

S.E.M. studies on seed coat patterns of genus Acacia, subgen. Aculeiferum Vassal

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S.E.M. studies on seed coat patterns of genus *Acacia*, subgen. *Aculeiferum* Vassal

JACQUES VASSAL

RÉSUMÉ

VASSAL, J. (1986). Etude microscopique (MEB) des téguments séminaux dans le genre, subgen. *Aculeiferum* Vassal. *Candollea* 41: 113-120. En anglais, résumé français.

Les téguments séminaux de 28 espèces d'*Acacia* appartenant au sous-genre *Aculeiferum* Vassal (= série *Filicinae* Benth. et série *Vulgares* Benth.) ont été examinés au microscope électronique à balayage. Quatre types principaux d'ornementations sont reconnus. Les résultats de cette étude confortent la validité taxonomique des sections *Filicinae* et *Aculeiferum*. Ils illustrent, en outre, un certain degré de diversification au sein de la section *Monacantha* Vassal et confirment la nécessité d'une révision de l'ensemble complexe des Acacias américains inermes ou à aiguillons.

ABSTRACT

VASSAL, J. (1986). S.E.M. studies on seed coat patterns of genus, subgen. *Aculeiferum* Vassal. *Candollea* 41: 113-120. In English, French abstract.

Spermoderms of 28 *Acacia* species from subgen. *Aculeiferum* Vassal (= series *Filicinae* Benth. and series *Vulgares* Benth.) were examined by scanning electronic microscope (S.E.M.). Four main seed coat patterns are distinguished. The results of this study warrant the taxonomic validity of sect. *Filicinae* and sect. *Aculeiferum*. Moreover, they illustrate some range of diversification within sect. *Monacantha* Vassal and confirm the necessity to revise the complex set of inermous and prickled American Acacias.

Ornamentations of seed surfaces, in the genus *Acacia*, have not practically been explored. We can only quote descriptions of spermoderm patterns of three species by TRIVEDI & al. (1979).

Observations with the help of S.E.M. have advanced more in some other genera of *Leguminosae*, especially in the *Papilionoideae* (see literature cited in VASSAL, 1984). They have proved helpful to provide new taxonomic characters.

As an extension of our current histological studies on seed coats, we undertook to investigate spermoderm surfaces in the three subgenera of the genus *Acacia*. A preliminary paper dealing with methodology and nomenclature of seed coat patterns was published in 1984 (see Bull. IGSM, 12). The present study concerns 28 species of subgenus *Aculeiferum* Vassal, taxon regrouping the two BENTHAM's series *Vulgares* and *Filicinae*.

List and classification of species studies¹

Species are firstly sorted out according to BENTHAM's subdivisions (1875). They are then referred to our own system of classification (VASSAL, 1972; GUINET & VASSAL, 1978).

Series *Filicinae*

A. boliviana Rusby (S. America); *A. aff. rosei* Standl. (N. America).

Series *Vulgares*

Americanae Capitulatae: *A. berlandieri* Benth. (N. America); *A. parviceps* (Speg.) Burk. (S. America); *A. parviflora* Little (N. America); *A. visco* Lor. ex Gris. (S. America).

Americanae Spiciflorae: *A. bonariensis* Gill. ex Hook. & Arn. (S. America); *A. coulteri* Benth. (N. America); *A. etilis* Speg. (S. America); *A. greggii* Gray (N. America).

Gerontogae Capitulatae: *A. brevispica* Harms subsp. *dregeana* (Benth.) Brenan (Africa); *A. concinna* (Willd.) DC. (Asia); *A. kamerunensis* Gandoger (Africa).

Gerontogae Spiciflorae

Ataxacanthae: *A. ataxacantha* DC. (Africa); *A. donnaiensis* Gagnep. (Asia).

Triacanthae: *A. dudgeoni* Craib. ex Holl. (Africa); *A. senegal* (L.) Willd. (Africa).

Diacanthae: *A. caffra* (Thunb.) Willd. (Africa); *A. catechu* (L. f.) Willd. (Asia); *A. chundra* Willd. (= *A.undra* (Roxb.) DC.) (Asia); *A. galpinii* Burt Davy (Africa); *A. gourmaensis* A. Chev. (Africa); *A. modesta* Wall. (Asia); *A. mellifera* (Vahl) Benth. (Africa); *A. modesta* Wall. (Asia); *A. nigrescens* Oliv. (Africa); *A. persiciflora* Pax (Africa); *A. polyacantha* Willd. subsp. *campylacantha* (Hochst. ex A. Rich.) Brenan (Africa) & subsp. *polyacantha* (Asia).

In our system of classification, three sections are recognized:

1. Sect. *Filicinae* (Benth.) Taub. = Series *Filicinae* Benth.;
2. Sect. *Aculeiferum* = *Triacanthae* Benth. & *Diacanthae* Benth. (from subseries *Gerontogae Spiciflorae* Benth.);
3. Sect. *Monacantha* Vassal: in this section have been included the following species: *A. ataxacantha* — *A. donnaiensis* (= *Ataxacanthae* Benth. from subseries *Gerontogae Spiciflorae* Benth.); *A. brevispica* — *A. kamerunensis* (from subseries *Gerontogae Capitulatae* Benth.); *A. berlandieri* — *A. parviflora*² (from subseries *Americanae Capitulatae* Benth.); *A. bonariensis* — *A. greggii* (from subseries *Americanae Spiciflorae* Benth.).

As this system takes into account juvenile characters, the taxonomic status of some species like *A. concinna*, *A. etilis*, *A. parviceps* and *A. visco* (incompletely described) remains uncertain. Moreover, the position of *A. coulteri*³ within the subgenus is not clearly established.

Voucher specimens are deposited at the Laboratoire de botanique & biogéographie, Université Paul Sabatier, Toulouse (TLS).

Methods

Fragments of seed integuments, after careful dehydration, were coated with a thin layer of gold-palladium, then observed with a JEOL/JSMT 200 under a constant tilt angle (45°) and an acceleration potential of 15-25 Kv.

The primary ornamentation⁴ is observed inside the pleurogram (= areole), a particular area of each side of the seed circumscribed by an elliptical or horse-shoe shape furrow.

Seed coat patterns in subgen. *Aculeiferum**Characteristics of seed coat patterns*⁴

Two levels of ornamentation can be characterized:

1. Primary ornamentation.
 - Macroornamentation (IMo): outer trace of Malpighian cells, it consists of reticulate (Figs. 4-8) or mamillate (Figs. 9-10) units (sizes $\leq 30 \mu\text{m}$), generally more conspicuous along the inner edges of the pleurogram (Fig. 4).
 - Microornamentation (Imo): mostly rugulate (Figs. 14-15) or striate (Fig. 17), rarely subradiate (Fig. 8) or microalveolate (Fig. 16), it is visible inside the reticulate and mamillate units. It can be the only ornamentation of the seed coat when the IMo is lacking.

2. Secondary ornamentation (IIo). This accessory ornamentation, visible on some species, consists of more or less regular macroalveoles, pits or ripples, often observable at low magnifications (Figs. 1-3).

Seed coat patterns of species studied

Four main spermoderm patterns are distinguished. In the 3 first ones (A, B, C), the two types of primary ornamentation can be observed; in pattern D, only the primary microornamentation (Imo) is conspicuous. Data on secondary ornamentation (IIo) are also given as complementary characters. Only distinct characteristics of spermoderms are illustrated (if seed coats of two species are very similar, one picture is given). Complementary illustration can be consulted in Bull. I.G.S.M. 12 (VASSAL, 1984).

1. Pattern A: IMo clearly reticulate, at least along the edges of the pleurogram — size of polygonal units $\leq 30 \mu\text{m}$. This pattern is observed in the *Diacanthae-Triacanthae* Benth. and in *A. ataxacantha*. Here are its main features:
 - Size of polygonal units: mostly from 5 to 15 μm (Figs. 4-8), rarely larger (some units up to 30 μm in *A. dudgeoni*).
 - Outlines of polygonal units: lightly to moderately prominent (Figs. 4, 7), in some cases thick when units are depressed (Fig. 8) or irregularly bloated as in *A. dudgeoni* (Fig. 5) and *A. gourmaensis*⁵, rarely furrowed as in *A. galpinii* (Fig. 6).
 - Surface of polygonal units: mostly flat and with Imo rugulate to striate (Figs. 4-7), in some instances more or less depressed and with Imo subradiate in *A. senegal* (Fig. 8), *A. caffra* (a few units only), *A. modesta* and *A. polyacantha*.⁵

A secondary ornamentation is observed in three species of this group. It consists of conical pits or of macroalveoles (diameters around 100 to 150 μm), especially outside the pleurogram, in *A. mellifera*⁵ and *A. persiciflora* (Fig. 1). In *A. galpinii*, the spermoderm is rather irregularly undulated (Fig. 2).

2. Pattern B: IMo more or less mamillate — surface sometimes partly smooth. This pattern is observed in *A. donnaiensis* (Fig. 9), *A. greggii* (Fig. 10), *A. brevispica* subsp. *dregeana*⁵ and *A. kamerunensis*. The Imo is striate to striate rugulate (Figs. 9, 10) or sometimes not conspicuous (surface partly smooth).⁶ A secondary ornamentation is visible on the spermoderm of *A. brevispica* subsp. *dregeana* and *A. kamerunensis*: pits, from 40 to 50 μm in diameter, are more or less regularly widespread inside the pleurogram.⁵
3. Pattern C: IMo reticulate or Imo only present (compare Figs. 13 and 14) — Size of polygonal units $\leq 10 \mu\text{m}$.
 - Subpattern Ca: surface of polygonal units not swelled, rather flat in *A. parviceps*, possibly depressed in *A. etilis* (Fig. 11). The Imo of these two species is striate (Fig. 3) to striate rugulate.
 - Subpattern Cb: surface of some polygonal units lightly swelled (mamillate) in *A. visco* (Fig. 12) and *A. bonariensis* (Fig. 13). Imo partly absent (some mamillae smooth, Fig. 13) or striate rugulate (Fig. 12) to rugulate (Fig. 14).

A secondary ornamentation consisting of oblong depressions, especially along the pleurogram margins is observable in *A. parviceps* (Fig. 3).

4. Pattern D: IMo absent — Imo only present. Six species can be referred to this pattern:
 - *A. aff. rosei* (Fig. 15) and *A. boliviana*:⁵ Imo coarsely rugulate, quite similar in the two species.
 - *A. coulteri* (Fig. 16): Imo unusual, very coarsely rugulate, with smooth creases delimiting more or less demarcated microalveoles.
 - *A. parviflora* (Fig. 17): Imo very finely striate or partly striate rugulate.
 - *A. berlandieri*⁵ and *A. concinna* (Fig. 18): Imo finely rugulate or hardly perceptible.

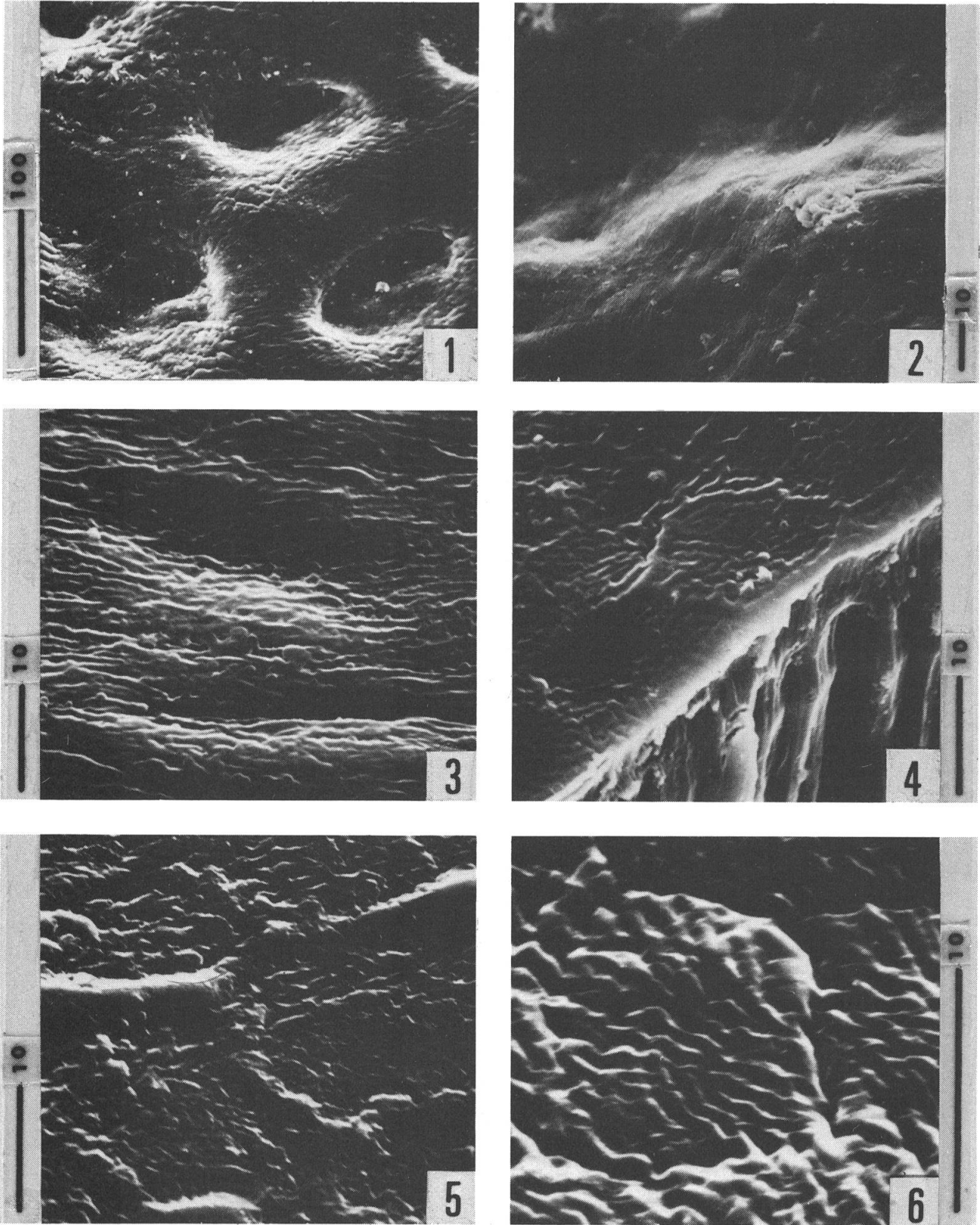


Fig. 1. — *A. persiciflora*, Ito macroalveolate.
 Fig. 2. — *A. galpinii*, Ito with irregular depressions.
 Fig. 3. — *A. parviceps*, Ito with oblong depressions (near the pleurogram edges).
 Fig. 4. — *A. ataxacantha*, pattern A (along the furrow of the pleurogram).
 Fig. 5. — *A. dudgeoni*, pattern A (outlines of units bloated).
 Fig. 6. — *A. galpinii*, pattern A (outlines of units furrowed).
 Scale: in μm .

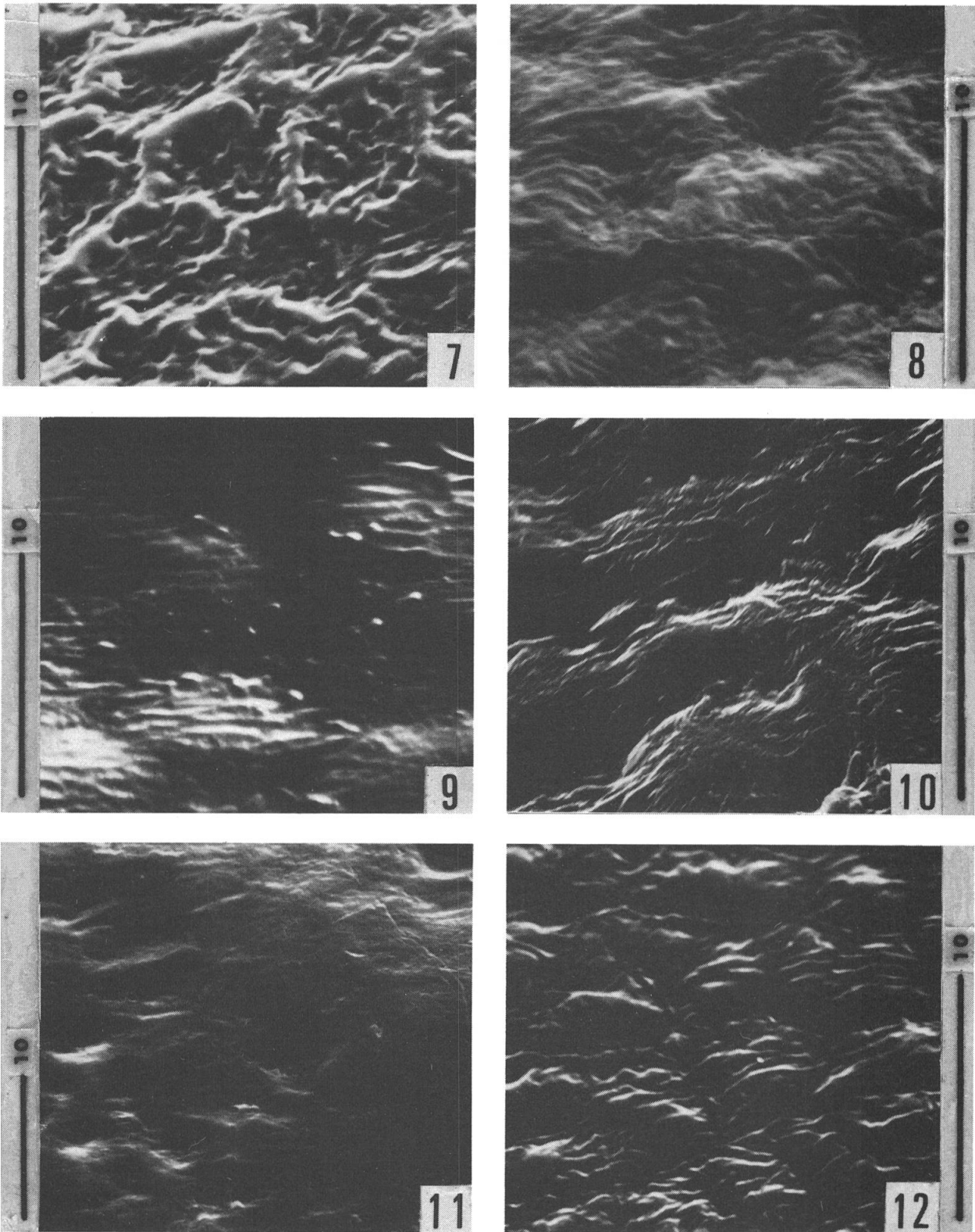


Fig. 7. — *A. polyacantha* subsp. *campylacantha*, pattern A.

Fig. 8. — *A. senegal*, pattern A (units depressed, Imo partly subradiate).

Fig. 9. — *A. donnaiensis*, pattern B.

Fig. 10. — *A. greggii*, pattern B.

Fig. 11. — *A. etilis*, pattern Ca (Imo visible or not — polygonal units depressed).

Fig. 12. — *A. visco*, pattern Cb (polygonal units lightly mamillate).

Scale: in μm .

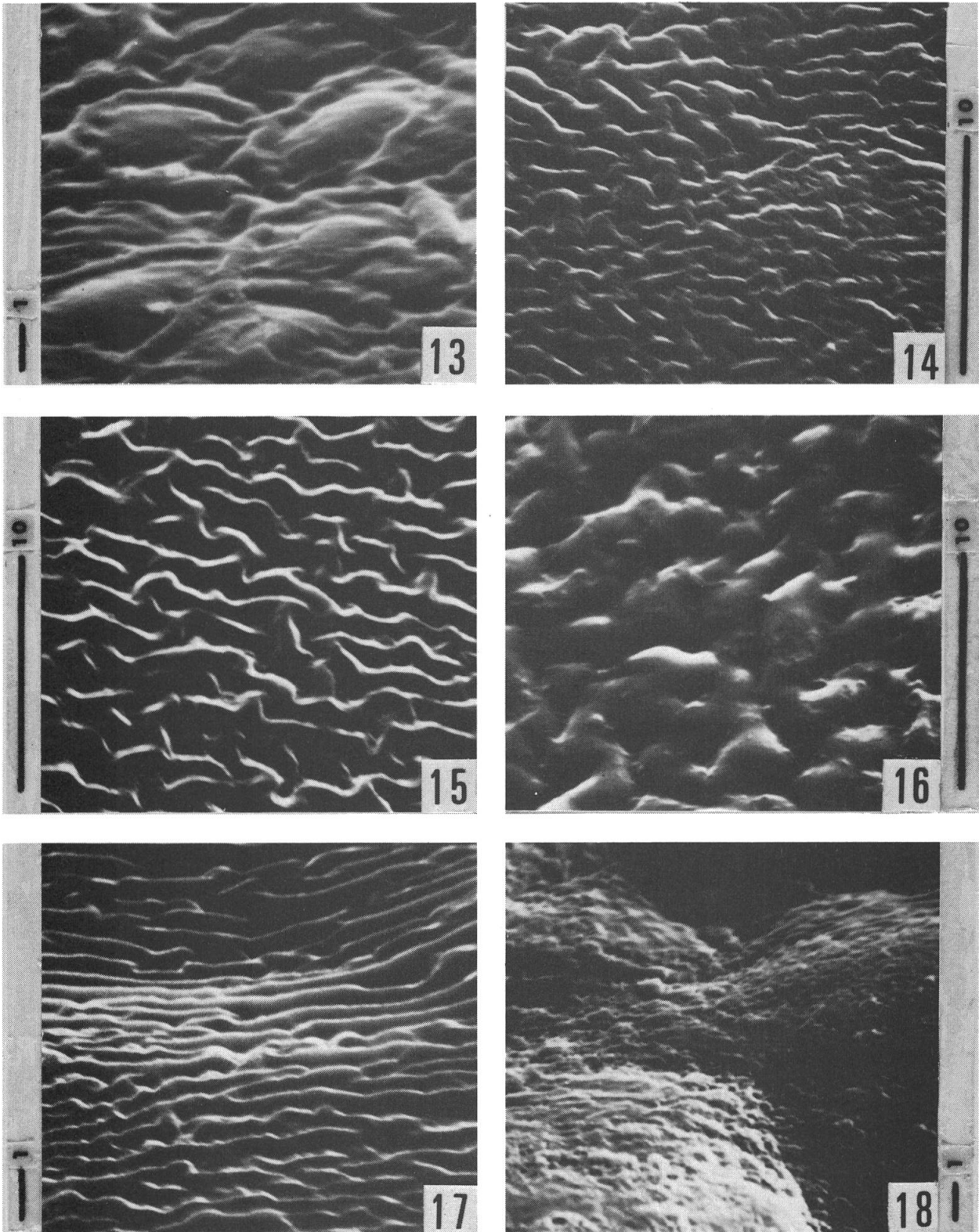


Fig. 13. — *A. bonariensis*, pattern Cb (polygonal units partly mamillate, some of them smooth).

Fig. 14. — *A. bonariensis*, Imo only present.

Fig. 15. — *A. aff. rosei*, pattern D.

Fig. 16. — *A. coulteri*, pattern D (microalveolate).

Fig. 17. — *A. parviflora*, pattern D.

Fig. 18. — *A. concinna*, pattern D (Imo hardly perceptible).

Scale: in μm .

A secondary ornamentation is observed in the three last species:

- *A. parviflora* (Fig. 17): irregular ripples especially near the pleurogram.
- *A. berlandieri*:⁵ pits more or less regularly widespread inside the pleurogram (diameters around 10 μm); macroalveoles outside the pleurogram (diameters around 100 μm).
- *A. concinna*: pits more or less regularly scattered inside the pleurogram (diameters from 10 to 25 μm , Fig. 18).

Discussion of results and conclusion

This S.E.M. study of seed coat ornamentations in *Acacia*, subgen. *Aculeiferum* suggests the following main remarks.

The diversity of spermoderm patterns within the *Vulgares Americanae* / *Gerontogae Capitulatae* (B, Ca-Cb, D) *Americanae* / *Gerontogae Spiciflorae* (A, B, Ca-Cb, D) indicates, once again, that systematic groupings on the basis of inflorescence types are not necessarily natural.

The most common IMo pattern is reticulate. Pattern A is typical of sect. *Aculeiferum*. The different characteristics of reticulate units (size, outlines, topography and Imo of surface) and, possibly, of secondary ornamentations, can be usable as taxonomic markers at the level of species in the section.

Spermoderm pattern A is also observed in *A. ataxacantha*, a species we included in sect. *Monacantha*. In a previous paper (1971), we pointed out some peculiarities of this species (seed shape, type of cotyledon) which can also be found in sect. *Aculeiferum*. Some other works on petiole and pod anatomy (ROBBERTSE, 1975a-b) and biochemistry (free amino-acids of seeds — EVANS & al., 1977) could also suggest some possible relationship of this species with this section. Bentham classed *A. ataxacantha* in a separate subdivision (*Ataxacanthae*) linked to the *Diacanthae-Triacanthae* (i.e. sect. *Aculeiferum*) within the *Gerontogae Spiciflorae*. According to these characters, this species seems to be located at the junction of the two sections *Aculeiferum* and *Monacantha*.

Pattern B (IMo more or less mamillate) is rather rare in the subgenus. The four species concerned belong to the three Bentham's groups: *Gerontogae Capitulatae*, *Gerontogae Spiciflorae* and *Americanae Spiciflorae*. In our system of classification, they are included in sect. *Monacantha*. The close relationships between *A. brevispica* and *A. kamerunensis*, African species of the "pennata" complex, are confirmed. In some degree, when mamillae are not clearly conspicuous, pattern B is near to pattern D (IMo absent).

Due to its particular characteristics (mamillate and reticulate trends), pattern C is intermediate between patterns A and B. We assign this type of spermoderm to four American species (*Americanae Spiciflorae* and *Capitulatae* Benth.). *A. bonariensis* belongs to sect. *Monacantha*; as for the 3 other species (*A. etilis*, *A. parviceps* and *A. visco*), further information is needed (biochemistry, palynology, seedling morphology...) to interpret taxonomically the mixed features of seed ornamentations.

Pattern D (no IMo) is characteristic of six species, mainly American.

A very same spermoderm pattern (coarsely rugulate) is observed in the two species *A. boliviana* and *A. aff. rosei* which belong to the *Filicinae* (inermous species). This observation reinforces the recognition of such a group.

The peculiar microalveolate (very coarsely rugulate) pattern of *A. coulteri* can be correlated with the equivocal taxonomic position of this species.³ *A. coulteri* has no clear relationships with the *Americanae Spiciflorae* Benth. neither with the three sections already recognized.

Pattern D could confirm affinities between *A. parviflora* and *A. berlandieri* (*Americanae Capitulatae* Benth. — Sect. *Monacantha* Vassal). These taxa are also probably related to *A. concinna* (*Gerontogae Capitulatae* Benth.).

On the basis of this preliminary S.E.M. study of seed surfaces in *Acacia* subgen. *Aculeiferum* Vassal, we can conclude that spermoderm patterns seem to warrant the taxonomic validity of sect. *Filicinae* (Benth.) Taub. and sect. *Aculeiferum*. Moreover, these ornamentations illustrate some range of diversity within sect. *Monacantha* Vassal and the uncertain taxonomic position of species

like *A. ataxacantha* or *A. coulteri*. Further S.E.M. observations on seed coat surfaces in subgen. *Aculeiferum* might probably help to solve some tangled biosystematic problems especially in a complex set of prickled and inermous American species.⁷

¹This set of species illustrates, as far as possible, the numerical importance and the diversity of the different subdivisions in the subgenus.

²For *A. parviflora*, personal communication of M. L. Rico Arce.

³Due to peculiar characteristics (no prickles but very short stipular spines — opposite and pinnate eophylls), we previously included *A. coulteri* in subgen. *Acacia* (1972). In spite of these unusual characteristics, chemotaxonomic studies of EVANS & al. (1977) proved that this taxon can be referred to subgen. *Aculeiferum* Vassal.

⁴For definitions of the nomenclatural vocabulary used, see VASSAL, Bull. IGSM 12. 1984.

⁵Illustration in VASSAL, Bull. IGSM 12. 1984.

⁶In some instances, this aspect can be due to a superficial peeling off making apparent a subjacent part of the Malpighian cells.

⁷At the last 5th meeting of the International Group for the study of Mimosoideae, in Mexico (sept. 1984), it was decided to undertake a complete revision of American *Mimosoideae* for Flora Neotropica.

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