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NEW DETAILS OF LEAF STRUCTURE IN *BILSDALEA DURA* HARRIS (*CONIFERAE*) FROM THE JURASSIC OF KRAKÓW, POLAND

Nowe szczegóły budowy liści *Bilsdalea dura* Harris (*Coniferae*) z jury okolic Krakowa

ABSTRACT. Leaf compressions of *Bilsdalea dura* Harris, a conifer of unknown affinity found in the Jurassic of Kraków, show new details of structure. Certain leaves from natural maceration show guard cells with apparently lignine dorsal and polar lamellae and a vein with tracheids and transfusion tracheids. Similarly, as in the material from Yorkshire, the leaf apices are specialized, representing perhaps a hydathode.

The observed details of leaf structure do not throw new light on the systematic position of *Bilsdalea*.

INTRODUCTION

Bilsdalea dura is an extinct conifer of unknown affinity. Harris (1952) first described its leaves from the Middle Jurassic of Yorkshire and in 1979 also a cone associated with leaves, but he did not include the genus in a conifer family.

Bilsdalea dura leaves were also found in the Middle Jurassic of Kraków (Reymanówna 1977). Another species, *Bilsdalea angustifolia* was described by Florin (1958) from the Jurassic of Bornholm.

The leaves of *Bilsdalea dura* described by Harris usually show a specialized apex. According to Harris this obtuse apex may be compared with a hydathode or associated with food bodies for insects. A similar apex can be found in many *Bilsdalea* leaves from the Kraków area. In addition, a few of them show certain new details of structure which are described in the present paper.

MATERIAL AND METHODS

The described material consists mainly of that collected and described previously by Reymanówna (1977) from the outcrop at Orlej and of some new material from the bore-holes at Zabierzów and Wiśniowa. At Orlej and Zabierzów the leaves occur in grey Grojec clays but at Wiśniowa in dark grey mudstone. *Bilsdalea dura* leaves are preserved as compressions. They were macerated in nitric acid in the usual way and the cuticles were embedded in glycerine jelly.

Usually in this way can be obtained only preparations of cutinized parts such as the cuticle of the epidermis. Occasionally, however, from particularly well preserved compressions it is possible, using special methods of maceration to obtain also preparations of other tissues such as sclereids (Reymanówna 1970).

Rarely compressions are preserved in a state of natural maceration and show without treatment the structure of cuticle, occasionally also of other elements. A few leaves from Orlej were preserved in such a manner. They show in addition to outlines of epidermis cells also details of the guard cells and certain internal elements of the leaf. Such leaves were cleaned only with a brush, then fixed with ammonia acetate and calcium chloride (Reymanówna 1970), in order to prevent uncutinized structures from dissolving in glycerine jelly.

Macerated cuticles were cleaned in hydrofluoric acid, thoroughly washed, coated with gold and photographed in a Jeol SMS₁ Scanning Electron Microscope.

SYSTEMATIC DESCRIPTION

Coniferales incertae sedis

Genus *Bilsdalea* Harris 1952

Bilsdalea dura Harris

Pls. I — III; Figs. 1, 2

1952. *Bilsdalea dura* Harris. Harris, p. 371, Text-figs. 6—8; 9A, D, F.

1958. *Bilsdalea dura* Harris. Florin, p. 315; Pl. 31, figs. 1—9; Pl. 32, figs. 1—4; Pl. 33, figs. 1—6.

1977. *Bilsdalea dura* Harris. Reymanówna, p. 13; Pl. 1, figs. 1—6.

1979. *Bilsdalea dura* Harris. Harris, p. 136; Figs. 63—65.

Description. Leaves (usually fragments preserved) 6 to at least 23 mm long, 1—2.5 mm wide, linear, coriaceous, narrowing towards apex, tapering towards basis. Leaf apex obtuse or rounded, occasionally twisted. Vein single, in leaves from natural maceration in the form of dark strand, occasionally widening at apex. Vein showing narrow elongated tracheids about $70\ \mu\text{m} \times 10\ \mu\text{m}$ with helical thickenings. Tracheids occasionally present in widening apical part of vein.

Inside leaf occasionally visible dark longitudinal filaments about 2 mm long, $30\ \mu\text{m}$ wide. Filaments present in almost whole width of leaf except margins and usually except parts above veins.

Cuticle about $20\ \mu\text{m}$ thick (in section seen in SEM) without papillae or hairs. Upper cuticle consisting of longitudinal rows of well marked rectangular cells about $67\ \mu\text{m} \times 27\ \mu\text{m}$. Periclinal wall with thin places in cutin, occasionally with delicate radiating or longitudinal striation. Anticlinal walls more or less straight, pitted.

Lower cuticle with two stomatal bands, and nonstomatal bands consisting of cells similar to those of upper cuticle, but more elongated and narrower, arranged into longitudinal rows. Normal epidermal cells in stomatal bands less regular than in nonstomatal bands. Stomatal bands consisting of 5—10 parallel files of longitudinally arranged stomata. In files stomata separated by 0—2 epidermal cells. Frequently polar subsidiary cell shared by two stomata, neighbouring files of stomata separated by 1—2 epidermal cells, occasionally in contact. Stomata consisting of two longer

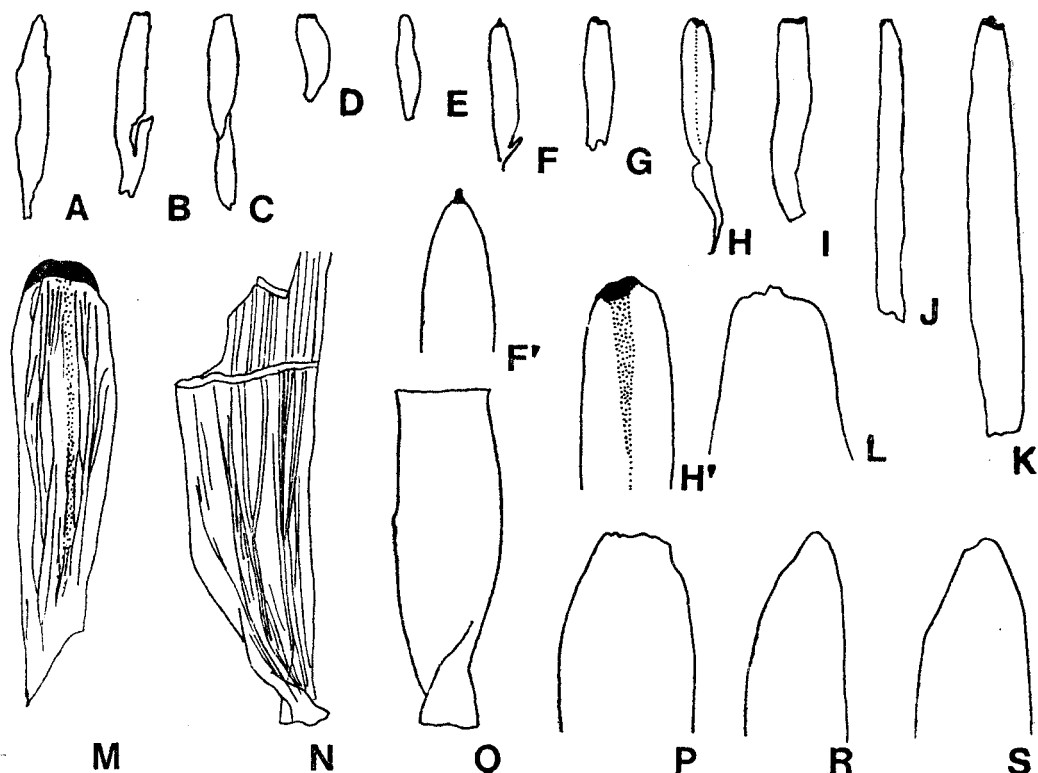


Fig. 1. *Bilisdalea dura* Harris. A — K leaves, A, C, F, H, I, K — Orlej IB PAN PM 864; B, J — Zabierzów IB PAN PM 865; D, E, G — Zabierzów IB PAN PM 866, all $\times 2$; F', H', L, P, R, S — leaf apices $\times 6$; H' — midrib broadening near apex; M, N — longitudinally arranged filaments in leaves (simplified), L, M, N, O, P, R, S, — Orlej IB PAN PM 867 M $\times 10$, N $\times 6$; O — twisted leaf base $\times 6$. Vein marked by stippling, dense leaf substance at apex marked black

lateral subsidiary cells, two shorter polar subsidiary cells and two sunken guard cells. Guard cells with cutinized lamellae around stomatal slit. Their walls opposite the slit visible approximately in the middle of lateral subsidiary cells. In material from natural maceration lignine lamellae in dorsal walls and between walls separating the polar ends of the guard cells, polar lignine lamellae dividing into two branches. Entrance to stomatal pit elongated and narrow, widening inwards.

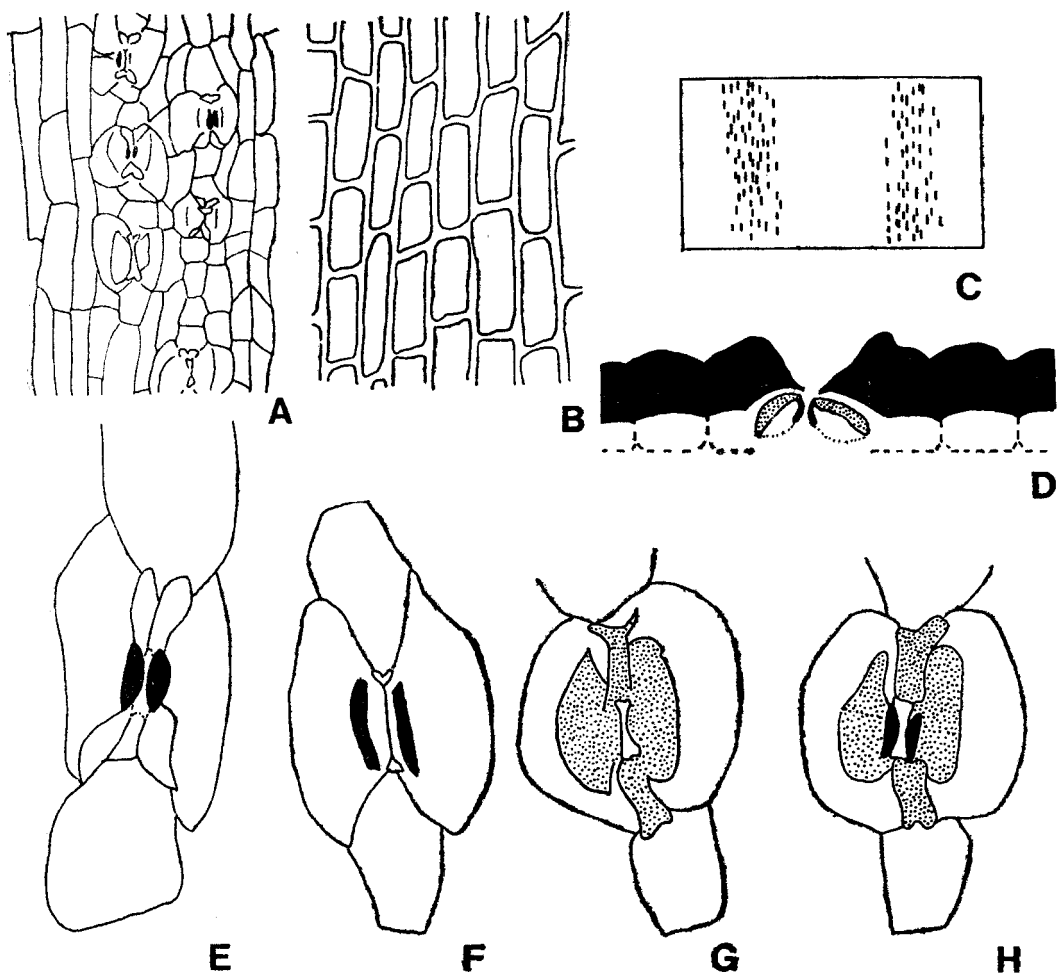


Fig. 2. *Bilsdalea dura* Harris. A — lower cuticle of leaf showing stomata from above, Orlej IB PAN PM 868, $\times 400$; B — upper cuticle of leaf, Wiśniowa IB PAN PM 869, $\times 400$; C — lower cuticle showing arrangement of stomatal bands, Zabierzów IB PAN PM 870, $\times 40$; D — suggested reconstruction of transverse section of stoma shown in fig. H; E — stoma after maceration showing polar parts of guard cells, Zabierzów IB PAN PM 871, $\times 1000$; F — stoma after maceration at higher focus showing subsidiary cells in contact, closing stomatal pit, Zabierzów IB PAN PM 871, $\times 1000$; G, H — stomata from natural maceration, Orlej IB PAN PM 872, $\times 1000$. Lignine lamellae of guard cells marked by stippling, cutin — black

DISCUSSION

The systematic position of the Polish material. So far two species of *Bilsdalea* had been described. Harris (1952, 1979) instituted the species *Bilsdalea dura*, into which were included leaves from Poland (Reymanówna 1977). The second

species *Bilsdalea angustifolia* from the Jurassic of Bornholm was instituted by Florin (1958). The Polish material from Orlej and the two new localities differs from *Bilsdalea angustifolia* in having wider leaves, a greater number of files of stomata in a stomatal band and in showing obtuse leaf apices. On the whole the leaves of *Bilsdalea* from Poland agree in most characters with *Bilsdalea dura* from Yorkshire (Harris 1952, 1979) though they show certain small differences. Firstly, there is a different percentage of types of leaf apices. In our material there was a larger amount of acute leaves, i.e. about 30 %, while in the Yorkshire one only 5 %. It is possible, however, that the difference results from a different definition of acute leaves by the two authors. Then, there seems to be a considerable difference in cuticle thickness. In the Kraków material it is about 20 μm (measured on SEM photographs of cuticle section), while according to Harris it is about 7 μm in the Yorkshire leaves (measured in cuticle folds). The much thicker cuticle appears not to be a taxonomic character, but rather to indicate a difference in environment.

On the whole, the differences from the Yorkshire leaves do not appear significant, therefore the leaves from Poland are attributed to the same species *Bilsdalea dura* Harris.

Stomata. It is interesting to note that in the Yorkshire material of *Bilsdalea dura* the guard cells seem not to be distinct, while in the Kraków material they are quite distinct perhaps as a result of stronger cutinization. Preparations of macerated cuticles (Reymanówna 1977) show frequently outlines of the median part of guard cells. Their polar part is not always visible, but the cutinized lamellae around the stomatal slit are distinct. On the opposite side usually can be seen the outline of the dorsal wall.

The leaves from natural maceration show more details of guard cell structure. In addition there can be seen lamellae which resemble lignine lamellae in stomata of conifers and other gymnosperms (Harris 1932). They are not built of cutine because they dissolve during maceration in nitric acid and it can be assumed that they consist of lignine. Such lamellae occur in the dorsal walls of the guard cells in the median part and in the common wall between their polar parts. The polar lamella divides distally into two branches. The cutinized lamellae of the stomatal slit are seen also in leaves from natural maceration. The stomatal slit seen from above is elongated and narrow but shortens inwards. The entrance of the stomatal pit is frequently closed by a dark substance. In general, the stoma of *Bilsdalea dura* possesses many xeromorphic characters. Although the described material shows new details of stomata, their structure is still not well understood.

Dark filaments. Harris (1952, 1979) mentions separate fibres about 2 cm long occurring in the leaves of *Bilsdalea dura*. In leaves from the Kraków material there occur brown filaments about 2 cm long. It seems that they can be interpreted in two ways. The filaments resemble sclerenchyma fibres occurring below the epidermis in many conifers (Knapp-Zinn 1966). They resemble, e.g. in size and shape fibers which I observed in leaves of *Podocarpus neriifolius*. However, they seem not to form a coherent sheet. The dark brown colour of the fibers in *Bilsdalea dura* is similar to that of the supposed lignine lamellae in the guard cells in the same leaves

from natural maceration. This would suggest that the filaments are fossilized sclerenchyma fibers.

I think, however, that there is also the possibility that the filaments are secretory. In favour of this interpretation speaks the loose arrangement of the filaments which seem not to form a layer similar to the hypoderm in conifer leaves. The dark colour resembles that of secretions occurring in tissues of fossil plants, e.g. in the "resin parenchyma" in the wood of the *Cupressaceae*. It is not possible to decide which interpretation is correct without examining leaf sections which I failed to obtain.

Vein. In two leaves from natural maceration in the vein can be observed tracheids of two types. In the middle run elongated tracheids with helical thickenings which belong to the vein. On both sides there are short barrel shaped transfusion tracheids with reticulate thickenings. They are very similar to these described recently, e.g. in *Metasequoia glyptostroboides* (Shobe & Lersten 1967). Harris (1940) mentions transfusion mesophyll in leaves of *Sagenopteris colpodes* but does not figure it.

Specialized leaf apex. Leaf apices of *Bilsdalea dura* both from Yorkshire and from the Kraków area vary from acuminate and acute forms throughout intermediate to obtuse ones. Harris (1979) described in detail obtuse leaf apices of *Bilsdalea dura* and regarded them as specialized. According to his description the cuticle near the apex became thinner and on the very apex Harris observed a break in the cuticle. In this region the internal substance of the leaf became dark and denser. The epidermal cells below the apex were shorter and wider than normally and the stomata irregular. The vein became broader near apex. He compares this type of apex with a hydathode or with "food bodies" in certain tropical angiosperms, but leaves the question open.

In the Kraków material obtuse leaf apices of *Bilsdalea dura* show the same characters mentioned by Harris. They have a vein widening occasionally below apex, short epidermal cells, a dense internal tissue and they show a break in the cuticle. It appears even, that in one or two leaves in the Kraków material tracheids are present in the widened part of the vein below apex.

The systematic position of *Bilsdalea*. In his first paper (1952) Harris compared *Bilsdalea* with certain recent conifers but did not classify it. Florin (1958) stated that the systematic position of *Bilsdalea* remains an open question. In his monograph of the Yorkshire flora (1979) Harris described cones and cone scales associated with *Bilsdalea* which are of an unusual type. He did not classify *Bilsdalea* with any conifer family.

From the structures described in the present paper nothing new can be added about the systematic position of *Bilsdalea*. No cone fragments were found in the Kraków material.

ACKNOWLEDGMENTS

This work was carried out in the Department of Palaeobotany, Institute of Botany, Polish Academy of Sciences as part of the programme MR. II. 2.6.1.a. under the supervision of doc. dr M. Reymanówna. I would like to express to her my thanks for the material from Orlej, for discussion and for the English

translation. I also thank prof. S. Siedlecki for the material from Zabierzów and doc. dr W. Moryc for the material from Wiśniowa.

SEM micrographs were taken in the Laboratory of Electron Microscopy of the M. Nencki Institute of the Polish Academy of Sciences.

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REFERENCES

- Florin R. 1958. On Jurassic taxads and conifers from North-Western Europe and Eastern Greenland. *Acta Horti Berg.*, 17 (10):357—402.
- Harris T. M. 1932. The fossil flora of Scoresby Sound East Greenland, 2. *Medd. Grønland.*, 85 (3): 81—85.
- 1940. On some Jurassic specimens of *Sagenopteris*. *Ann. Mag. Nat. Hist. Ser.* 11, 6:249—265.
- 1952. Notes on the Jurassic flora of Yorkshire, 52—54. *Ann. Mag. Nat. Hist. Ser.* 12, 5:362—382.
- 1979. The Yorkshire Jurassic flora, 5. *Coniferales*. *Brit. Mus. Nat. Hist. London*.
- Napp-Zinn. 1966. Anatomie des Blattes. I. Gymnospermen. *Handbuch der Pflanzenanatomie VIII*, 1. Borntraeger, Berlin.
- Reymanówna M. 1970. New investigations of the anatomy of *Caytonia* using sectioning and maceration. *Paläontol. Abh. B. Paläobot.*, 3(3/4): 651—655.
- 1977. On *Bilsdalea dura* Harris (*Coniferae*) from the Jurassic of Poland. *Acta Palaeobot.*, 18 (1):13—18
- Shobe W. R. & Lersten N. R. A technique for clearing and staining gymnosperm leaves. *Bot. Gaz.* 128 (2):150—152.

Plate I

Bilsdalea dura Harris

1. Leaf apex showing a break in the cuticle Zabierzów, IB PAN PM 873, SEM $\times 40$
2. Macerated leaf apex showing cell structure seen in light microscope. Orlej, IB PAN PM 874, $\times 40$
3. Tracheids and dark filaments in leaves from natural maceration, Orlej, IB PAN PM 872, $\times 150$
4. The same, $\times 540$
5. The same, $\times 1200$
6. Stomata with distinct dark lignine lamellae of guard cells visible in leaf from natural maceration, Orlej, IB PAN PM 872, $\times 270$
7. The same, $\times 540$

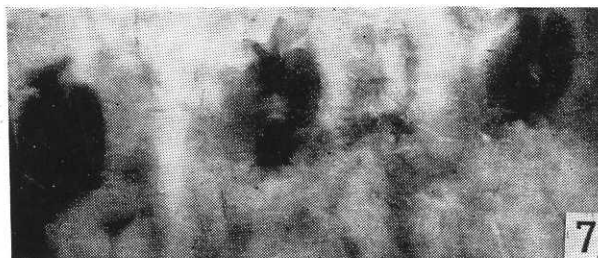
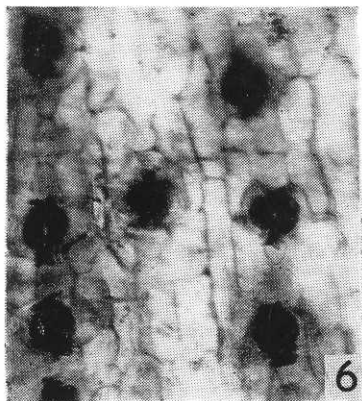
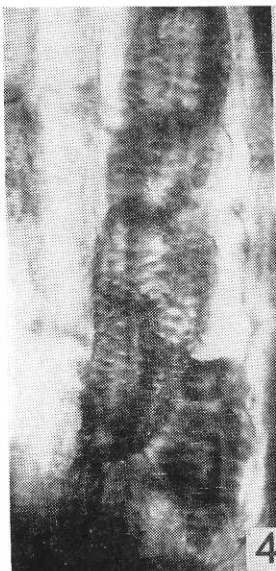
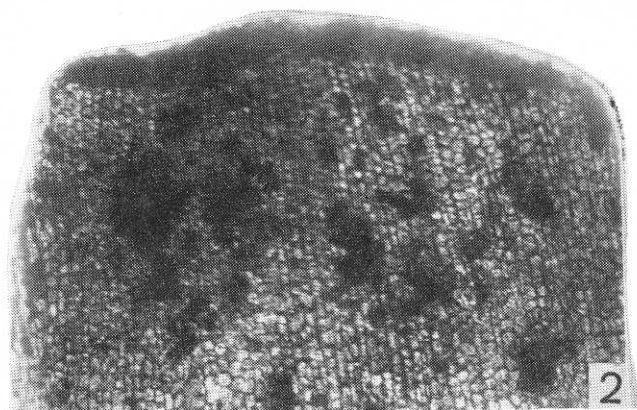
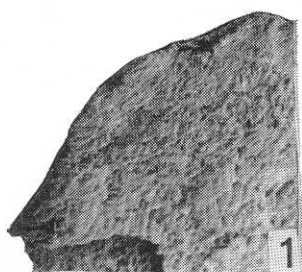


Plate II

Bilsdalea dura Harris

All figures are SEM micrographs

1. Irregular stoma near the apex from below, Orlej, IB PAN PM 875, $\times 1000$
2. Stoma from below showing incomplete polar parts of guard cells, Orlej, IB PAN PM 876, $\times 1000$
3. Another stoma from below, Orlej, IB PAN PM 877, $\times 1000$

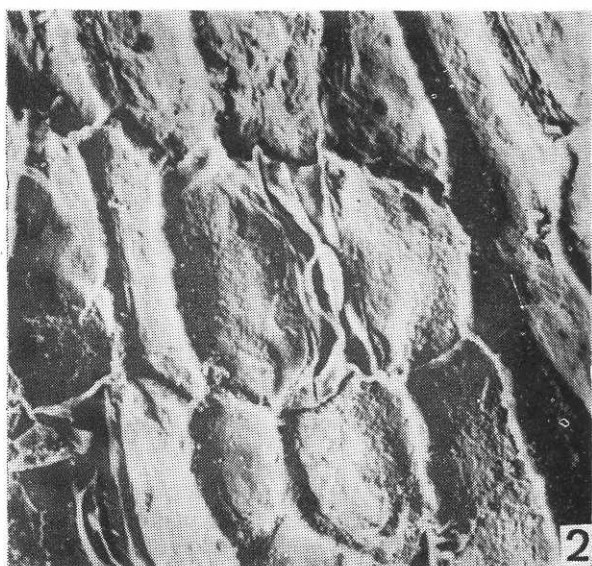
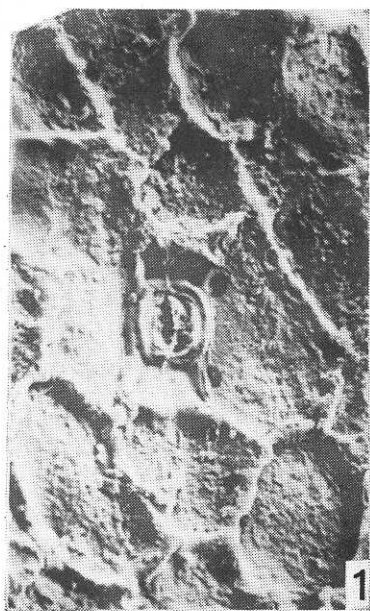


Plate III

Bilsdalea dura Harris

All figures are SEM micrographs

1. Stoma from below, Zabierzów, IB PAN PM 878, $\times 1000$
2. Lower cuticle from above showing the surface of epidermal cells and stomata and the section through cuticle. Gaps in cuticle marked by arrows, Zabierzów, IB PAN PM 879, $\times 1000$

