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Scanning Electron Microscopic Studies of Wing Microsculpturing in Termites (Isoptera). II. Genera *Amitermes* and *Eremotermes* (Termitidae, Amitermitinae)*

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To find out the true nature of the microsculpturing elements on the wing surfaces of termites, scanning electron microscopic (SEM) studies were made on two amitermitine genera, *Amitermes* and *Eremotermes*. Earlier light microscope examinations demonstrated the presence of papillae and micrasters on both wing surfaces in these genera. The SEM studies have revealed, in addition, the abundant presence, of another type of micraster composed of a basal, leafy vase of a pair or two of thin, gauzy petals, with central arms or rods (0–4 in number); in addition, asteroids are present. *Amitermes*: Papillae thorny. Micrasters: Vase-type with 1-3 arms (82%) and asteroids. Size 6–12 μm × 5–8 μm. Density 6800–7400/mm^2. *Eremotermes*: Papillae thorny. Micrasters: Vase-type (95%), either without arm or with 1–4 arms; and asteroids. The taxonomic and phylogenetic value of microsculpturing is discussed.

Key Words: **Wing microsculpturing, Scanning electron microscopic images, Termites, Isoptera (Termitidae, Amitermitinae),** *Amitermes, Eremotermes*

Introduction

In an extensive series of studies (Roonwal and co-workers 1967–1983), it was shown, on the basis of light microscope (LM) studies, that termite wings are covered densely with at least 8 different types of microscopic structures, besides the papillae which occur universally on the margins. All the major families and over 250 species have been studied.

In the current series*, scanning electron microscope examinations have revealed the intimate nature of these structures in two amitermitine genera, *Amitermes* and *Eremotermes*, which have earlier been examined only under the light microscope. The bearing of the new findings on taxonomy and phylogeny is discussed.

Results

Genus **Amitermes** Silvestri

(Silvestri, 1901, *Bull. Mus. Zool. Anat. compar. Torino*, Turin, **16** (389), p. 4.)

*Part I (Roonwal 1985) dealt with the genera *Heterotermes* and *Microtermes*

A single species, *A. belli*, was available.

1. *Amitermes belli* (Desneux)
(figure 1 and plates 1 & 2).

(*Termes belli* Desneux, 1906, *Annal. Soc. ent. Belg.*, Brussels, **49** (12), p. 352. Sind.)

Material: Imagoes from a colony in trunk of date palm, Siriska (Alwar District, Rajasthan, India).

LM studies have been made by Roonwal and Rathore (in press) who report the occurrence, on both wing surfaces, of a single row of small (length 3–5 μm), thorny papillae at the anterior margin and numerous 5- to 8-armed micrasters on the membrane (sizes 6–8 μm × 5–7 μm, density 9200–9600/mm^2).

The present SEM examinations (figure 1 and plate 1) have revealed that the majority (82%) of the 'micrasters' are of a new type, with a flower-like, leafy basal vase of thin, gauzy material, with slender, more solid-looking, centrally placed, pistil-like rods or arms whose number varies from 1 to 3 (those with 2 arms being the most common, 59%).

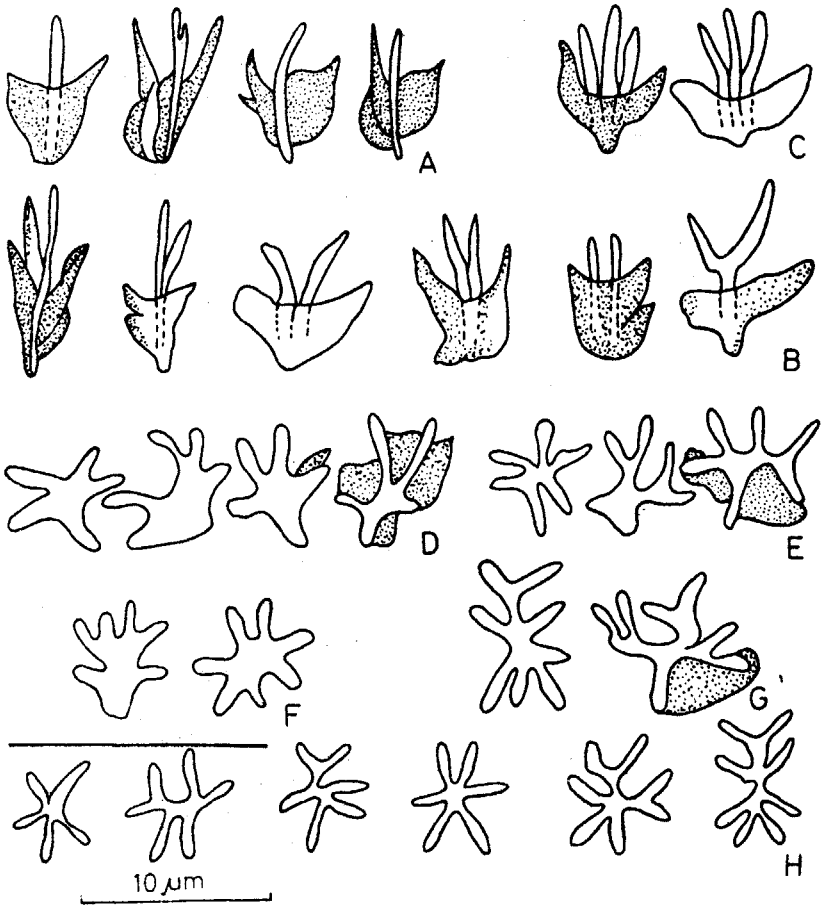

Figure 1 *Amitermes belli*. Variations in micrasters on dorsal surface of forewing. (*A–G*, from scanning electron micrographs; thin, gauzy areas of sheath are stippled. *H*, light microscope images). *A*. Vase with one central, pistil-like arm. *B*. Ditto, with two arms. *C*. Ditto, with 3 arms. *D*. Other (asteroid) shapes with 5 arms. *E*. Ditto, with 6 arms. *F*. Ditto, with 7 arms. *G*. Ditto, with 8 arms. *H*. Light microscope images (asteroid and subasteroid shapes, with 5-8 arms)

Occasionally, a rod may terminally fork into two. (This vase-like type was not evident at all in the LM images.) In addition, there are some (18 %) asteroid and other irregularly-shaped types of micrasters. Some of them have thin, gauzy, leafy attachments, suggesting that these latter types may have evolved from the former by the addition of more arms and the disappearance of the gauzy, leafy material. The micrasters give the impression of ridges on a flat surface. The proportions of the various types are as follows:

Type	*Percentage*
1. Vase-type with one central arm	20
2. Vase-type with two arms	59
3. Vase-type with three arms	3
4. Asteroid and other shapes, with 5–8 arms.	18

Sizes (length×width) vary as 6–12 μm× 5-8 μm (av. 8.1×6.6 μm). Densities 6800–7400/mm² (av. 6860/mm²), these being rather lower than those from LM images.

Genus **Eremotermes** Silvestri

(Silvestri, 1911, *Bol. Lab. Zool. gen. et agric. roy. Ist. super. Agric. Portici*, Portici, **6**, p. 108. Revision, Roonwal and Sen-Sarma, 1960, *Contrib. Syst. Orient. Termites*, New Delhi ICAR, Ent. Monogr. 1, p. 46.)

Menozzi (1940), while describing the imago of *Eremotermes indicatus* Silvestri (from Tripoli, N. Africa), showed the figure of a wing as densely punctated (presumably by micrasters), but made no mention of this in the text. The occurrence of true micrasters on *Eremotermes* wings was first shown by Roonwal and Sen-Sarma (1960) in three species, *E. dehraduni* Roonwal and Sen-Sarma (p. 63, wing "densely covered with numerous micrasters"), *E. fletcheri* Holmgren and Holmgren (p. 65) and *E. paradoxalis* Holmgren (p. 88 and figure 16). Subsequent detailed LM studies on these species are by Roonwal and Rathore (1977, 1982, on basal scales), Roonwal and Verma (1980), and Roonwal (1983b, summary). Microsculpturing consists of papillae at the margins and thin, brown, 4- to 6-armed, nonasteroid and asteroid micrasters.

2. *Eremotermes paradoxalis* Holmgren (figure 2 and plates 3 & 4)

(Holmgren, 1913, *J. Bombay nat. Hist. Soc.*, **22** (1), pp. 115-116, Bangalore, India).

Material: Imagoes from Jodhpur (Rajasthan, India).

LM studies (Roonwal & Rathore 1977, Roonwal & Verma 1980), had shown the presence, on both wing surfaces, of a row of small (4–6 μm×3–4 μm), pointed papillae at the anterior margin, a similar row of smaller ones at the posterior margin, and numerous small (3–8 μm×3–8 μm), thin, variously shaped, nonasteroid and asteroid micrasters with 3–6 arms on the membrane (plate 4); density ca. 5600–6000/mm².

The SEM micrographs (figure 2 and plate 3, show that the majority of micrasters are really vase-like bodies (apparently lying flat on the wing surface), with a petal-like or leaf-like shroud of a pair (sometimes two pairs) of thin, gauzy material, and thin, longish, more solid, pistil-like arms or rods emerging from the vase. The number of arms may vary from 0–4. Besides these, a few micrasters have asteroid or subasteroid shapes with 5–7 arms. The majority of the micrasters are of the one-armed vase type, the proportions of the various types being as follows:

Type	*Percentage*
1. Vase-type without central arm	3
2. Vase-type with one arm	58
3. Vase-type with two arms	31
4. Vase-type with three arms	2
5. Vase-type with four arms	1
6. Other types (asteroid, sub-asteroid, with 5-7 arms)	5

The micrasters on the forewing tend to be longer, narrower and somewhat denser (5–10×4–7 μm, av. 7.7×4.9 μm; density 5400–6000/mm², av. 5525/mm²) than those on the hindwing where they are squarish (av. 7.3×8.0 μm; density 5000–5600/mm². (av. 5300/mm²).

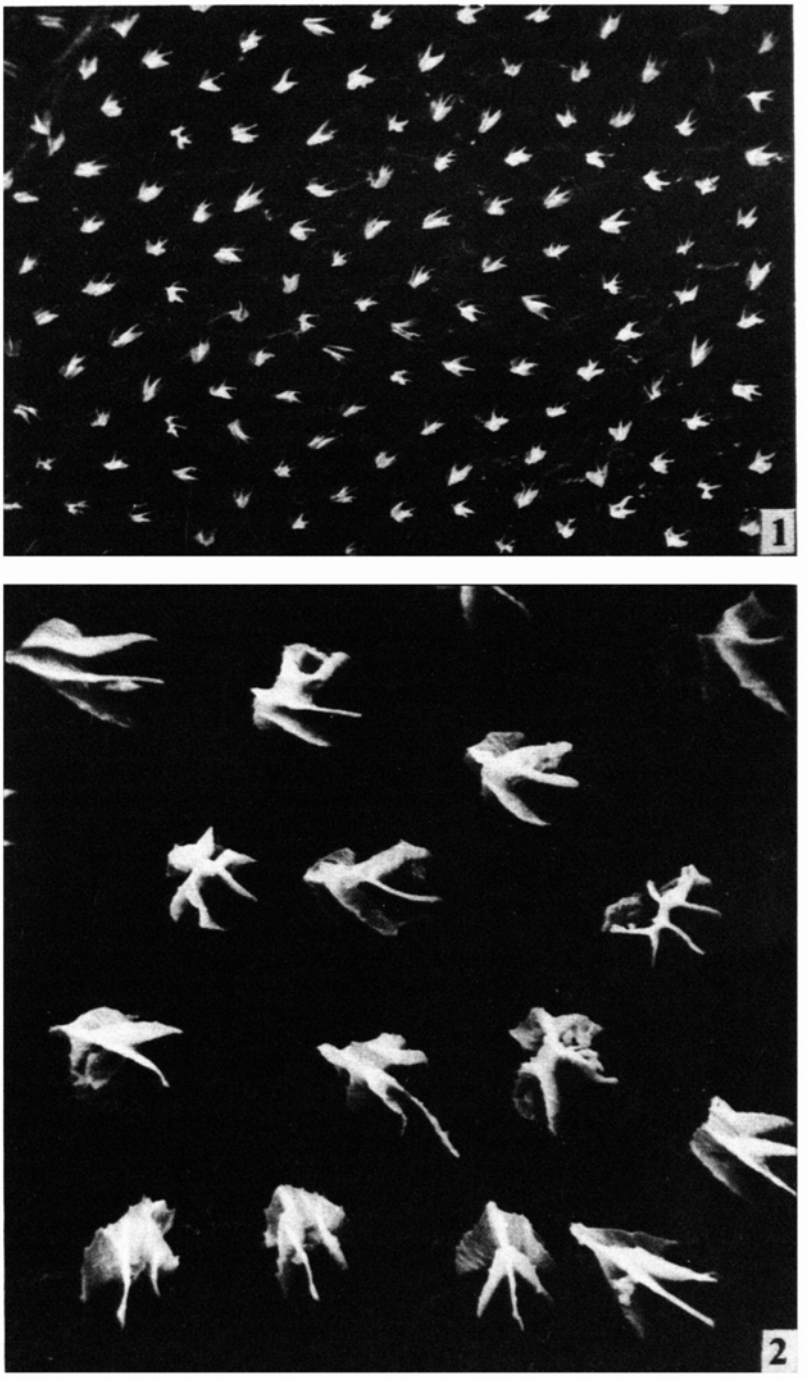

Plate 1 *Amitermes belli.* Scanning electron micrographs of middle portion of dorsal surface of forewing, to show micrastersr. [1 (× 600) 2 Same, more magnified (× 2400)].

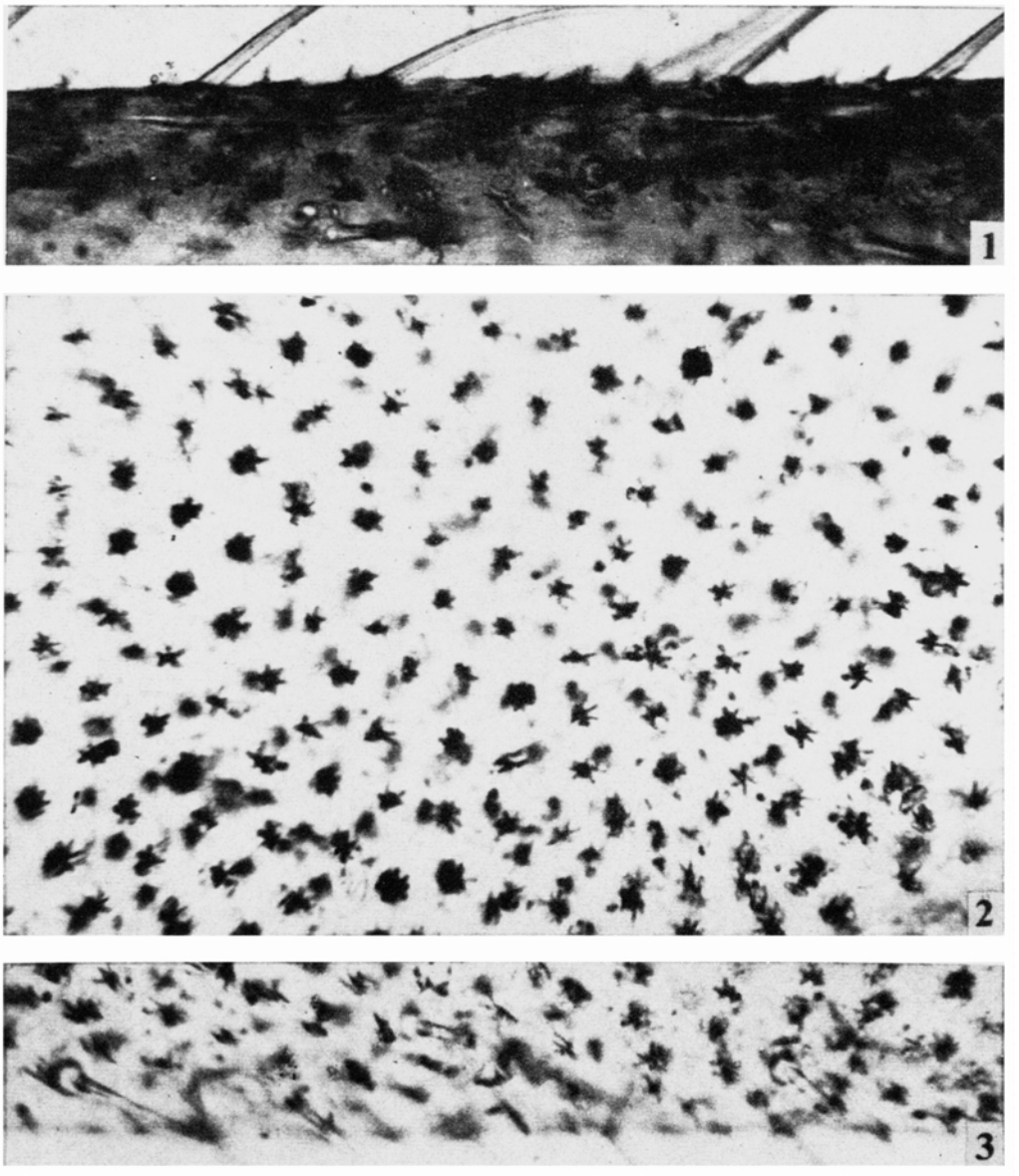

Plate 2 *Amitermes belli*. Light microscope photomicrographs of dorsal surface of forewing, to show microsculpturing (× 700); 1, Anterior margin of wing, to show papillae (at the edge) and a few hairs; some micrasters also seen below the margin; 2, Middle of wing, to show micrasters. Note circular and curved arrangements; 3, Posterior margin, to show thorny papillae and a few hairs at the edge; also micrasters in the upper part

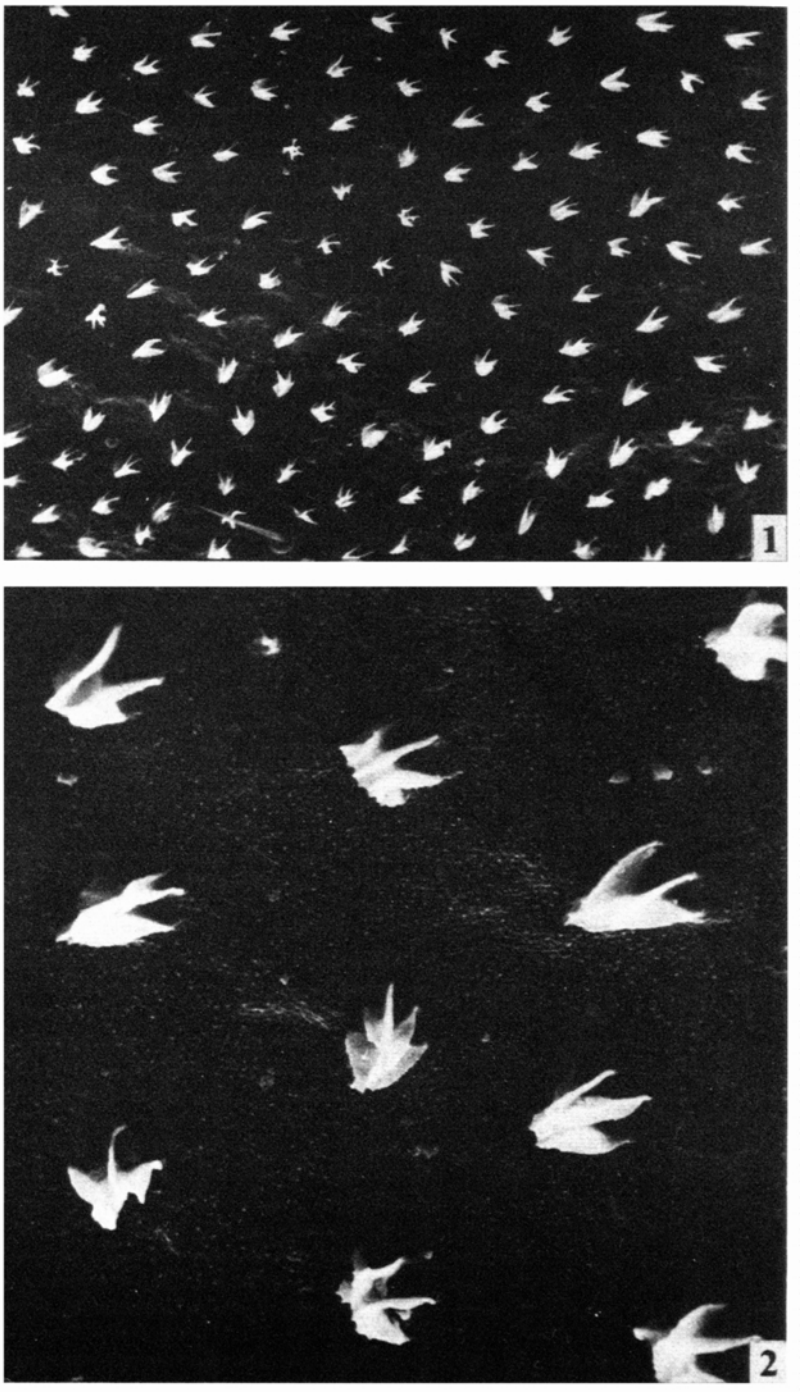

Plate 3 *Eremotermes paradoxalis*. Scanning electron micrographs of middle portion of dorsal surface of hindwing, to show microsters [1 (× 600); 2, Same, more magnified. (× 2400)]

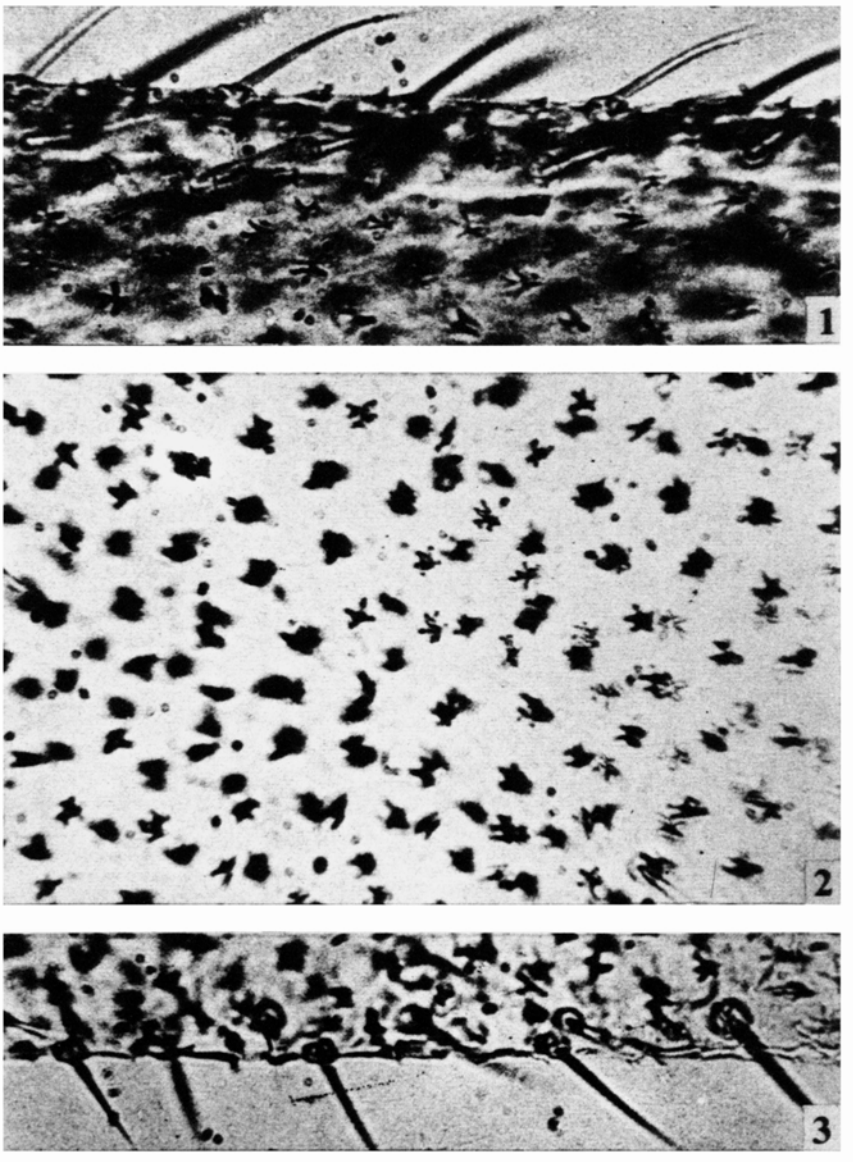

Plate 4 *Eremotermes paradoxalis*. Light microscope photomicrographs of dorsal surface of hindwing, to show microsculpturing (× 700); 1, Anterior margin of wing to show pointed papillae and hairs (at the edge); also micrasters below; 2, Middle of wing, to show micrasters; 3, Posterior margin, to show small, pointed papillae (at the edge), a few hairs and some micrasters

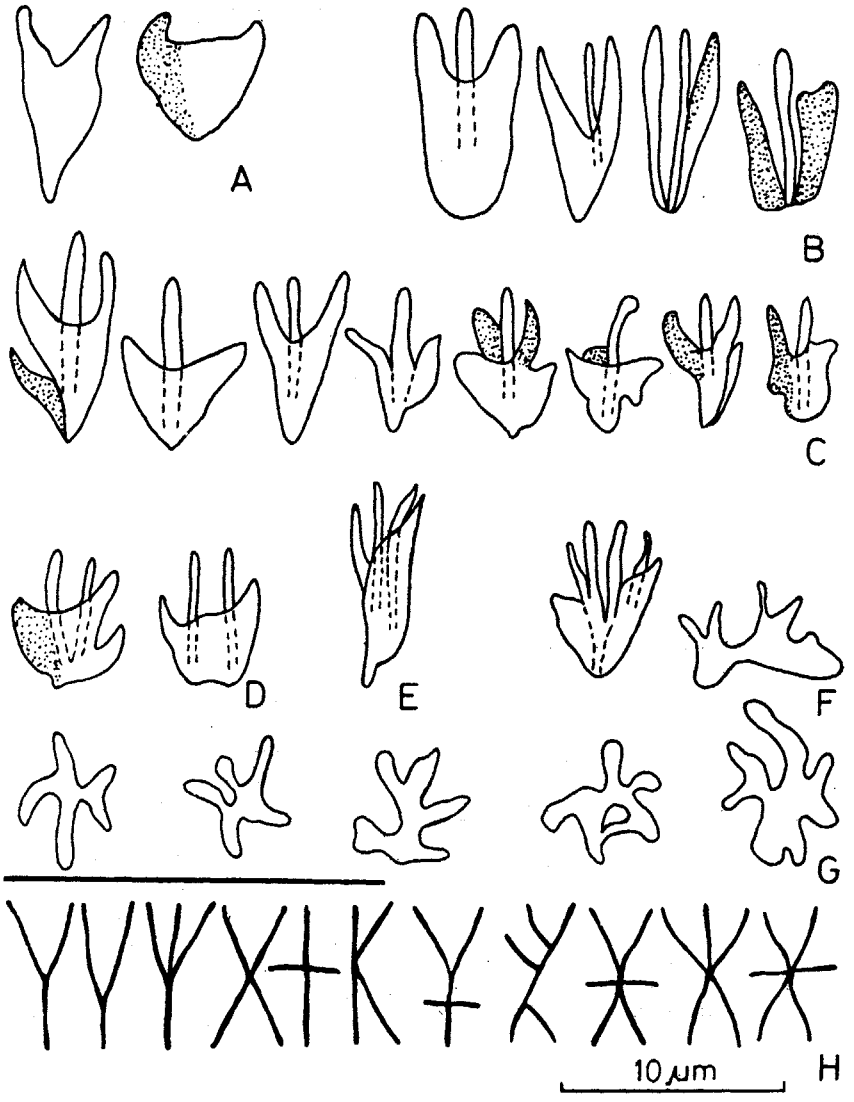

Figure 2 *Eremotermes paradoxalis.* Variations in micrasters on dorsal surface of hindwing. (*A–G*, from scanning electron micrographs; thin, gauzy areas of vase are stippled. *H*, light microscope images). *A.* Vase (sheath) without arm. *B, C.* Ditto, with one arm. *D.* Ditto, with 2 arms. *E.* Ditto, with 3 arms. *F.* Ditto, with 4 arms. *G.* Other shapes (asteroid, semiasteroid), with 5–7 arms. *H.* Shapes as visible under light microscope

Discussion

In both the genera under study, SEM images have revealed in the micrasters an altogether different type of structure from that seen in LM images, viz., a flowery vase of a pair or two of leaves, with or without central, pistil-like arms or rods emerging from the centre, the number of arms varying from 0 to 4. This type is indistinguishable in LM images from the nonasteroid and asteroid micrasters. In addition, there are a few asteroid-like shapes in both genera. The micrasters of *Amitermes* can be readily distinguished from those of *Eremotermes* by being more squarish and in having more gauzy, leafy material. The Amitermitinae are a relatively uniform subfamily where the micrasters have achieved full and universal development, and there is, as a rule, no other type of microsculpturing; except, occasionally, the arrowheads (*Alyscotermes* and *Anoplotermes*). *Amitermes* and *Eremotermes* conform to this rule.

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