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# Studies on the Morphology of Different Valve Types of the Centric Diatom Species *Pleurosira laevis* (Ehr.) Compère

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**Abstract:** Specimens of the centric diatom species *Pleurosia laevis* were collected from many natural habitats in Egypt and examined using LM and SEM. This work aimed to study the morphology of different valve types (Polymorphic types). The polymorphism phenomena observed in the in the species *Pleurosira laevis* investigated in this study. Four different morphological valve types exist side by side, normal vegetative type, long and narrow width vegetative type, the resting spore and the intermediate valve type in the same specimen. Full description of two types of vegetative cell structure, resting spore morphology and an intermediate form of valve structure were done and comparisons between these structures were recorded. Environmental conditions, which affect on the formation of the polymorphic structures, were discussed. Finally, the resting spore and intermediate valve types of *Pleurosia laevis* are recorded and described for the first time.

**Keywords:** Resting spores, polymorphism, *Pleurosia laevis*

## INTRODUCTION

Although most diatoms divide to produce valves that are virtually identical to the parent valves, except in size, a few species are pleomorphic, the new valves differ from the parents in the degree of silicification and even to some extent ion the arrangement of the areolae (Round *et al*,. 1990).

During resting spore formation different morphologically valve types may be found which cannot easily be and probably often have been identified as belonging different species. These valve types are normal vegetative valves, rudimentary valves, resting spore in addition intermediate valve types between those mentioned and representing various degrees of development are often seen (Hasle and Syvertsen, 1996).

The problems of the polymorphism phenomena in diatoms cause taxonomists are relatively overcome through the careful study of natural populations.

Vegetative cells structure, auxospore, and the initial cell of the *Pleurosia laevis* (Ehr.) Compère (*Biddulphia laevis*) were studied, but is not clear from the literature any observation about the morphology of resting spores of this species.

In Egypt, *Pleurosia laevis* (*Biddulphia laevis*) was recorded in different aquatic habitats during many floristic and ecological studies. These habitats include hard water with relatively high electrical conductivity (El-Awamri, 2007); fresh water aquatic habitats (Foged 1980, Shaaban 1994, El-Attar, 2000, Dehyab *et al.,* 2000 and El-Awamri 2005) and brackish water habitat (El-Awamri *et al*; 2000 and Saleh; 2003).

The aim of the work is to study the morphology of vegetative valves, resting spores and any intermediate valve types of the species *Pleurosia laevis* based on material collected from different localities and natural habitats in Egypt in trail to complete the different polymorphic valve types of this species.

### *Ecology, taxonomical and nomenclatural history of Pleurosia laevis (Ehr.) Compère:*

*Pleurosia* was suggested by Meneghini (1846) for a subgenus of *Melosira*; the only species cited thus the type of the name *Pleurosia*, was *Melosira (Pleurosia) thermalis* Menegh.

The subgenus was raised to genus by Trevisan (1848). Thus the genus name *Pleurosia* (Menegh.) Trevis. Then the type species of *Melosira*, was rapidly classified under different names (in Pritchard 1861) or *Biddulphia laevis* Ehr. (Hustdt 1927-1930), and the genus name *Pleurosia* was never used again after 1848. Compère (1981 a, b) suggested that diatoms closely related to *Biddulphia laevis* Ehr. as *Ceratalulus laevis*. Compère (1982) validated the name *Pleurosia* as the correct genric name for the diatom which has long been called *Ceratalulus laevis* (Round *et al*,. 1990).

Ecology of *Pleurosia laevis* is a typical brackish diatom (Cholnoky 1968). It is commonly found in the estuaries of large rivers, but it is also to survive in inland waters with a higher conductivity, it is also cosmopolitan distributed and seems more abundant in warm-temperate and tropical waters.

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## MATERIALS AND METHODS

***Material:***

Specimens of *Pleurosia laevis* were collected from many localities in Egypt. The main localities were:

- Giza: Small irrigation canals at El- Baragel, Kom Bora, Bartus villages, El-Mansuria canal and El-Moheet Drain, Saft El-laban(small canal), and Giza Zoo. The collected samples appeared as greenish-brown to brown filaments, intermingled with many other filaments and attached algae. These samples are mainly aerial, subaerial and submergeds epilithic filaments.
- Cairo: Specimens were collected from the ground seepages water at Kobri El- Kobba station as subaerial and submerged filaments.
- Alexandria: El-Possilly region near Edku Lake on the road of Alexandria Rossetta (sand dune region), scraping from small cemented irrigation canals intermingled with *Spirogyra* sp. filaments.
- El-Fayum: Wadi El-Rayan region from the small canal connected the upper and lower lakes of Wadi El-Rayan. These samples were subaerial and aerial epilithic benthic filaments. Also, many samples were collected from the woody Persian wheels (El-Sawaky) at El- Fayum City as a brownish and greenish brown scraping.
- El-Qaleobiya: samples were collected from Tall El-Yahodea and Kafr Hamza as brown epilithic greenish to greenish-brown filaments.

***Methods:***

The collected samples were preliminary examined microscopically, then preserved and fixed by adding few drops of formalin (4%). These samples were prepared for Light (LM) and scanning electron microscope (SEM) investigation by cleaning frustules using the method described by Jouse *et al.* (1949), For LM study, the material was mounted according to the method described by Proschkina-Laverenko *et al*., (1974). The technique used to prepare diatoms for SEM is that adopted by Hasle and Fryxell (1970). The terminology of the ultrastructure of diatoms follows the suggested by Anonymous (1975), Ross *et al*., (1979) and Round *et al*., (1990)

## RESULTS AND DISCUSSIONS

***Results:***

***Observations:***

During this study of *Pleurosira laevis* four morphological forms existed side by side in the same specimens at two regions, El-Possilly and Wadi El-Rayan regions. The four morphological forms are two forms of vegetative cells, a resting spore and of an intermediate form of valve morphology. The normal vegetative cells of *Pleurosira laevis* is flourished in the Persian wheels (EL-Fayum), Kobri El-Kobba (Cairo) and Giza Zoo. Full description of the vegetative cells frustular structure, the resting spore structure and the intermediate form of valve structure using LM and SEM are represented as follows:

***Description of the Vegetative Cells Frustular Structure:***

The cells are cylindrical and united together in zig-zag filaments by means of mucilage pads extruded through ocelli which occur at the edge of valve face. There are two ocelli on each valve but only one is involved in cell attachment (Plate I, fig. 1). Plastids are many and discoid. In girdle view cells are rectangular. The length of the cell may be varying greatly between 45-210 µm., this is due to the varying number of girdle bands in the cingula. Girdle bands ranged from three to eight bands. Shorter cells often have a little number of bands (Plate I, figs. 1 – 5). The first girdle band (valvocopuola) underlaps valve mantle (Plate I, figs. 2 – 5). The second and subsequent copulae have ligulae (Plate I, figs. 2 & 3).

The width (diameter) of the cells varies between 20 – 90 µm, the valves are clearly differentiated into two parts, a vertical mantle and a flat face (valve face). The valve face is circular or broadly elliptic, provided with two marginal ocelli (Plate I, fig. 4 and Plate II, figs. 1 – 4). Though a slightly increase in the diameter is noted on a line passing through the ocelli. The valve face usually flat and two labiate processes (rimoportulae) located in the central part, about midway between the centre and the margin or little nearer to the centre (Plate II, figs. 1 – 4).

The two ocelli are usually lie on the valve rim and extend partly on to the valve face and partly on the mantle (plate I, fig. 4 and Plate II, figs. 1 – 4). They are usually oval (4 – 5 µm in width and 8 – 15 µm in length) and project a little from the valve rim (Plate II, figs. 1 & 4 and Plate III, figs. 1 & 2). The porelli in the ocelli are closely spaced but form no recognizable pattern and the ocellus is delineated by papillose ring.

Areolae arranged in striae (13 – 15 in 10 µm radiating from one or more centres on the valve surface (Plate II, figs. 1 & 3). The surface is ornamented with spines, numerous and well developed on the valve rim and toward the mantle (Plate I, fig. 3 & 4 and Plate II, figs. 2 & 4). The valve rim is rounded but valve face and mantle at an angle of 90º. The valve face and mantle are similar in structure

(Plate I, fig. 3 & 4 and Plate II, fig. 4). On the internal valve surface (Plate II, fig. 3), the rimoportulae occur in slight depression. The free edge of the mantle has a projecting flange which has fimbriate margin. The first (valvocopuola) underlapes the mantle in a split ring and has a fimbriate margin (Plate I, fig. 3 and Plate III, fig. 3).

***Description of the Resting Spores of Pleurosira laevis:***

The resting spores infrequently observed and found in the examined specimens mainly from the collected samples of EL-Possilly and Wadi El-Rayan regions. The resting spores were only recorded in the filaments of long cells and their diameter 25-45 µm. (Plate I, fig. 1). These spores have a distinct morphology differ than the morphology of the normal vegetative valves.

The spore is endogenous type i.e. completely enclosed within the parent cell (Plate III, figs. 5 & 6. and Plate IV, figs. 1 & 3). There are one or more resting spores enclosed within the vegetative cell (Plate III, fig.5).

The resting spore contains only one large ocellus appears as a volcano opening through the upper valve (Plate III, fig. 6), spherical in shape. The spore has a heavily silicified wall (Plate IV, figs. 2 & 4). The ocellus is present at the top of the spore, 8 µm in diameter, with fine poroid areolae. The ocellus is slightly elevated from the spore wall. The spore is surrounded by one or more girdle bands, (cingula) their diameter 20-35 µm. The areolae of the resting spore are closely spaced arranged in circle rows until they reach to the ocellus, their number is 13-15 in 10 µm. The spore surface is ornamented with numerous and thicken short spines (Plate IV, figs. 2 & 5).

***Description of the Intermediate Valves of P. Laevis: (Plate Iv, Figs. 5&6):***

The intermediate valves described here obtained from the specimens collected from El-Possilly and Wadi El-Rayan regions. The frustule has a structure more closely resembling a normal vegetative valve in basic structure although, presence of certain differences in both valves. The intermediate valve has a heavily silicified frustule, the valve is rectangular in girdle view. The length of the cell ranged from 45-50 µm and 25-30 µm in width. Girdle bands are present but slightly silicified. Like the vegetative cell, the first girdle band underlaps the valve mantle. The valve face is flat with slightly depression in which one rimoportulae is present. The valve face is nearly circular provided with two very large elevated ocelli, these ocelli lie on the valve rim and extend partly on the valve mantle. The ocellus is oblong ovate 9-10 µm in length and 5 µm in width.

Fine poroid areolae are seen on the valve face, valve mantle and girdle bands. Areolae arranged in radiating manner. The valve surface is covered with heavily silicified spines. The valve face and mantle are similar in structure and the valve rim is rounded. The connecting region between the epivalve and valvocopula covered with a numerous spines.

In brief, the main characteristic features of the intermediate frustules are, small size of the valve, long cell frustule, large mantle, very large ocelli comparing the dimension of the main valve face, condensed number of spines in the region connecting between epivalve and (valvocopula) and presence of only one rimoportulae.

Comparing between the two types of vegetative cells (normal vegetative cell and long and narrow vegetative cells) it was found that, the first one has broadly elliptic to circular valve face with large diameter. Three to five girdle bands, absence of resting spores inside the frustule and is characterized by a narrow vertical mantle. While the other valve type (long and narrow vegetative cell) is usually circular in valve face, number of girdle band 4-8 with narrow width, produces resting spores inside the valve.

***Discussion:***

Changes is size during the life cycle are frequently accompanied by changes in morphology of diatoms (Mann, 1990).

The polymorphism phenomena observed in the in the species *Pleurosira laevis* investigated in this study. Four different morphological valve types exist side by side, normal vegetative type, long and narrow width vegetative type, the resting spore and the intermediate valve type in the same specimen it is suspected that they may be different products of the same genotype and produced as a result of changes in the environmental conditions.

Gradual changes in the environmental variables generally produce graduated rather than abrupt changes in morphology. In genus *Pleurosira* slight gradual decreases in valve width or diameter can occur with elevated (Jahn, 1986) or lowered salinity (Cox, 1995). Various valve morphology types may be found in a population of species capable of developing morphologically distinct forms in response to the environmental influences. In general diatom resting spores are normally formed as a response to unfavorable environmental conditions and germination occurs when the conditions improve (Hargraves and French, 1983). In the examined specimens, resting spores were found in natural habitats characterized by presence of periods of drought at intervals. This observation was recorded in the same and nearly conditions in Sultante of Oman (El-Awamri and Hamed, 2005). The considerable extension of the pervalvar axis in cells of narrow filaments suggest that in the particular habitats size reduction has come to a half. Cells less than 40µm diameter are the ones on which auxospore and resting spores are formed. It is possible that when they reach this size they rarely divide and grow occurs by laying down of more gridle bands elements and intermediate valve type may also formed. Polymorphism, during and after environmental changes specimens may be found which have to do different valves reflecting different environmental conditions. This type of morphological adaptation has been formed also in *Thalassiosira rotula* (Syvertsen, 1977).

Ehrlish (1982 a,b) described frustular structure, auxospore and the initial cells of the inland brockis water *P. laevis* and reported for the first time and reported that intial epivalve (funnel shape), open at both ends and locks ocelli. The initial hypovalve is cup-shaped and with ocelli and regularly arranged areolae resemble the normal vegetative valves more closely than that the initial epivalve. It is not clear from liltrature any observations about the morphology or the intermediate valve types recorded in this work i.e. the endogenous resting spore of *Pleurosira laevis* is described for the first time.

In conclusion many forms of valve types of the centric diatom *Pleurosira laevis* are known until now, these are normal vegetative, long and narrow cells, auxospore, initial cells (rudimentary valves) resting spores and the intermediate valve types.

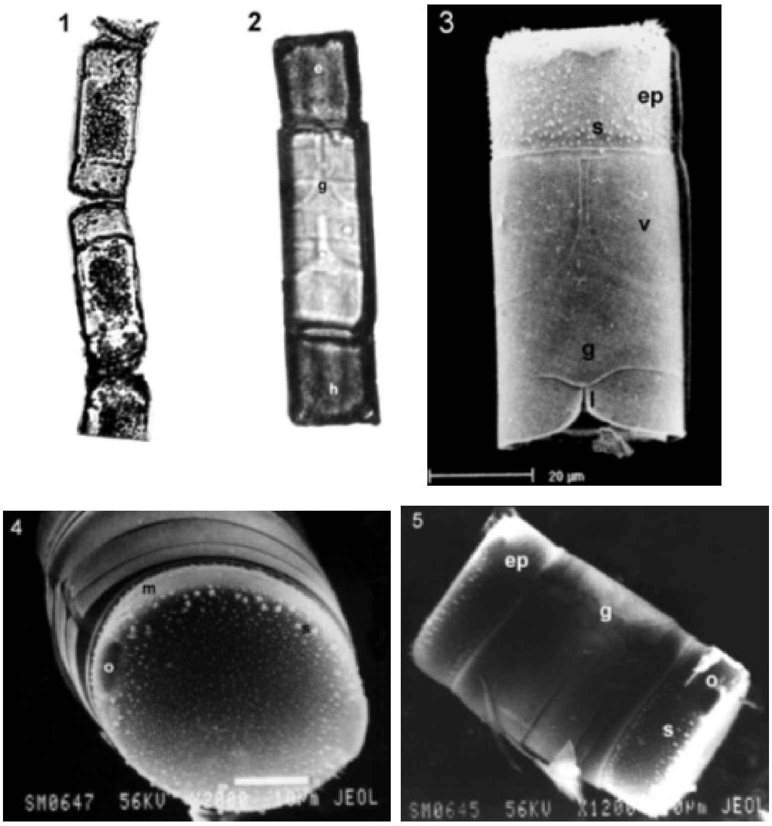



**Plate I**

**Fig. 1:** Photomicrograph of fresh material. Cells from girdle view connected together in zig-zag filaments of mucilage pads. LM, x400.

**Fig. 2:** Long cell frustules from girdle view showing epivalve (e), hypovalve (h), number of girdle bands (g) and ocellus (o). LM x800.

**Fig. 3:** Epitheca of long cell frustules with epicingulum (ep), spines (s) on mantle (m), valvocopula (v) underlaps edge of the mantle and ligulae (l). SEM, bar = 20µm.

**Fig. 4:** Whole frustule (valve and girdle views) showing epivalve (e), hypovalve (h), number of girdle bands (g), two ocelli (o), spines, areolae, mantle (m). SEM, bar = 10µm.

**Fig. 5:** Whole frustule showing epivalve (e), hypovalve (h), ocellus (o), spines (s), girdle bands (g). SEM bar = 20µm.

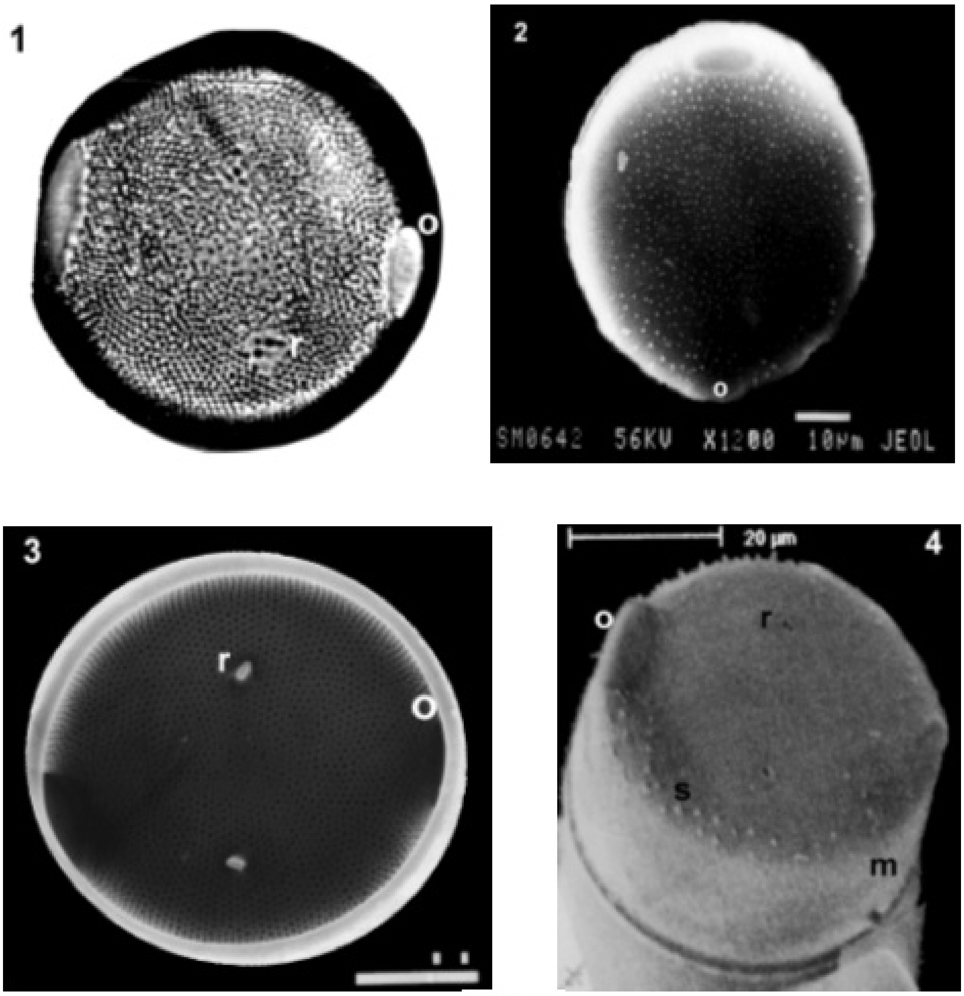
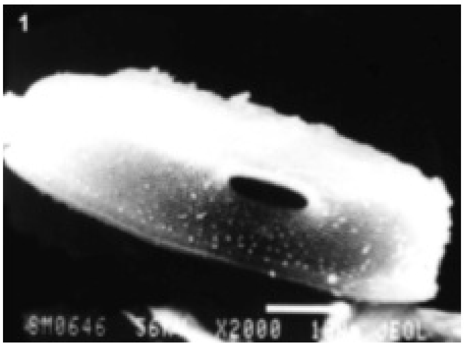
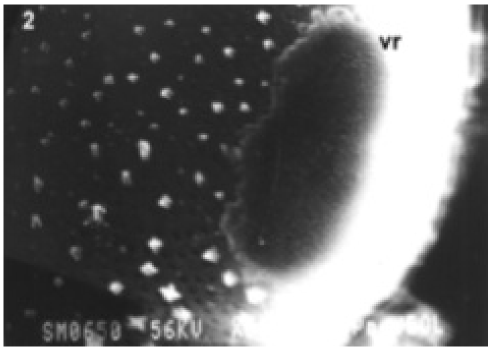
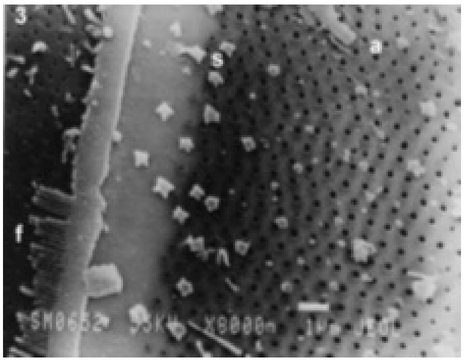


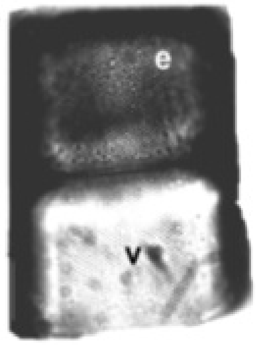

**Plate II**

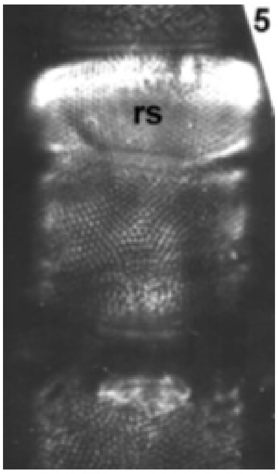
**Fig. 1:** Valve view showing circular valve, rimoportula (r), ocellus (o). LM , x1000.
**Fig. 2:** External valve showing 2 ocelli (o), areolae, spines (s). SEM bar = 10µm.
**Fig. 3:** Internal valve showing two rimoportulae areolae (a), ocellus (o). SEM x1500.
**Fig. 4:** Magnified part of epivalve showing elevated ocellus (o), mantle (m), spines (s), rimoportulae. SEM, bar = 20µm.



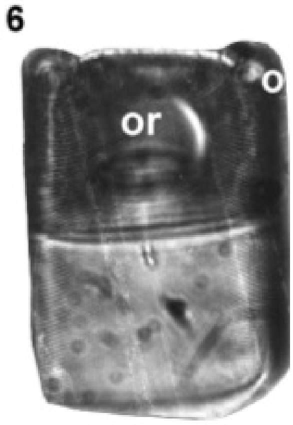




**Plate III**

**Fig. 1:** Epivalve, showing ocellus (o), mantle (m), mantle edge, spines. SEM, bar = 10µm.
**Fig. 2:** Magnified part of ocellus (o) showing fine areolae, spines, valve rim (vr). SEM bar = 1µm.
**Fig. 3:** Part of inner valve showing poroid areolae (a), spines (s) lateral flanges (f). SEM, bar = 1µm.
**Fig. 4:** Epitheca of long cell showing dark colour epivalve, first valvocopula (v). LM, x1200.
**Fig. 5:** Part of frustule (girdle view) showing endogenous resting spore (rs) inside the valve. LM x1500.
**Fig. 6:** Epitheca of long cell showing an ocellus opening of the endogenous resting spore inside the valve (or). LM, x1500

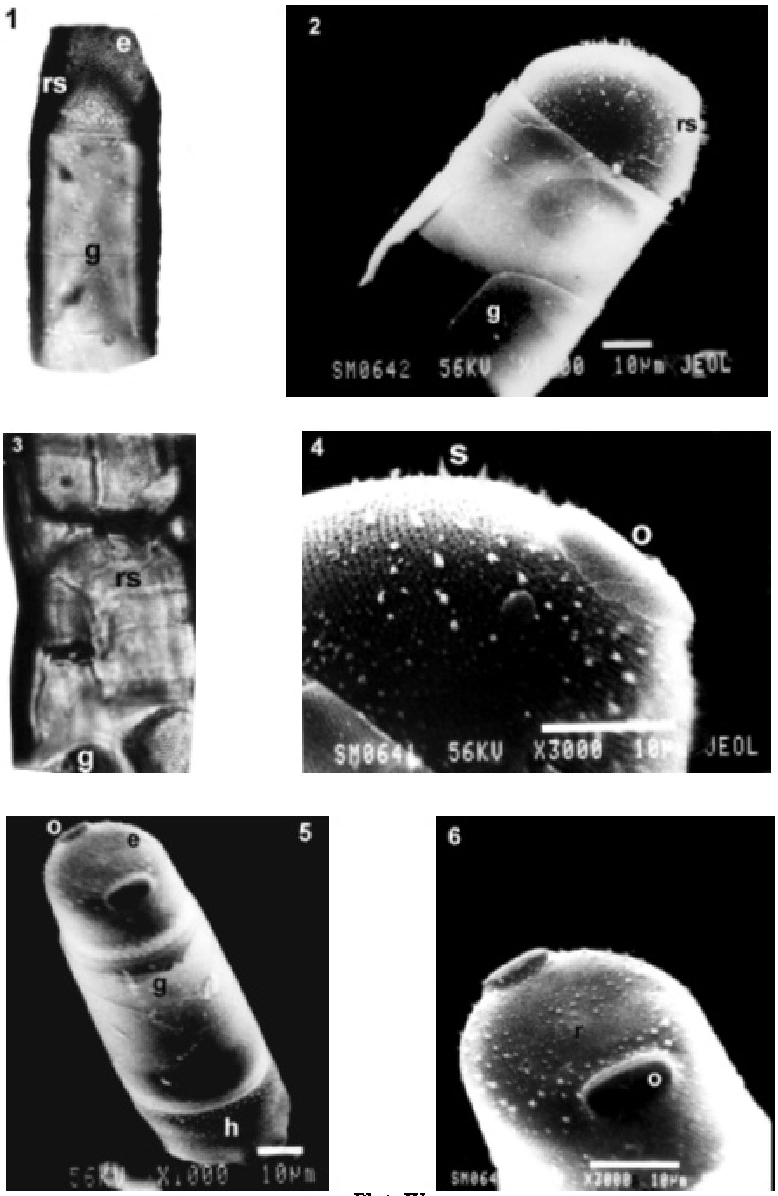



**Plate IV**

**Fig. 1:** A long cell showing epivalve (e) resting spore (rs), girdle bands. LM, x1000.

**Fig. 2:** A spherical shape resting spore (rs) showing spines (s), areolae (a), girdle bands cover half of the endogenous type resting spore. SEM bar = 10µm.

**Fig. 3:** Part of broken valve showing a spherical resting spore, a broken girdle band. LM x1200.

**Fig. 4:** Magnified part of the same resting spore (fig. 2) showing one ocellus, arrangement of areolae, spines (s). SEM, bar = 10µm.

**Fig. 5:** Intermediate valve of Pleurosira laevis. Whole frustule showing epivalve (e), hypovalve, every valve with two large elevated ocelli (o), girdle bands, spines (s). SEM, bar = 10µm.

**Fig. 6:** Magnified part of Intermediate valve of fig. 5 showing, ocelli (o), spines, rimoportulae, areolae. SEM, bar = 10µm.

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