater sponge species which contributed to the sediments, 2) identify the living sponges of genus *Dosilia* collected from the lake and also presents in the sediments, 3) contribute to the paleoenvironmental study of the lake.

MATERIALS AND METHODS

Lake Caracaranã (3°51'N-59°48'W) has a shore line of 5,8 km and is presently a perennial lake which receives its waters from a number of

ephemeral upstream ponds linked by narrow creeks ("veredas"). The lake inlet flows into its sole site of rooted aquatic vegetation (2m deep). The lake deepest area (5m) corresponds to the place were Core 94-9 was recovered (Fig. 1). Characteristics of the lake water are presented in Table 1 (Simões Filho, 2000).

Examined specimens: Roraima, Normandia, lago Caracaranã, MCN 1936, P. S. Mera leg. 16.XII. 1987; Alto Alegre, Ilha de Maracá, grassy-pond, MCN 1509, MCN 1379 (Volkmer-Ribeiro, 1992).

Examined sediments: Core 94-9, measuring 190 cm, was recovered by a vibro core device and its studied fractions are numbered in Table 2. The sediments were dated by the radiocarbon method from the beginning of the Holocene to the present age. The litology and the ^{14}C ages are presented in Fig. 2, according with Simões Filho (2000), showing three main sedimentary units.

Digestion of organic materials from specimen MCN 1936 as well as from the sediments followed Volkmer-Ribeiro & Rützler, 1997; and Volkmer-Ribeiro & Turcq, 1996 for respectively TLM (Transmission Light Microscopy) and SEM (Scanning Electron Microscopy). All analyzed materials (sponge and sediments) are deposited and catalogued in the Porifera Collection of Museu de Ciências Naturais (MCN) of Fundação Zoobotânica do Rio Grande do Sul.

RESULTS

The living sponge collected from lake Caracaranã (MCN 1936) was seen to belong to genus *Dosilia* Gray, 1867 which has only one Neotropical species, *D. pydanieli* Volkmer-Ribeiro, 1992. The specimen was compared to type material of *D. pydanieli* from the Ilha de Maracá, Roraima. The microscleres of the living specimen include many short acanthotylostyles (Figs. 3, 10 and 11) whilst the spiny asters of *D. pydanieli* are missing. All other characteristics of specimen MCN 1936 agree with the species description, including spicular sizes. However the acanthotylostyles length may be longer than the asters main diameters (Table 3). The SEM study of the microscleres from MCN 1936 shows however also microscleres which come very close to the variations of the asters in *D. pydanieli* from the Ilha de Maracá which depart from a spicule with a conspicuous «centrum» bearing a variable number of irregular, perpendicular, straight spiny rays (Fig. 4a and

4d). From that condition a gradual reduction of the number of rays takes place (Figs. 4c, 4e, 7 and 8) reaching a spiny anfioxea with none or just one ray projecting from the "centrum" (Fig. 4f). A drastic reduction of the microsclere rays seems to have been attained in specimen MCN 1936. All grading steps of this ray suppression from an aster with a reduced number of rays down to an acanthotylostyle can be seen in that specimen (Figs. 3, 10 and 11) as well as in the cored sediments (Figs. 6-9).

However the sediments from core 94-9 have spicules of four (Table 2) of the five freshwater sponges characteristic of Brazilian savanna ponds (Volkmer-Ribeiro et alii., 1998): *Dosilia pydanieli* Volkmer-Ribeiro, 1992, *Metania spinata* (Carter, 1881), *Trochospongilla variabilis* Bonetto & Ezcurra de Drago, 1973 and *Radiospongilla amazonensis* Volkmer-Ribeiro, 1983. The sediments taken from 54-55 cm depth (Table 2: MCN 3382) have, on the other hand, megascleres and gemoscleres of *D. pydanieli* plus the two kinds of microscleres, i. e., the short acanthotylostyles and the characteristic spiny asters (Figs. 5-9), whilst above that level the acanthotylostyle microscleres were the only ones seen. Only the typical asters were seen together with the megascleres and gemoscleres of *D. pydanieli* at the very bottom of core 94-9 (Table 2: MCN 3389).

A sedimentological and geochemical study of 94-9 core indicated a first development of aquatic vegetation from the base to 132 cm (8600 yrs cal. B.P.), then a dryer phase until 67cm (3800 yrs cal. B.P.) and a new lake level rise reaching its full present-day development at 45cm (1800 yrs cal. B.P.) (Simões Filho, 2000).

Sediments of core 94-9 (Table 2) were richer in diatoms than in sponge spicules indicating a competition between the two organisms in habitat conditions that favored diatoms instead of sponges.

DISCUSSION

The freshwater sponge community characteristic of the usually shallow, eutrophic Brazilian savanna ponds (Volkmer-Ribeiro et alii., 1998) has five species, i.e., the four ones detected in the Lake Caracaranã sediments plus *Corvomeyenia thumi* (Traxler, 1895) which encrusts the aquatic vegetation close to the water/air interface from the middle to the end of the dry season. *C. thumi* was not detected in the past as well as the present Lake Caracaranã thus indicating that seasonal remarkable lowerings of the water level did not

occur in this lake although lake dryings are presently observed in the lake during exceptionaly dry years (**e.g.** during 1983 El Niño South Oscillation – ENSO) and very probably occured inter-anualy during the past dryer periods (Simões Filho, 2000). On the other hand the sponge *Metania spinata* that was seen to be the first one to appear in spongillite forming ponds seems to prefer the deeper phase of those ponds history (Volkmer-Ribeiro et alii., **op. cit.**). *Metania spinata* occurred in the upper organic sediments of Lake Caracaranã indicating that the water column has increased towards the present time. The spicules of *Dosilia pydanieli* (among them the normal microscleres) appear from the middle to the top of the spongillite deposits formed in the Brazilian savanna ponds (Volkmer-Ribeiro et alii., **op. cit.**). The species optimum seems to be related to seasonal dry periods resulting in higher dissolved silica in the water. The increasing of the Lake Caracaranã water column corresponds to the formation of the reduced *D. pydanieli* microscleres thus indicating an unfavorable habitat for the species. The larger water depth in the lake would have favored the development of planctonic diatoms and accounted for less available silica in the water and thus for the formation of microscleres with a reduced number of rays. Also indicative of a quite perennial deep water column are the facts that macrophytes have never colonized the center of the lake since 10,000 yrs cal. B.P. and that gemoscleres (and so the gemule production) are scarce throughout the sediment column. Gemule production is a remarkable characteristic of tropical fresh water sponges subjected to seasonal dry periods (Volkmer-Ribeiro, 1981). Besides, the scarcity of macrophytic stands in the lake produced a lack of available substrate for sponge fixation.

CONCLUSION

The conclusion is thus apparent that a perennial, oligotrophic condition with reduced occurrence of aquatic vegetation prevailed during most of Lake Caracaranã life what seems to have favored diatom instead of sponge production. The missing aquatic vegetation would also have accounted for the absence of substrate needed for sponge fixation. Harrison & Warner (1986) remarked already that spicules become abundant as the sediments increase in pollen and aquatic vegetation remains.

The unfavorable conditions prevailing in Lake Caracaranã in what respects sponge production indicate that the microscleres of *D. pydanieli*, either from modern specimens or preserved in the sediments, stand for an

ecomorphic variation that represents an answer or adaptation to the environment change. The illustration of these variations seen in the asters of paratypes of *D. pydanieli* from Ilha de Maracá, also in Roraima State, (Figs. 3 and 9) already evinced that trend. However, the most convincing evidence to sustain the identification of the modern and past spicular materials as *D. pydanieli,* springs from the fact that in one past same level (54-55 cm) both microscleres could be seen side by side together with the species gemoscleres (Table 2, MCN 3382 and Figs. 4-8). At that time the lake was recovering from an evident previous drier period (level 75-76cm).

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TABLE 1 – Characteristics of modern sediments (% C) and of the water column (pH, conductivity, depth, and aquatic vegetation coverage) from Lake Caracaranã, Roraima, Brazil, in the dry (left) and wet (right) season.

	Lago Caracaranã
Surface (ha)	80,0
Depth (m)	2,0-5,0
% Coverage of Aquatic vegetation	10
PH	5,0-6,7
Conductivity (μS)	38,6-52,5
% COT	8,20

TABLE 2 – Taxonomic analysis of sponge spicules found in sediments of Core 94-9, recovered from Lake Caracaranã, Municipality of Normandia, Roraima State, Brazil.

MCN Number	Depth (cm)	Characteristics of the silicious remains
3380	1-2	Spicules rare and thin: Alfa and beta megascleres and gemoscleres of *Metania spinata*, megascleres and gemoscleres of *T. variabilis*, gemoscleres and modified microscleres of *Dosilia pydanieli*. Diatoms make the bulk of the siliceous remains with the presence of *Pinnularia*, *Aulacoseira*, *Eunotia* and *Frustulia*. No charcoal fragments. No sand.
3381	16-17	Spicules and diatoms same as for 3380. However the megascleres of *T. variabilis* are the dominant spicules.
3382	54-55	Spicules are few with dominance of the *T. variabilis* megascleres, however **both kinds of the *D. pydanieli* microscleres, the aster with reduced rays and the acanthotylostiles, are seen.** Diatoms show a conspicuous reduction but make yet the bulk of the siliceous remains. Some charcoal fragments and sand grains present.
3383	75-76	Biogenic siliceous structures (diatoms and spicules) almost absent. Rare modified microscleres of *D. pydanieli*, megascleres of *T. variabilis* and of *M. spinata* can be seen. Charcoal fragments and sand grains are present.
3384	101-102	Rare spicules, a few aster microscleres of *D. pydanieli* and a few megascleres of probably *T. variabilis*. No diatoms and abundant sand grains. Charcoal fragments also present.
3385	128-129	The rare spicules are megascleres and gemoscleres of *T. variabilis*. Diatoms also rare and broken. Much sand grains. Few charcoal fragments.
3386	134-136	Spicules rare: megascleres and gemoscleres of *T. variabilis* and *R. amazonensis*. Diatoms also rare, mostly broken. Some small grained sand. No charcoal fragments.
3387	152,5-153,5	Spicules are some rare gemoscleres of *D. pydanieli* and *T. variabilis*. Centric diatoms make up the bulk of the sediment. Some rare small charcoal fragments. No sand.
3388	165-166	Sponge spicules rare with broken gemoscleres of *R. amazonensis* and of *D. pydanieli*. The bulk of the sediment is made of broken diatoms. Considerable amounts of small charcoal fragments. No sand.
3389	189-190	The only biogenic siliceous structures present are sponge spicules, which are however not abundant and mostly broken. Megascleres and gemoscleres of *R. amazonensis*, gemoscleres of *T. variabilis* and gemoscleres of *D. pydanieli* and also aster microscleres of the last species. No charcoal. Much sand grains.

TABLE 3 – Spicular dimensions in micrometers for specimens of *Dosilia pydanieli* from the Maracá Island and from Lake Caracaranã, Roraima, Brazil.

	Length Range	Mean ± SD	Width Range	Mean ± SD	Diameter Range	Mean ± SD
MCN 1379/Maracá						
Megascleres	(448,4 - 303,4)	396,8 ± 29,8	(15,5 - 6,7)	11,9 ± 1,9	–	–
Microscleres						
Oxeas	(85,6 - 41,4)	56,8 ± 9,5	(4,9 - 2,1)	2,9 ± 0,5	–	–
Aster	–	–	–	–	(55,9 - 26,8)	41,3 ± 6,8
Gemoscleres	(115,0 - 83,1)	100,6 ± 5,3	(6,0 - 2,9)	4,2 ± 0,6	(36,4 - 22,5)	29,5 ± 2,5
MCN 1509/Maracá						
Megascleres	(452,1 - 358,5)	405,8 ± 20,4	(15,9 - 10,7)	12,8 ± 1,4	–	–
Microscleres						
Oxeas	(70,5 - 37,5)	56,2 ± 7,6	(2,9 - 1,9)	2,4 ± 0,3	–	–
Aster	–	–	–	–	(64,7 - 29,4)	44 ± 7,8
Gemoscleres	(114,4 - 95,6)	103,6 ± 4,4	(5,6 - 3,4)	4,6 ± 0,5	(35 - 24,8)	29,9 ± 2,2
MCN 1936/Caracaranã						
Megascleres	(555,0 - 441,0)	493,8 ± 26,0	(21,5 - 13,0)	17,2 ± 1,7	–	–
Microscleres						
Acanthotylostyles	(84,1 - 49,0)	59,8 ± 6,5	(6,1 - 2,9)	4,3 ± 0,7	–	–
Aster	–	–	–	–	–	–
Gemoscleres	–	–	–	–	–	–
MCN 3382/Caracaranã						
Megascleres	–	–	–	–	–	–
Microscleres						
Acanthotylostyles	(76,3 - 32,7)	57,9 ± 10,3	(4,4 - 2,4)	3,5 ± 0,6	–	–
Aster	–	–	–	–	–	–
Gemoscleres	(111,2 - 88,2)	100,7 ± 8,5	(6,5 - 3,8)	5,2 ± 0,9	(33,2 - 26,7)	30,2 ± 2,1

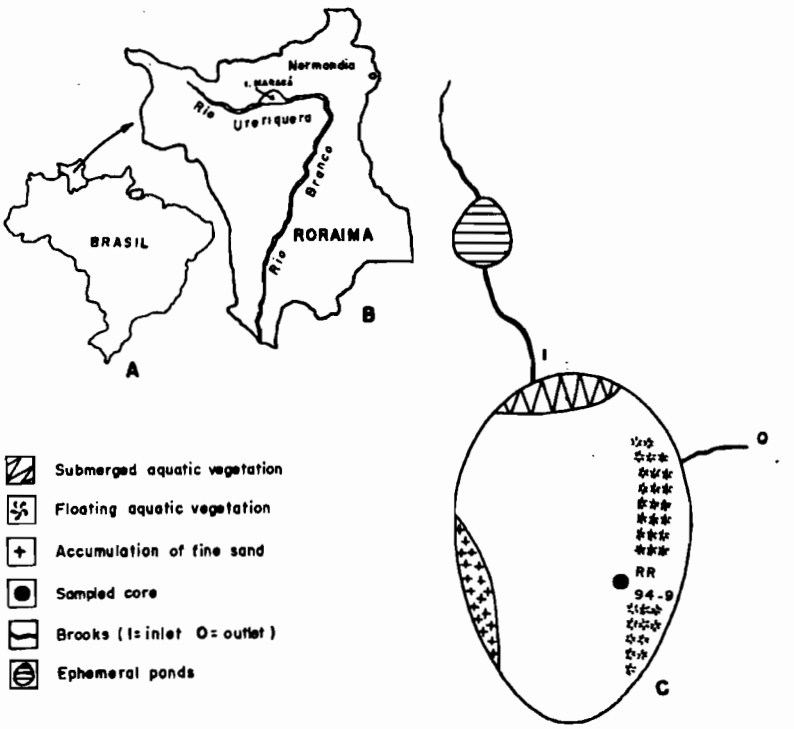


Fig. 1. Localization maps: a-b) Normandia and Ilha de Maracá, Roraima, Brazil; c) Localization of Core 94-9 in Lake Caracaranã.

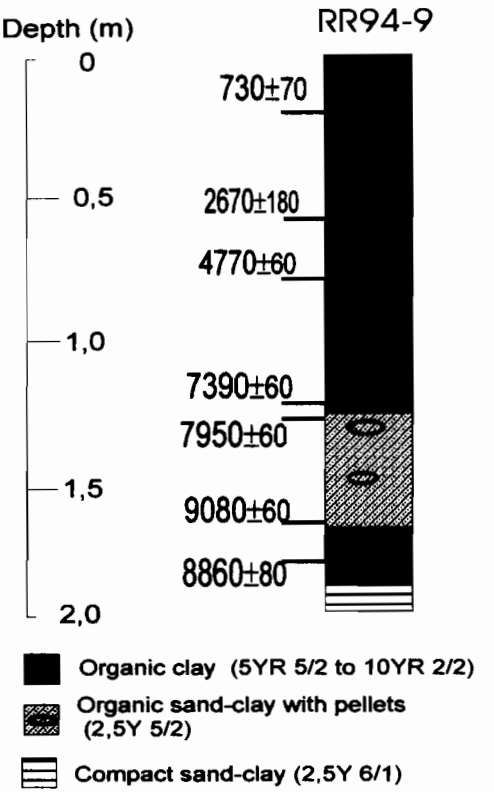


Fig. 2. Litological description and ^{14}C ages of core RR94-9 from Caracaranã Lake. (Simões Filho, 2000).

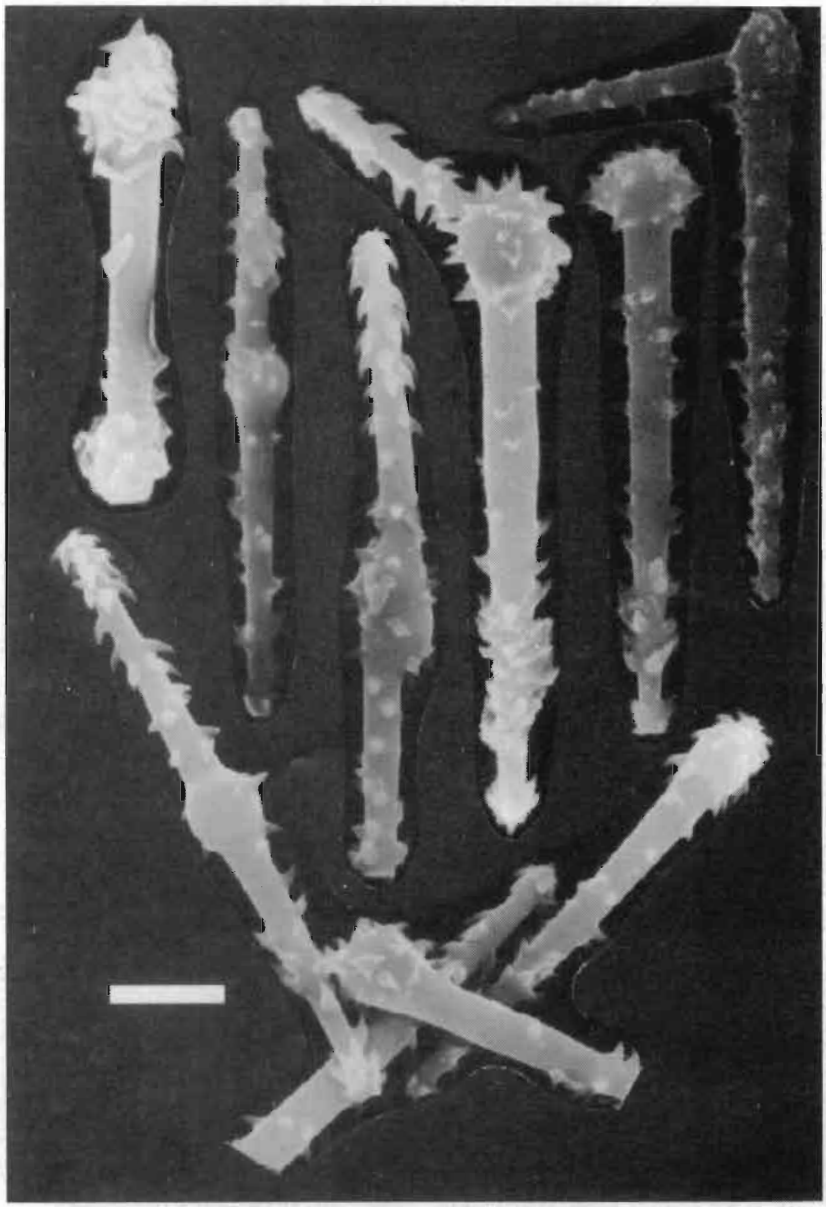


Fig. 3. SEM of modified microscleres (acanthotylostiles) from *D. pydanieli*, MCN 1936 (scale = 10 μm).

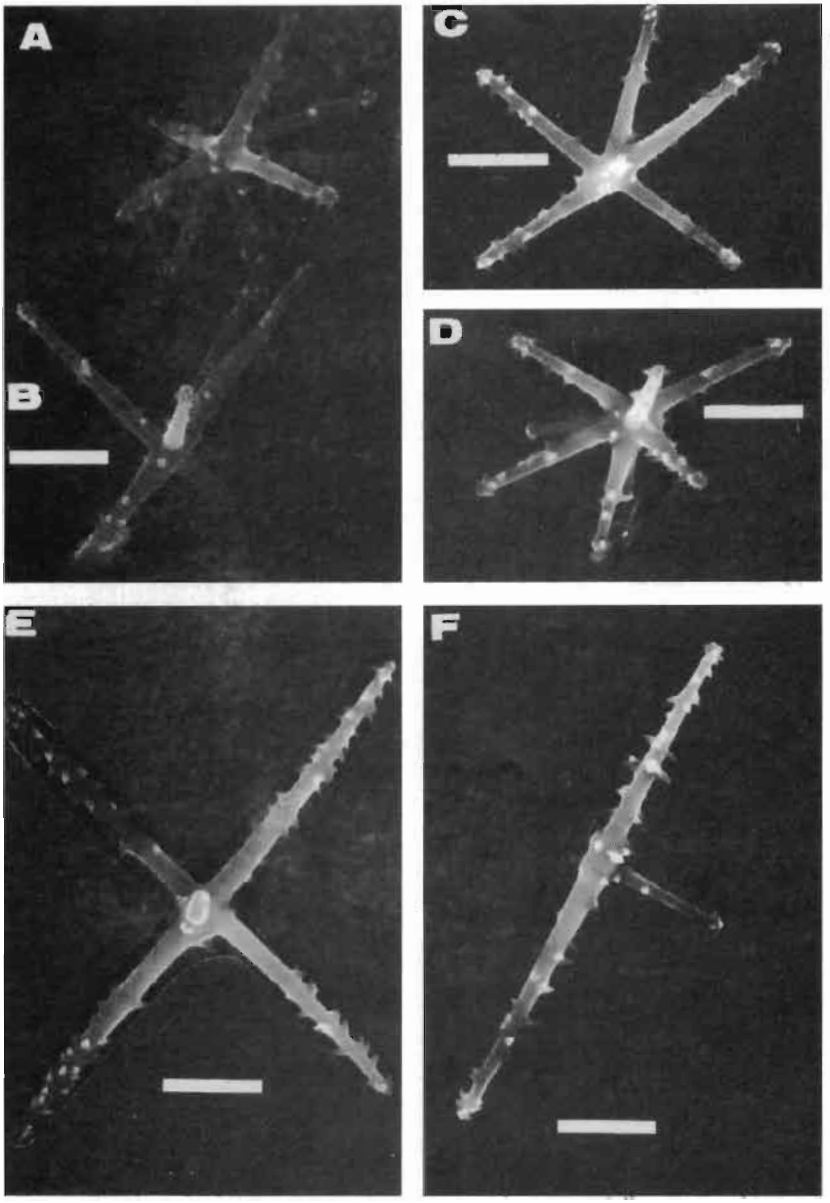
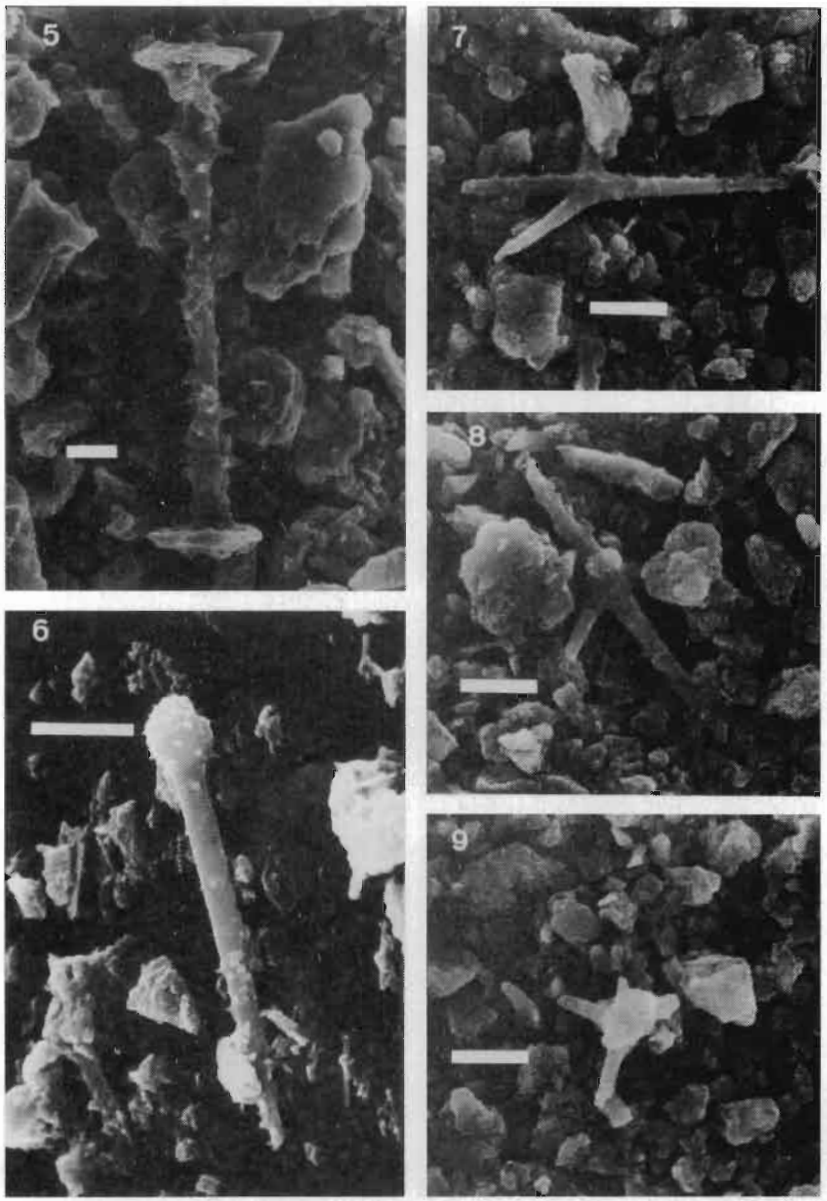


Fig. 4. SEM of microscleres of *D. pydanieli* (MCN 1509), showing the reduction of the rays: a-d) asters with six or more rays; e) aster with 4 rays; f) anfioxea with only one, perpendicular, ray. (Scale = 10 μm)



Figs. 5-9. SEM of spicules of *D. pydanieli* present in the sediment of core 94-9 (MCN 3382): 5) gemosclere; 6) acanthotylostile microsclere; 7-8) microscleres with reduced rays; 9) aster microsclere with broken rays. (Scale = 10 μm)

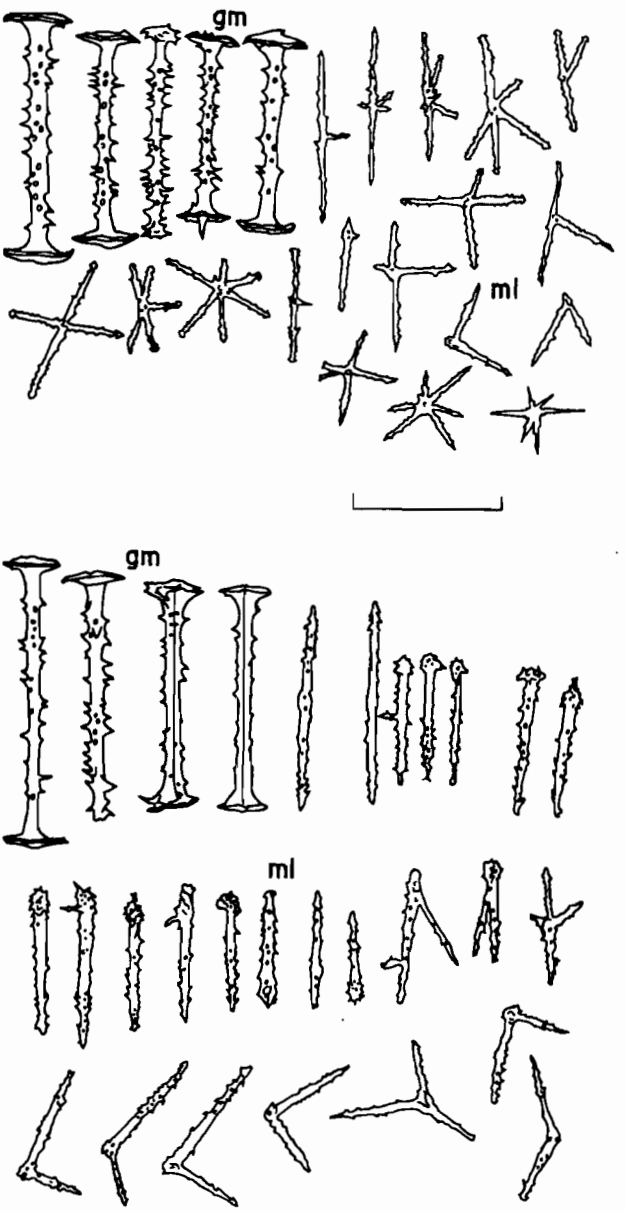


Fig. 10. Camera Lucida drawings of spicules of *D. pydanieli* (MCN 1379 and MCN 1509) (upper half) and MCN 1936 (bottom half): gm = genioscleres; mi = microscleres. (Scale = 50 μm)

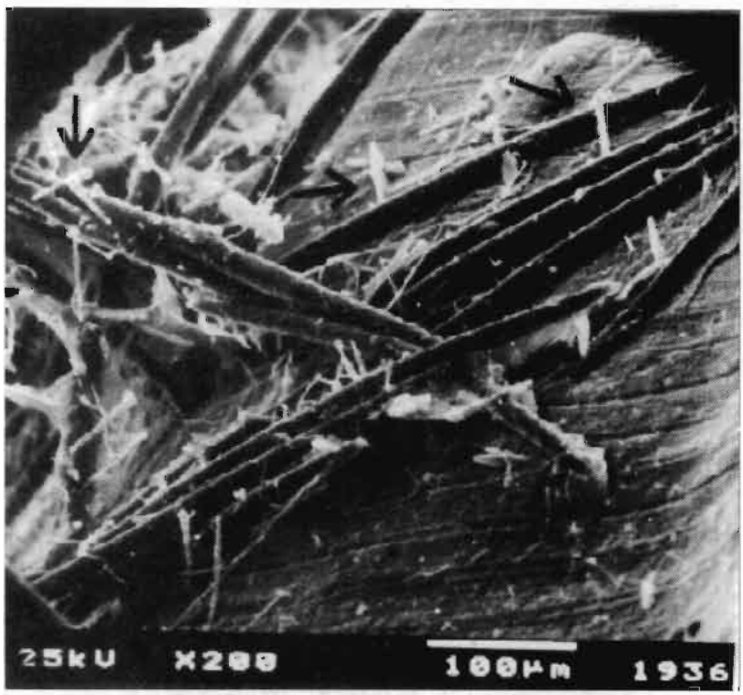


Fig. 11. SEM of the poorly developed squeletal structure of modern *D. pydanieli* (MCN 1936) showing several acanthotylostiles (arrows). The sponge encrusted the stem of aquatic vegetation. (Scale = 100µm)