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Microstructural characters as a tool for taxonomy

(Coleoptera: Bostrichidae: *Minthea* and *Dinoderus*)

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Abstract

Minthea and *Dinoderus* both are difficult genera for species identification. We examined specimens by ESEM and found microstructural characters that facilitate identification of *Minthea reticulata*, *M. rugicollis*, *Dinoderus brevis* and *D. minutus*.

Introduction

Bostrichids are commonly known as powder-post beetles, because of the ability of the larvae to reduce sapwood, particularly of hardwoods, into a powdery frass. Hence, the beetles are of considerable economic importance to forestry and the wood-using industries, and a few species have become important pests of timber, wooden works and ancient structures in tropical countries (LIU et al. 2008).

Character searching is one of the main tasks for taxonomists and is always time-consuming; finding out new sets of diagnostic characters is especially important. With the help of the Environmental Scanning Electronic Microscope (ESEM), we can now find more microstructural characters that facilitate systematic work without damaging specimens.

Minthea (Lytcini) *and Dinoderus* (Dinoderinae) are taxonomically difficult genera. HO (2000) noted that *Minthea reticulata* usually shared the same habitat with *M. rugicollis*, so it is very easy to confuse and misidentify the species. VRYDAGH (1955) mentioned that *Dinoderus brevis* and *D. minutus* can easily be confused if one does not have specimens in good condition. We want to find helpful characters to distinguish these species with the help of ESEM.

Materials and Methods

All the specimens examined in this paper were loaned from the Natural History Museum, London or the Entomology department of the National Chung Hsing University, Taichung, Taiwan.

In order to avoid any unexpected damage to the specimens, we used a FEI (model: Inspect-S) Environmental Scanning Electron Microscope (ESEM) to examine the elytra of specimens. We did not remove the specimens from their mounts or pins, neither sputtered the specimens. The settings of the ESEM for examining the specimens are beam spots from 2.5 to 4.0, acceleration voltage between 15kV and 30kV, and low vacuum between 0.6 mbar and 0.8 mbar. We paid particular attention to the middle part of the elytral disc of *Minthea* and *Dinoderus*, and elytral declivity of *Dinoderus*.

Collection data of the material examined by ESEM in this study:

Minthea reticulata LESNE, 1931
TAIWAN / Chunghaua / in bamboo by hand / 2005.09.15 / LIU, Lan Yu TAIWAN / Taipei FJU / coll. by vacuum / 1998.06/KaoF.L. \\ *Minthea / reticulata* / Det. LIU, L. Y. *Minthea / rugicollis* (WALKER 1858).
TAIWAN / Nantao: BAM / coll. by hand / 2005.04.07 / Liu, Lan Yu \\ *Minthea / rugicollis* /(WALKER) / Det. LIU, Lan Yu

Dinoderus brevis HORN, 1878
Mt. Makiling / Luzon, Baker \\ Philippine Is. / C.F.Baker / 1919-207 4718 \\ Port Darwin. / 02-2 // *Dinoderus / brevis*. HORN / LESNE det.

Dinoderus minutus (FABRICIUS, 1775)
TAIWAN / Nantao / in Bamboo / 2005.05.18 / Liu, Lan Yu TAIWAN / Changhua / in Bamboo by hand / 2005.09.15 / LIU, Lan Yu det.

After the examination by ESEM, these and three further specimens of each species were examined by light microscope under 400x to confirm the results by LM.

Results and Discussion

From the examination of microsculptures and hairs on the elytral disc, there are clearly differences between three difficult taxa found.

Minthea reticulata versus *M. rugicollis*

HO (2000) pointed out *Minthea reticulata* is easily confused with *M. rugicollis*, so he tried to find a new character to help in determination: *M. reticulata* has 7 to 12 stiff narrow hairs on the lateral margin of the pronotum on each side, while *M. rugicollis* has 13 to 19 broad hairs on each side. In our experience, the hairs on the lateral margin are easily broken and lost. Even though the character may be helpful in specimens in good condition, we need a more useful character to help determine older or damaged material.

The type of hairs **(Fig. 1)** is a useful new character to help distinguish *M. reticulata* from *M. rugicollis*. Both species have the short thick hair with an open brush-like end and 4-6 serrulate-like ribs as the major type of hair. But the second type of hair differs between the two species. In *M. reticulata*, the second type of hair is long lamelliform, about one and half times longer than the major short thick hair. In *M. rugicollis*, the second type of hair is small, fine, soft about half long as the major short thick hair.

Dinoderus brevis versus *D. minutus*

The type of punctures is different on the elytral disc and declivity in *Dinoderus brevis* and *D. minutus*. There are shallow subcircular punctures with a corrugated rim on the disc and shallow subcircular punctures with corrugated rim and convex inside on the declivity **(Fig. 2)**. But the surface between the hair-bearing punctures on elytral declivity **(Fig. 2)** is different between *D. minutus* and *D. brevis*. In *D. minutus*, the surface with dense tiny punctures; in *D. brevis*, the surface is rather smooth.

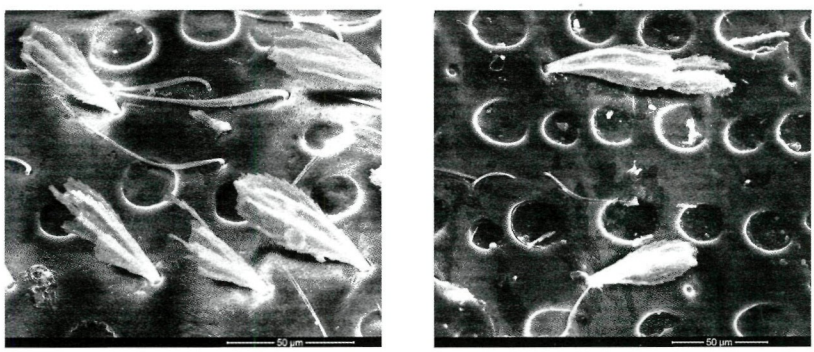

Fig. 1: The microstructures on the elytral disc of *Minthea reticulata* LESNE, 1931 (left) and *Minthea rugicollis* (WALKER, 1858) (right).

There are usually two different types of hairs on the elytral disc and a third type of hairs on the declivity in *Dinoderus*. No previous author mentioned the difference in the types of hairs on the disc and on the declivity. Both *D. brevis* and *D. minutus* have stout hairs with serrulate ridges on the sides of the declivity (**Fig. 2**, right). But the shape of the hairs on the disc (**Fig. 2**, left and middle) is different between the two species. In *D. brevis*, one type of hairs is long and thick with a densely feathery end, and the other type is short, simple fine hairs. In *D. minutus*, the first type of hair is similar to *D. brevis*, long and thick, but the other type is longer than in *D. brevis* and the hair is feathered on one side.

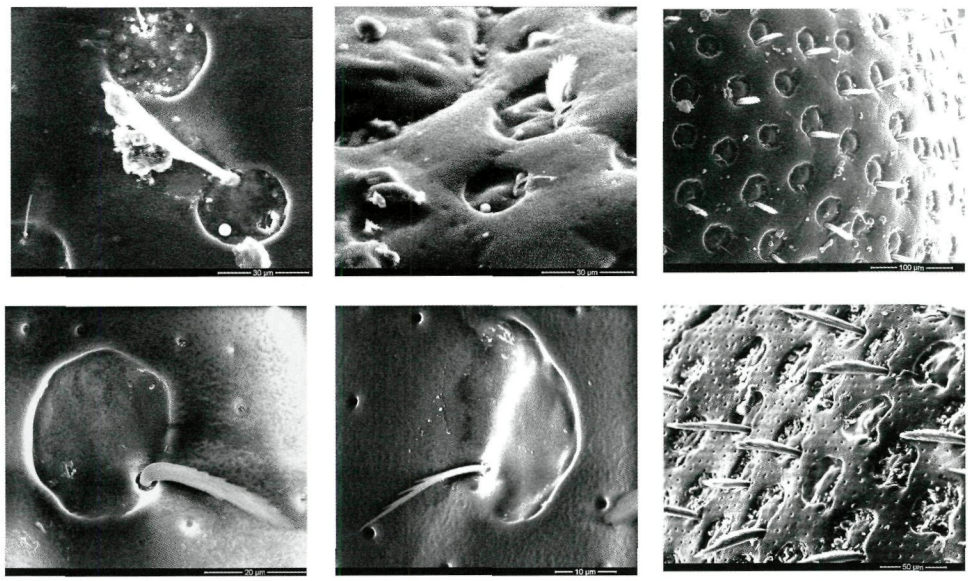

Fig. 2: The microstructures on the elytral disc (left and middle) and elytral declivity (right) of *Dinoderus brevis* HORN, 1878 (upper row) and *Dinoderus minutus* (FABRICIUS, 1775) (below).

Conclusion

The special advantages of the environmental scanning electronic microscope are the possibility to detect and depict three-dimensional structures with a very large depth of focus, and the fact that the image is built up almost purely from the surface of the specimen. The three-dimensional picture is very important to describe the fine structures.

Our work did not only find more taxonomically useful characters in the micro-structures on the surface of specimens, but also showed that we can now examine the specimens without any unexpected damage under ESEM. On the other hand it is not really necessary to have an ESEM to recognize the characters described above for practical sake. To find such subtle differences, however, ESEM was crucial. Once the differences are found and described, a good light microscope will mostly also be sufficient. This could be proved by light microscope in our study.

Zusammenfassung

Die Gattungen *Minthea* und *Dinoderus* (Bostrichidae) sind bekannt dafür, dass ihre Arten sehr schwer zu bestimmen sind. In der vorliegenden Arbeit wurden Tiere dieser Gattungen mit einem so genannten ESEM (= Environmental Scanning Electron Microscope) untersucht. Ein ESEM ist eine spezielle Variante des Rasterelektronenmikroskops. Der wesentliche Unterschied zu einem konventionellen Rasterelektronenmikroskop sind der höhere Druck („schlechteres Vakuum") in der Probenkammer und ein speziell angepasster Detektor. Eine Beschichtung der Probe mit Gold („besputtern") ist hierbei nicht nötig, so dass auch kostbares Sammlungsmaterial untersucht werden kann. Es werden Merkmale der Kutikulastruktur und der Morphologie der Haare gezeigt und beschrieben, an Hand derer eine Bestimmung der Arten *Minthea reticulata*, *M. rugicollis, Dinoderus brevis* und *D. minutus* zweifelsfrei möglich ist.

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