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Spore Micromorphology and Anatomy of the Fern Genus *Histiopteris* J. Sm. (Dennstaedtiaceae) in Peninsular Malaysia

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Abstract: More recent classifications used mainly morphological data when *Histiopteris* was included as one of the genera in the family Dennstaedtiaceae. A study on spore micromorphological and anatomical studies of *Histiopteris* J. Sm. from Peninsular Malaysia was undertaken to provide spore micromorphological and anatomical information of the stipes, lamina and rhizomes for the genus. These information would become the source of reference and comparison for other members within the family Dennstaedtiaceae and would deem necessary in future classification considerations of *Histiopteris* when similar studies are carried out for all genera of the Dennstaedtiaceae in the near future.

Key words: Spore, micromorphology, anatomy, *Histiopteris*, Peninsular Malaysia

INTRODUCTION

The genus *Histiopteris* J. Sm. was first classified into the tribe Pterideae by Beddome in 1833. Holttum (1968) included *Histiopteris* in the family Dennstaedtiaceae with 11 other genera under the sub-family Pteridioideae. Later, Piggott (1988) included the genus *Histiopteris* into the family Hypolepidaceae. Parris and Latiff (1997) moved *Histiopteris* back to the family Dennstaedtiaceae. However, Hassler and Swale (2001) moved the genus back into the family Hypolepidaceae. The presence or absence of an indusium was the main reason for this classification instability. Piggott (1988) and Hassler and Swale (2001) described both species as having an indusium. On the other hand, Holttum (1968) and Parris and Latiff (1997) did not find any indusium but the reflexed edge of the lamina which looked like an indusium. Smith *et al.* (2006) also included the Peninsular Malaysian genera *Dennstaedtia*, *Hypolepis*, *Microlepia*, *Monachosorum*, *Paesia* and *Pteridium* in Dennstaedtiaceae based on morphology and some molecular data. This initial effort was undertaken to provide anatomical information on the stipes, lamina and rhizomes and spore micromorphology for *Histiopteris* which could become the basic reference and comparison for other members of the family Dennstaedtiaceae. These information would be useful in future classification considerations of *Histiopteris* which was moved in and out of the family Dennstaedtiaceae.

MATERIALS AND METHODS

Specimens of *Histiopteris incisa* (Thunb.) J. Sm. and *H. stipulacea* (Hook.) Copel. were collected from Cameron

Highland (MZ 35, MZ 37, MZ 38), Fraser's Hill (MZ 43, MZ 44, MZ 51) Gunung Ulu Kali (MZ 55, MZ 56, MZ 59); Genting Highlands (MZ 61, MZ 63, MZ 65) and Gunung Telapak Buruk (MZ 69, MZ 71, MZ 73). Voucher specimens were deposited in the Herbarium at the Faculty of Forestry, Universiti Putra Malaysia in Serdang. For the anatomical studies, rhizomes, stipes and lamina of approximately 2 cm long were preserved in 100% alcohol in vials. Anatomical sections were made using the modified method of Saas (1958). Spores were first separated and fixed in 4% glutaraldehyde for about 12-24 h at 4°C. They were then prepared using the modified method of Moore and Webb (1978) before critically dried for about 30 min, then stuck onto the stub using double-sided tape, gold coated and finally observed under the Scanning Electron Microscope Model Philips XL 30.

RESULTS AND DISCUSSION

Spore micromorphology: The spores of *Histiopteris incisa* are bilaterally symmetrical, elliptic in polar view and of size 44.5-51.5 µm; monolete, laesural arms without margo, almost reaching the equator, or 2/3 of the spore length; exine 3.9-6.5 µm thick, verrucose-regulate (Fig. 1).

The spores of *H. stipulacea* are larger with a size range of 44.8-54.3 µm and exine foveolate and dented on the lower side (Fig. 2).

Anatomy

Rhizome: The cross section of the rhizome shows the meristele formed is a continuous ring. In *H. incisa*, the

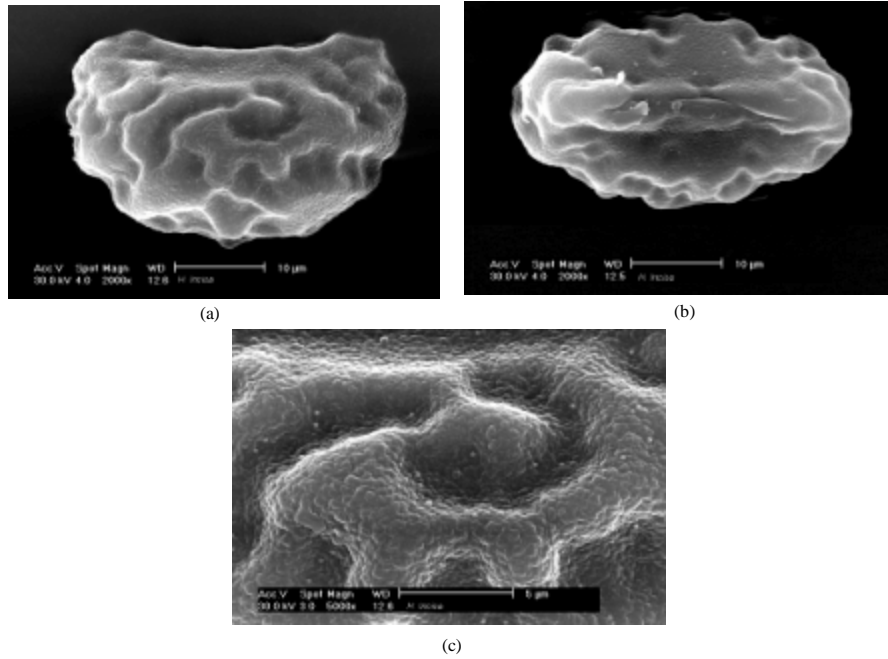


Fig. 1: SEM photomicrographs of spores of *Histiopteris incisa* showing the shape and exine. (a) Polar view, (b) Equatorial view and (c) Verrucose-rugulate sculpturing of the exine

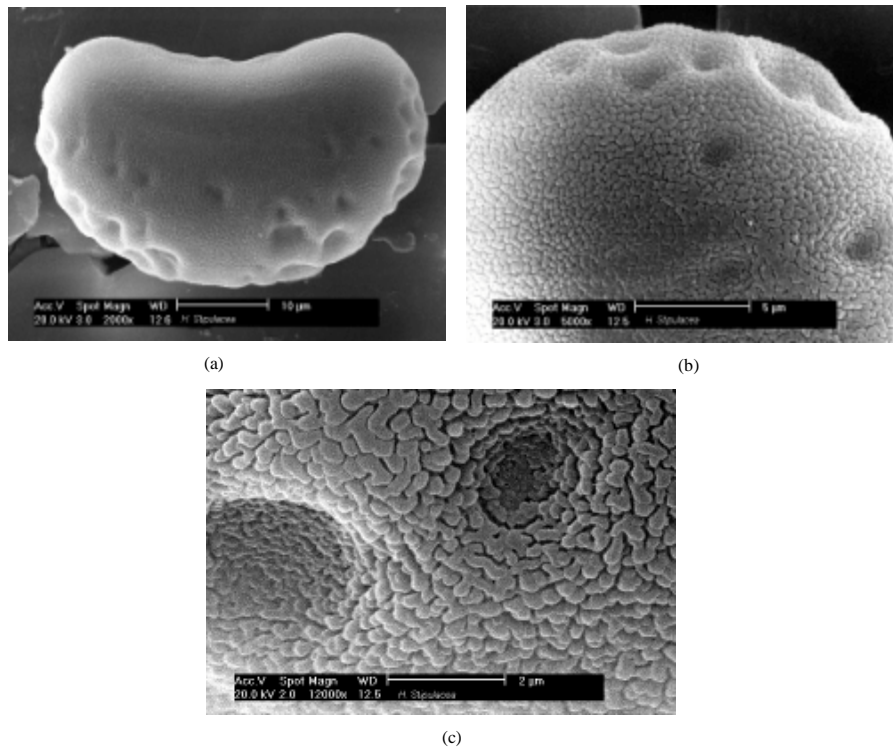


Fig. 2: SEM photomicrographs of spores of *H. stipulacea* showing the shape and exine, (a) Spore shape in the polar view with dents on the lower side, (b) A semi-equatorial view of the spore and (c) Exine foveolately sculptured with distinct dents

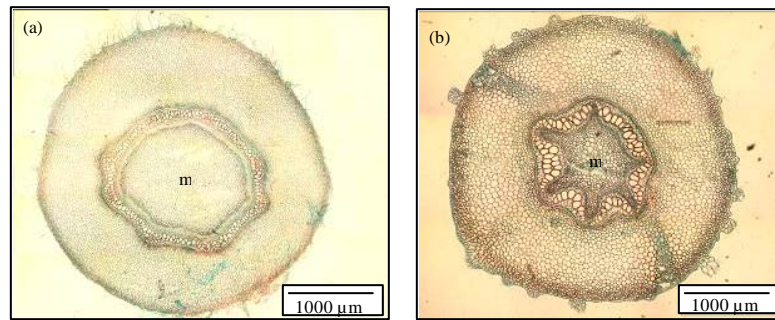


Fig. 3: Light micrographs of transverse sections of rhizome showing the meristele (a) *H. incisa* with an irregularly-ringed meristele and (b) *H. stipulacea* with star-shaped meristele (m-meristele)

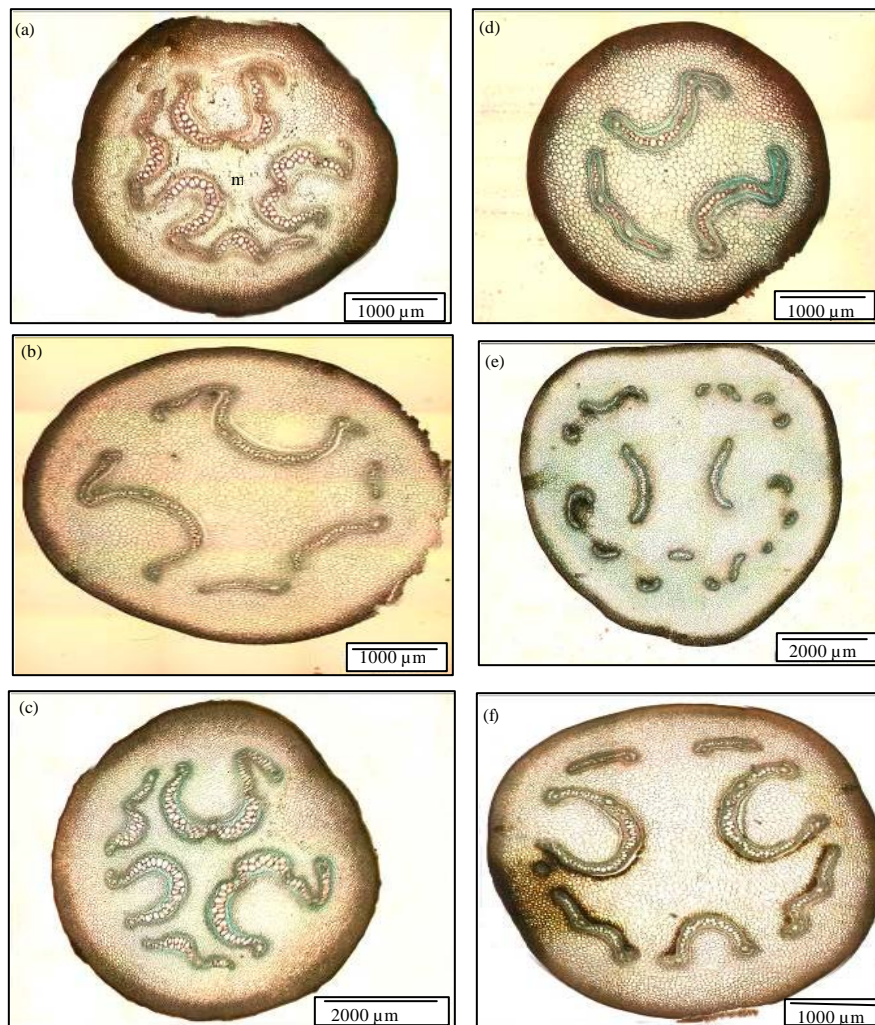


Fig. 4: Light micrographs of transverse sections of the stipe, (a, b, c) Meristele become less enhanced in shape towards the middle with the number remaining constant in *H. incisa* and (d, e, f) Meristele broken up towards the middle in *H. stipulacea* (m-meristele)

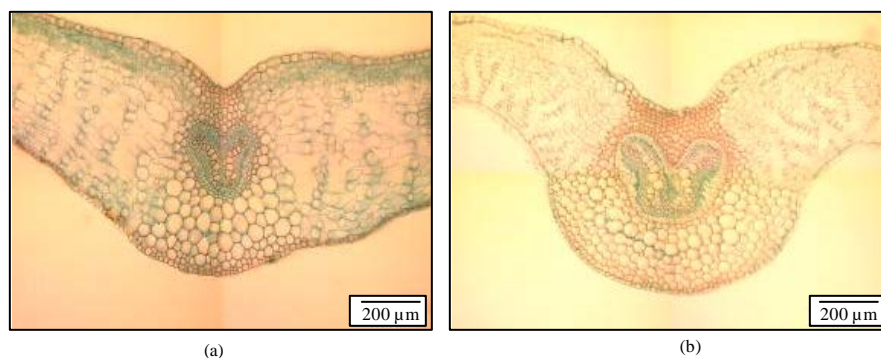


Fig. 5: Light micrographs of transverse sections of the midrib showing the heart-shaped meristele. (a) *H. incisa* and (b) *H. stipulacea*

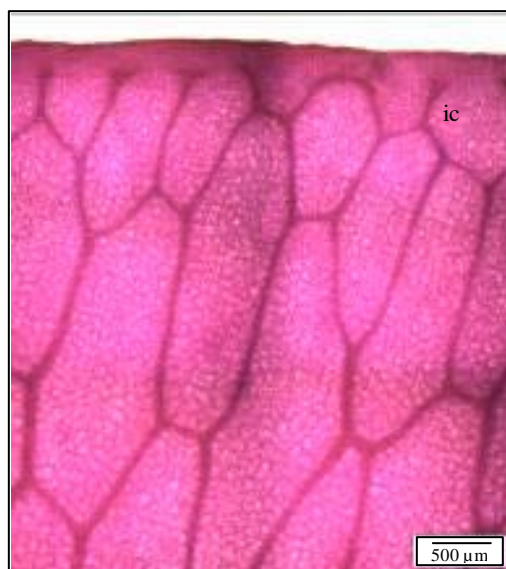


Fig. 6: Light micrograph of cleared lamina showing incomplete veins at margin of *H. incisa* (ic-incomplete venation)

meristele is an irregular ring but the shaped is more defined like a star in *H. stipulacea* (Fig. 3).

Stipes: The epidermis is surrounded by sclerenchyma cells; thin-walled parenchyma cells filling up the whole stipe. The number and shape of the meristeles vary along the stipe. Meristeles are of two shapes viz., irregular and u-shaped. In *H. incisa*, the meristele number remains constant at five throughout the stipe but becoming less enhanced in shape towards the middle. However, in *H. stipulacea* the meristele number tends to increase towards the middle to a maximum of 17, becoming less enhanced in shapes and smaller in size. Figures 4a-f show the differences in anatomical characters along the stipe.

Lamina: In cross section, the midribs of the lamina are U-to V-shaped adaxial and more or less rounded abaxial (Fig. 5); meristele heart-shaped; veins incomplete towards the margin (Fig. 6). Except for the hemiparacytic stomatal-complex type present in *H. stipulacea* in addition to the anomocytic stomata (Dilcher, 1974), the lamina anatomy of *H. stipulacea* is similar with *H. incisa* (Fig. 7). The anticlinal ell walls of the lamina adaxial surface is undulate (Fig. 8).

In systematic treatments of plant taxa, when one discipline fails to provide a stable classification it would be worthwhile to include other disciplines such as anatomy, palynology, phytochemistry and molecular data. This was the case with *Histiopteris* which was taken in and out of the family Dennstaedtiaceae because it was

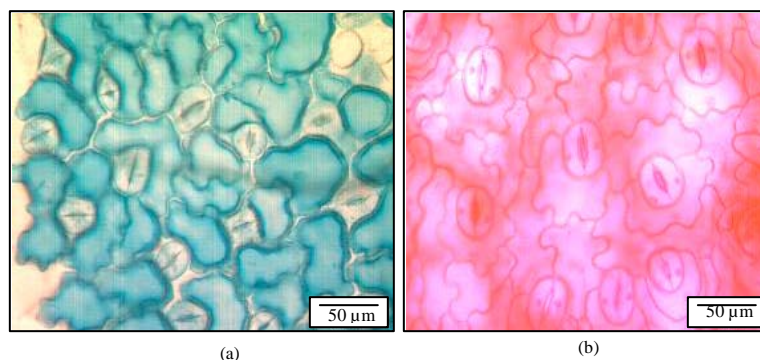


Fig. 7: Light micrographs of the stomatal-complex types arrangement of the lamina abaxial surface in *Histiopteris*. (a) *H. incisa* showing the anomocytic-type and (b) *H. stipulacea* showing both anomocytic and hemi-paracytic types

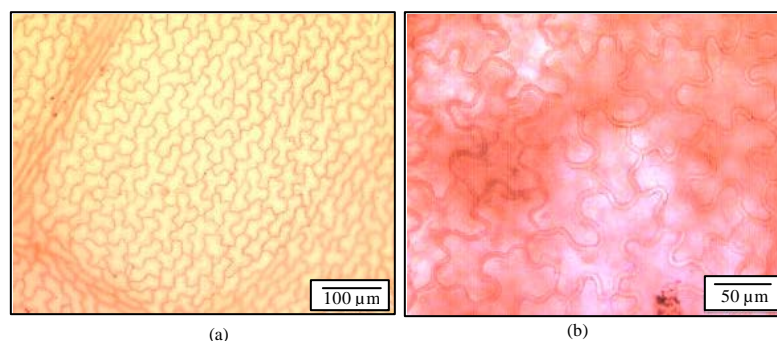


Fig. 8: Light micrographs of the adaxial surface of lamina epidermis showing undulate anticlinal cell walls. (a) *H. incisa* and (b) *H. stipulacea*

mainly based on morphology. Some anatomical data on the stipes, lamina and rhizomes and spore micromorphology for *Histiopteris* which were obtained from this initial studies on the family Dennstaedtiaceae could become the source of reference and comparison for the remaining genera in this family, hence future classification considerations of *Histiopteris* show similar characteristics shown by *Histiopteris* anatomically and palynologically appear for the remaining genera in Dennstaedtiaceae, then it is evident *Histiopteris* remains in this family; however it proved otherwise a reclassification of the genus remains to be considered.

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