

NOTES ON ARYTERA (SAPINDACEAE)

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SUMMARY

Consequently upon a revision of *Mischocarpus* (Van der Ham, 1977a), a detailed study has been made of several characters in *Arytera* in order to get a better understanding of the delimitation of the two genera mutually.

The differences between *Mischocarpus* and *Arytera* given by Radlkofer (1931) in his key are vague and can only be used when fruiting material is available. However, several species in *Arytera* were described by him and others on flowering material only. Two species of *Mischocarpus* could be connected with species of *Arytera*. One species of *Arytera* appeared to be the same as *Mischocarpus exangulatus*. *M. exangulatus* has, besides typical *Mischocarpus* characters, several features unique in *Mischocarpus* but more regularly occurring in *Arytera*.

Radlkofer distinguished 4 sections with 24 species. A few more species were described afterwards but were not placed in a section. When searching for new characters on which to base a better delimitation against *Mischocarpus*, variation in several characters of *Arytera* turned out to be rather wide for a genus within the *Cupanieae*. Moreover, these variations appeared to be discontinuous. With help of a few characters, groups of species could be formed which are more natural and better based than the sections made by Radlkofer. Several species or groups of species turned out to be wrongly placed or at least dubious in *Arytera*. Even the naturalness of *Arytera* as provisionally accepted here can be questioned.

The material studied mainly comes from L and M (types of Radlkofer). Material of nearly all species was available.

I. SPECIES EXCLUDED FROM ARYTERA

Arytera concolor (Gillespie) A. C. Smith, J. Arn. Arb. 31 (1950) 298. — *Guioa concolor* Gillespie, Bull. Bish. Mus. 83 (1931) 17, f. 19. — T y p e: Fiji Islands, Taveuni, near Waiyevo, Gillespie 4794, 3-3-1928, along streams in the coconut belt, alt. 200 m, fl. (BISH, n.v.; iso in A, DS, GH, K, US).

Mischocarpus guillauminii Kanehira, Bot. Mag. Tokyo 46 (1932) 672. — T y p e: Carolines. Truk Islands, Tol, Kanehira 1368, -6-1931, alt. c. 450 m, fr. (FU, n.v.; iso in A, US with Kanehira 1268 on label).

Mischocarpus paradoxus auct. non Radlk.: Kanehira & Hatusima, Bot. Mag. Tokyo 57 (1943) 79.

CAROLINES. Truk Islands, Kanehira 1368; Hosokawa 8323 (US); Wong 277 (A).

Fiji ISLANDS. V i t i L e v u. Gillespie 3780 (A, BISH, DS, GH, K, US); Smith 4490 (A, L, US), 4857 (A, US), 5053, 5287, 5580 (A, L, US); Degener 15398 (A, L, US), 15508 (A). — T a v e u n i. Gillespie 4763, 4765, 4793, 4794, 4795 (A, BISH, DS, GH, K, US).

Arytera concolor from Fiji appeared to be almost identical with *Mischocarpus guillauminii* from the Carolines. Collections from the Carolines have fruits with a glabrous endocarp while those from Fiji have fruits which are densely hairy inside. When revising *Mischocarpus*, *M. guillauminii* had to be excluded from that genus. In view of the variability in

indumentum of the endocarp in various species of *Mischocarpus*, the collections from Fiji and from the Carolines may well belong to the same species.

This species, unknown to Radlkofer, has been placed in three genera until now, but neither of these is satisfactory. It was described by Gillespie in *Guioa* on the strength of a doubtful observation of two crested scales on each petal. Neither in his figure nor in the material there is a trace of a crest on the scales, however. Guillaumin considered the material from the Carolines to belong in *Mischocarpus*, probably because of the superficial resemblance of the fruit and of the reticulation of the leaflets. Also the reasons to place it in *Arytera* are doubtful. Smith mentioned the presence of hairs on the endocarp which he said to be characteristic of *Arytera brackenridgei* (A. Gray) Radlk. However, collections from the Carolines have a glabrous endocarp and such hairs as mentioned do occur in many other genera (e.g. *Mischocarpus* and *Gongrodiscus*). Also the minute glandular scales present in the very young parts, said to be a feature of *A. brackenridgei*, can be found in other genera (*Cupaniopsis*, *Sisyrolepis*, *Dictyoneura*, *Lepiderema*). Other characters present in the material, not mentioned by Smith, are very unlike those of *Arytera*:

Calyx: opening late, sepals not connate, unequal, imbricate, membranaceous at the margins; this is a typical 'Cupania-calyx' (Radlkofer, 1879, 1931), noticed by Gillespie but not by Smith. *Arytera* is characterized by a 'Matayba-calyx': opening early, sepals about equal, not imbricate, small, not membranaceous at the margins.

Fruit: neither Gillespie, nor Smith, nor Kanehira observed the presence of incomplete septa leading to a 3-merous, 1-locular fruit. This character is further only met in *Gongrodiscus* as far as I know. The seed is completely enveloped by an ariloid attached with a broad ring (pseudohilum) around hilum and micropyle. The ariloid in *Arytera* is either completely different, or attached with a narrow ring.

On account of these characters, the species is not correctly placed in *Arytera*. When we follow Radlkofer's key (1931): fruit opening with three valves, embryo notorrhizal, Pacific distribution, petals with two scales without crest, 'Cupania-calyx', we come to *Cupaniopsis*. All of the characters mentioned above, except for the reduced septa, fit in the description of that genus. Also one of the sections of *Cupaniopsis* contains species provided with glandular scales. With good reasons we can make a new combination here: ***Cupaniopsis concolor*** (Gillespie) Van der Ham.

N o t e s. The species has pollen type B (see: Muller & Leenhouts, 1976).

When revising *Cupaniopsis* it is worth remembering *Gongrodiscus* as a genus much alike *C. concolor*.

Arytera sordida Radlk., Bot. Jahrb. 56 (1920) 301; Hartley c.s., Lloydia 36 (1973) 269. — **T y p e:** East New Guinea, East Sepik Dist., Felsspitze, Kaiserin Augusta-Fluss-Expd., Ledermann 12492, -8-1913, alt. 1400-1500 m, fl. (B, lost; M, iso).

NEW GUINEA. **E a s t.** Morobe Dist., Edie Creek near Wau, Hartley 11676, 23-4-1963, alt. c. 1950 m, fl. (L); Mt. Shungol, near Wagau, Hartley 12566, 17-12-1963, alt. c. 2100 m, fl. (L); Central Dist., 9.9 S, 147.43 E, NGF 34723, fr. (L).

This species was described on flowering material only, while fruits are said to be characteristic for *Arytera*. Radlkofer described it as having petals with two minute scales but probably he did not see the whole variation: from one big scale via a retuse scale to two smaller, almost separated auricles. Possibly Radlkofer observed the more reduced condition or maybe he saw the remnants of one big scale. When pulling out a petal, the scale is very easily detached because of its dense indumentum which makes the scale cling to the densely hairy disk and stamens. Such a condition of the scale is rather strange

for *Arytera*. When fruits became available to me, the species could be placed with certainty in *Sarcopteryx*. Characteristic are also the very small club-shaped glands on the leaflets in part of the material. A new combination is made: ***Sarcopteryx sordida*** (Radlk.) Van der Ham.

N o t e s. The species has pollen type B (see: Muller & Leenhouts, 1976).

In due time, when *Sarcopteryx* is revised, this species may possibly be reduced to some species already known.

Arytera subnitida C. T. White, Proc. R. Soc. Queensl. 47 (1936) 56 = ***Mischocarpus exangulatus*** (F. v. M.) Radlk., see Blumea 23 (1977) 266.

II. DUBIOUS SPECIES PROVISIONALLY KEPT IN ARYTERA

Arytera lautereriana (F. M. Bailey) Radlk., Fedde Rep. 20 (1924) 37, from Australia, is the only species in Radlkofer's section *Mischarytera*. It is a very strange species in *Arytera*, having fruit characters even unique in the *Cupanieae*.

In *Mischocarpus macrobotrys* Merr. & Perry, a species which had to be removed from *Mischocarpus* and which appeared to be closely related to *A. lautereriana*, these characters turned out to be also present and still more extreme. *M. macrobotrys* is known from several collections made in E. New Guinea (Brass 7464, 7618, 8057, and Hartley 12077). The fruit is irregularly lobed and one or two out of three locules are abortive. Ripe fruits are irregularly dehiscent with hardly a trace of valves; in young ones vague sutures can be noticed. This character is not in accordance with the description of the fruit of *Cupanieae* which is loculicidally dehiscent by valves. The sclerenchymatic endocarp in a locule radiates from the funicle and is separated in two halves, the gap between them more or less indicating the place of a suture in the pericarp. The sclerenchymatic endocarp is only lining the proximal hemisphere of the locule and in ripe fruits (*i.s.*) it is completely detached from the outer fruitwall, forming a cupule-like structure around the seed and the ariloid, attached only around the funicle. The situation in fresh material is not known. The seed cover is said to be a translucent acid pulp. In the herbarium it is rather variable: a subcoriaceous to somewhat fleshy to spongy brittle mass surrounding the whole seed; probably, this depends on the stage of maturity of the fruit and the way of drying. On closer examination the seed cover appears to be an ariloid attached around the hilum, leaving the micropyle free (see: Van der Pijl, 1955, f. 1c).

In *A. lautereriana* the characters mentioned are somewhat different but essentially the same.

Concluding: there is a relationship consisting of at least two species (maybe Hartley 12077 represents a third one), distributed in Australia and E. New Guinea, which demonstrates characters that are rather unique in *Cupanieae*. Till further knowledge is gathered, this relationship is maintained as a dubious group within *Arytera*: the *mischarytera*-group. Consequently, one new combination must be made: ***Arytera macrobotrys*** (Merr. & Perry) Van der Ham (Basionym: *Mischocarpus macrobotrys* Merr. & Perry, J. Arn. Arb. 21 (1940) 524. — **T y p e:** E. New Guinea, Western Dist., Middle Fly R., Lake Daviumbu, Brass 7618, —8—1936, fl. (A; iso in BRI, L)).

N o t e. The pollen of all collections are of type B and rather uniform, seen with the lightmicroscope.

Arytera leichhardtii (Benth.) Radlk., Sapind. Holl.-Ind. (1879) 44, from Australia, Queensland. The position of this species is doubtful: fruits are not known and with

vegetative parts or flowers only no connections can be laid to other species in *Arytera*. Until complete material is available, this species is kept as dubious in *Arytera*. The pollen type is B, but sometimes pollen transitional to type A occurs (see Pl. 2: 3—6).

III. UNKNOWN SPECIES

No material was available of two species:

Arytera foveolata F. v. M., probably related to *A. xerocarpa* (Bl.) Adalb.

Arytera exostemonea Domin, according to Radlkofer related to *A. divaricata* F. v. M.

IV. SUBDIVISION OF ARYTERA

With help of a few characters, the remaining species of *Arytera* can be arranged into groups that seem to be more natural and better characterized than the sections made by Radlkofer. The characters studied are:

leaflet: glandular scales present or not; domatia present or not.
 pollen type: A or B.
 fruit: habit; type of arilloid.

Glandular scales

Some species have glandular scales, which are more or less densely spread over all parts of the plant. They give young parts a sticky somewhat shining appearance. Sometimes they are very scarce and only found in sunken parts near the base of the leaflet or on very young leaflets.

Domatia

Some species are provided with domatia, though mostly not all collections of one species or all leaflets of one collection have them. In other species domatia never occur.

Pollen

Muller in Muller & Leenhouts (1976) distinguished several pollen types in *Sapindaceae*. Two of them, type A (spherical, tricolporate) and type B (triangular, syntricolporate), are found in *Arytera*. According to Muller & Leenhouts, pollen type A represents the basic type in *Sapindaceae* and occurs in all tribes. Type B is more specialized and is found in *Melicoccae*, *Schleichereae*, and *Cupanieae* only. On the photoplates the two pollen types are shown as well as a range of sculptural development of the ektexine.

Fruit

Habit. The description of the fruit made by Radlkofer (1931) in his key to the genera: 'Frucht gewöhnlich knopfig-gelappt mit aus einander gespreitzten Lappen' (fruit mostly lobed, lobes spreading) is, as it already says, only partially true. Actually, two basic types can be distinguished:

1. In accordance with the description of Radlkofer: the axial parts of the fruit are limited in growth and 2 or 3 lobes are present. When an ovule is abortive, the corresponding lobe is not expanding. Septa between the locules are hardly present. This type is mostly glabrous inside; only along the sutures hairs are sometimes present when ripe. Mostly only the lobes are opening; the axial part is not teared up (see fig. 1).

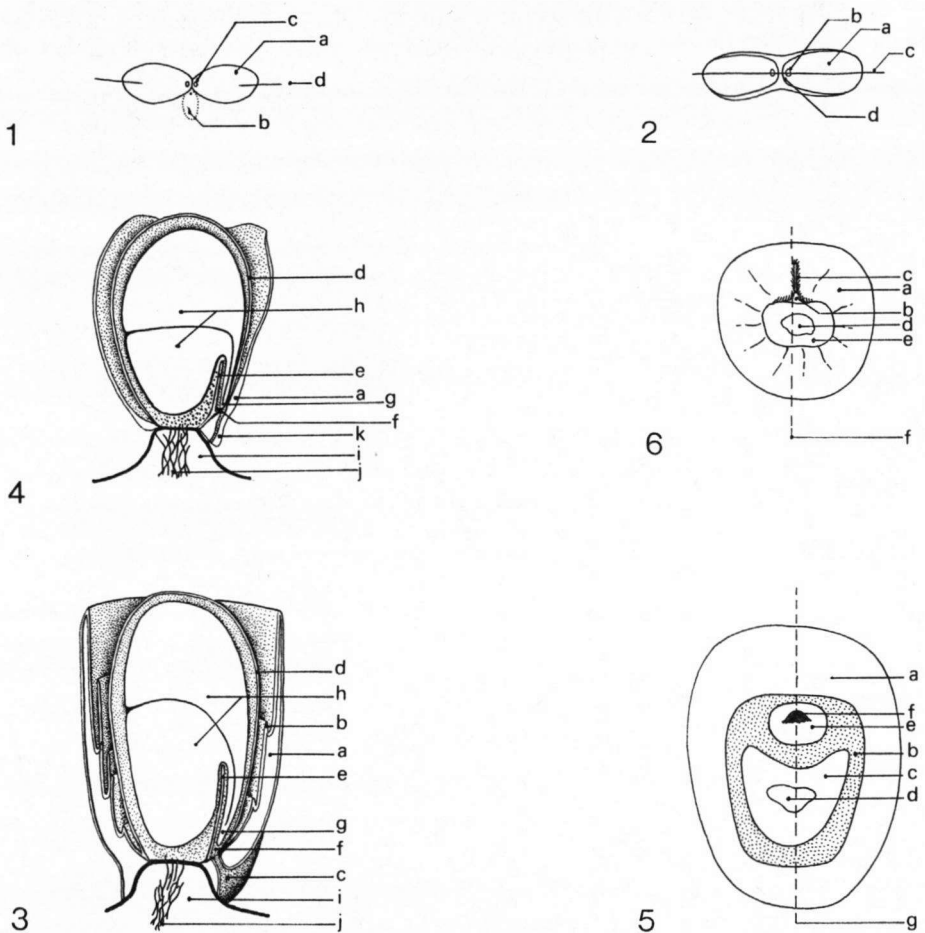


Fig. 1. cross-section through fruit of type 1. $\times \frac{1}{2}$ (a: lobe with fertile ovule. b: lobe with abortive ovule. c: point of attachment of ovule. d: line indicating place of opening of the lobe.) — fig. 2. cross-section through fruit of type 2. $\times 1$ (a: lobe. b: point of attachment of ovule. c: line indicating place of opening of the fruit. d: septum.) — fig. 3. section through arilloid of type 1. $\times 3$ (a: arilloid. b: fold of arilloid. c: micropylar slit in arilloid. d: testa of seed. e: internal fold of the testa. f: micropyle. g: radicle of the embryo. h: cotyledons of the embryo. i: funicle. j: bundle.) — fig. 4. section through arilloid of type 2. $\times 3$ (a—j: see under fig. 3. k: cap of arilloid overlying the micropyle.) — fig. 5. aspect of the hilar region of the seed (schematically) (a: testa free from arilloid. b: testa to which the arilloid is attached (pseudohilum). c: hilum. d: bundle trace. e: micropylar region. f: micropyle. g: line indicating plane of section in fig. 3 and 4.) — fig. 6. arilloid of type 1 seen from below (hilar aspect), $\times 2$ (a: arilloid. b: part of arilloid attached between hilum and micropyle. c: micropylar slit in arilloid. d: bundle trace. e: hilum. f: line indicating plane of section in fig. 3).

2. Here, the axial part is not much limited in growth, which results in a hardly lobed fruit. There are two locules and a septum between them. The endocarp is always hairy. Seeds can only come free when also the axial part of the fruit is teared up (see fig. 2).

Arilloid. For all species the seed cover is an arilloid originating from and attached to the testa around hilum and micropyle (Van der Pijl, 1955, f. 1b). Two types of arilloid are observed:

1. Mostly folded inside near the base; thick, subcoriaceous-fleshy; some layers can be distinguished with low magnification: an inner and outer one which are thin, soft, light-coloured, and a middle one which is thick, firm, dark-coloured (see fig. 3).

2. Not folded inside; membranaceous, mostly somewhat fleshy near the base; only one layer can be distinguished which is yellowish (see fig. 4).

Type 1 is almost like an arillus: the descending parts of the arilloid seem to be fused with the funicle; the funicle is nearly completely surrounded by the arilloid. The middle layer of the arilloid is very much alike the tissue of the funicle as seen with low magnification.

The aspect of the hilar region of the seed is about the same in type 1 and 2: the place where the arilloid is attached is seen as a lightbrown testa (pseudohilum) around hilum and micropyle (see fig. 5).

A micropylar slit is only observed in type 1 (see fig. 6). In type 2, there is a cap, overlying the micropyle and the part of the arilloid which is attached between micropyle and hilum (when such a cap would be lengthened, the same situation as in *Mischocarpus* would be reached: an arilloid with an appendix arising abaxially of the micropyle).

In table 1 the species are grouped by the characters mentioned above. *Arytera xerocarpa* (Bl.) Adelb. = *Arytera littoralis* Bl. as cited by Radlkofer. Some of the species were incompletely available.

Four groups are characterized. However, these are not just phenetic groups of species which have some characters in common; during several months of careful study they gradually revealed themselves as coherent groups of mutually distinctly related species.

xerocarpa-group (sect. *Euarytera* p.p.)

Pollen type A is rare in Asian *Cupanieae*. The group is well characterized by the arilloid type 1. It has mainly Malesian distribution from SE. Asia via New Guinea to E. Australia.

azarytera-group (cf. sect. *Azarytera*)

Noteworthy is the presence of glandular scales also met in a Pacific section of *Cupaniopsis* and in a few other genera in the *Cupanieae* (see also chapter I. *Arytera concolor*). The calyx is not always a pure 'Matayba-calyx': there are transitions to the 'Cupania-calyx' (see also *A. concolor*). The distribution of the group is predominantly a Pacific one.

Arytera o'shanesiana (cf. sect. *Xylarytera*)

This is a rather isolated species in *Arytera*. Distribution: Australia (Queensland).

chartacea-group (sect. *Euarytera* p.p.)

Remarkable is a character also occurring in *Cupaniopsis* (*C. fruticosa* Radlk.) and *Gongrodiscus*: hairs on the hypocotyl of the embryo. The 5-lobed disk, which sometimes occurs, is also known from *Gongrodiscus*. Both species of this group (as well as *Cupaniopsis fruticosa* and *Gongrodiscus*) come from New Caledonia.

The groups roughly correspond to the sections distinguished by Radlkofer. Radlkofer grouped these sections (and sect. *Mischarytera*) in one genus because of a resemblance in

TABLE 1

species of Arytera	glandular scales	domatia	pollen type	fruit type	type of arilloid
<i>gigantosperma</i>					
	described on fruits only			1	1
<i>xerocarpa</i>	-	x	A	1	1
<i>brachyphylla</i>	-	x		1	1
<i>densiflora</i>	-	x	A	1	
<i>divaricata</i>	-	x	A	1	1
<i>distylis</i>	-	x	A	1	
<i>microphylla</i>	x	-		2	2
<i>xanthoneura</i>	x	-	B	2	2
<i>arcuata</i>	x	-		2	2
<i>lepidota</i>	x	-		2	2
<i>gracilipes</i>	x ?	-	B		
<i>brackenridgei</i>	x	-	B	2	2
<i>samoënsis</i>	x	-		2	2
<i>setosa</i>	x	-		2	2
<i>livida</i>	x	-			
<i>o'shanesiana</i>	-	x	A	resembling 2	2
<i>chartacea</i>	-	-	B	resembling 1	2
<i>collina</i>	-	-	B	resembling 1	2
<i>lautereriana</i>	-	x	B	} unlike } 1 or 2	} unlike } 1 or 2
<i>macrobotrys</i>	-	x	B		
<i>leichhardtii</i>	-	x	B	not known	

fruit. Actually, however, at least two fruit types can be distinguished: the *xerocarpa*-type (1) and the *azarytera*-type (2). The fruit types in the other groups are classified as: resembling type 1 or 2, or as: totally different (*mischarytera*-group). Besides, there is a correlation with differences in vegetative characters, pollen types, and ariloid types. The flowers, not discussed here, also seem to be different.

Conclusion: *Arytera* proves to be very heterogenous; the resemblance in fruit noticed by Radlkofer appears to be superficial, covering many differences. Three species have to be excluded and can be placed in other genera. Three further species (incl. the *mischarytera*-group) are dubious in *Arytera*. The remaining species can be arranged into 4 natural groups, which mutually, however, have not much in common. Future research may learn whether they could better be added to some other genera of the *Cupanieae*. For the time being, however, the groups are kept in the one genus *Arytera*. The genus then comprises:

xerocarpa-group (8 species; moreover, probably including *A. foveolata* and *A. exostemonea*)

azarytera-group (10 species)

chartacea-group (2 species)

Arytera o'shanesiana

and provisionally also:

mischarytera-group (2 species)

Arytera leichhardtii

V. THE DELIMITATION OF ARYTERA AGAINST MISCHOCARPUS

A simple differentiation between *Mischocarpus* and *Arytera* in a key is not well possible because of the heterogeneous nature of the latter. As long as the true relations hips of *Arytera* are not clear, the best one can do is to compare *Mischocarpus* with each group separately. With regard to the characters studied the following can be mentioned for *Mischocarpus*:

glandular scales:	absent
domatia:	present in most species
pollen type:	B (exceptionally A; see Van der Ham, 1977c).
ariloid type:	2
fruit type:	not lobed, 3-locular.

On account of these characters, *Mischocarpus exangulatus* appears to be clearly a *Mischocarpus*. The resemblances with some species of the *xerocarpa*-group (style with stigmatic lines, pattern of nervation in the leaflets) are not based on true relationship.

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EXPLANATION OF PLATES

Plate I. Pollen type A. — 1—3. *Arytera xerocarpa* (Bl.) Adelb. (*Backer s.n.*, 1904, Java, herb. L). Pollen grains tricolporate, subspheroidal [P/E 1.00 (1.04) 1.05]. Equatorial outline rounded or slightly rounded triangular. Size: P 21—23 μm , E 22—24 μm . Ektoapertures distinct, fairly long, narrow in the equatorial plane. Endoapertures elliptic, about 3 μm . Tectum striate-rugulate (1) to reticulate-rugulate (3), muri anastomosing in three dimensions. — 1. oblique polar view, $\times 3700$. — 2. equatorial view of apertural region, $\times 3700$. — 3. equatorial view of mesocolpium, $\times 3700$.

4—6. *Arytera o'shanesiana* (F. v. M.) Radlk. (*Brass 19157*, Queensland). Pollen grains tricolporate, sub-oblite [P/E 0.80 (0.82) 0.87]. Equatorial outline rounded triangular. Size: P 21—22 μm , E 25—28 μm . Ektoapertures distinct, fairly long. Endoapertures rounded, about 3 μm . The tectum appears to be built of a basal membrane in which round to elliptic perforations are present. On this membrane are fused more or less curving ridges anastomosing in three dimensions, causing a reticulate-striate appearance of the outer surface (5). — 4. polar view, $\times 3400$. — 5. oblique polar view, $\times 3400$. — 6. detail of 5, $\times 13600$.

Plate II. Pollen type B. — 1—2. *Arytera collina* (Pancher & Sebert) Radlk. (*McMillan 5049*, New Caledonia). Pollen grains parasyntricolporate, oblate to suboblite [P/E 0.73 (0.77) 0.81]. Equatorial outline rounded triangular to triangular. Size: P 24—25 μm , E 30—33 μm . Apocolpium 9—13 μm , about triangular. Ektoapertures distinct. Endoapertures elliptic, 2—3 μm . Tectum striate, striae subparallel, anastomosing mostly in two dimensions. — 1. oblique polar view, $\times 2550$. — 2. detail of 1, $\times 6300$.

3—6. *Arytera leichhardtii* (Benth.) Radlk. (*Lam 7631*, Queensland). Pollen grains parasyntricolporate, suboblite [P/E 0.78 (0.81) 0.88]. Equatorial outline rounded triangular. Size: P 21—22 μm , E 23—28 μm . Apocolpium 4—6 μm , about rounded triangular, sometimes continuous with one mesocolpium. Ektoapertures distinct. Endoapertures elliptic, about 3 μm . Tectum reticulate-substrate, appearing as a membrane with perforations upon which a pattern of three-dimensionally anastomosing muri is lying. The lumina are superposed on the perforations. — 3. polar view, $\times 2150$. — 4. detail of 3, $\times 8300$. — 5. equatorial view, $\times 3800$. — 6. detail of 5, $\times 7600$.

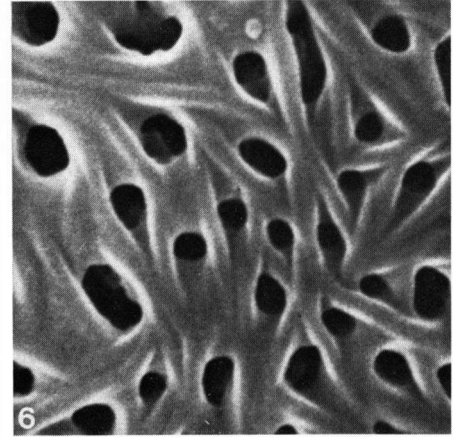
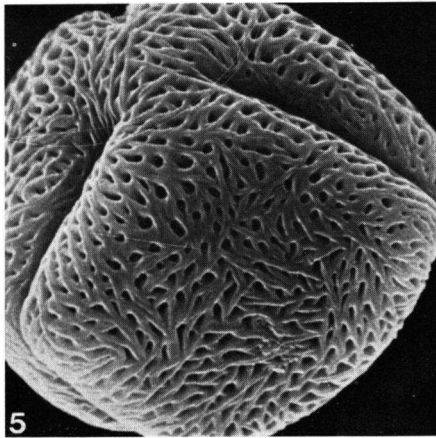
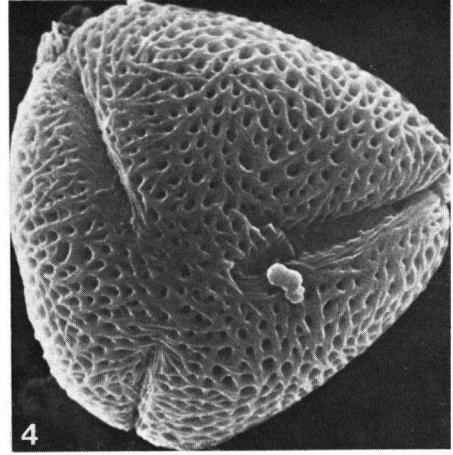
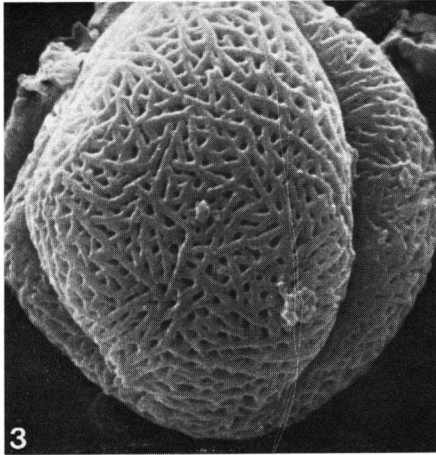
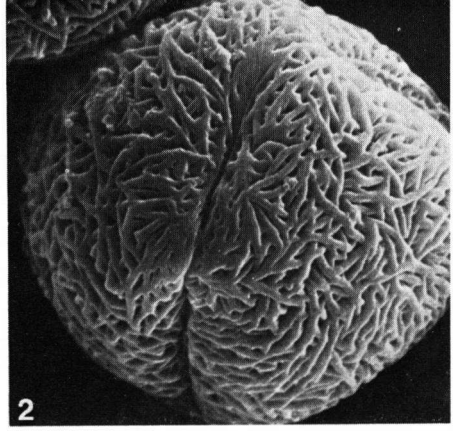
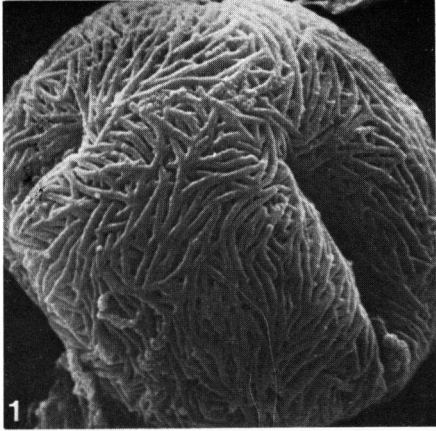


PLATE I

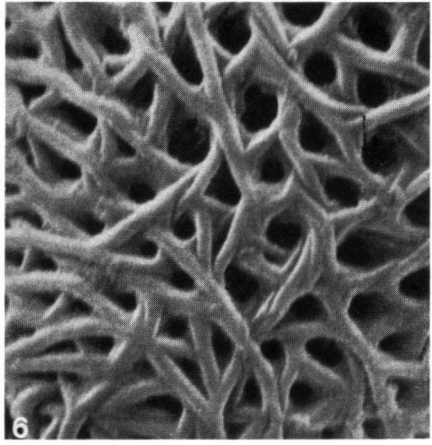
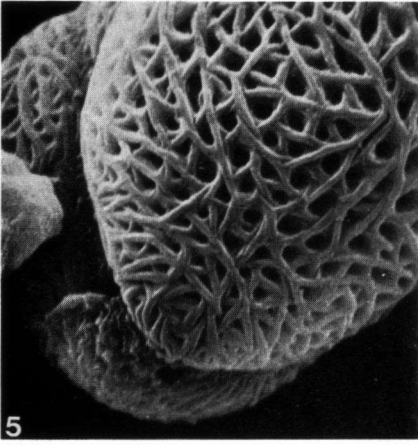
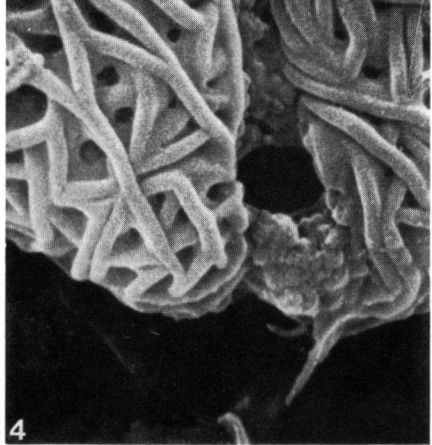
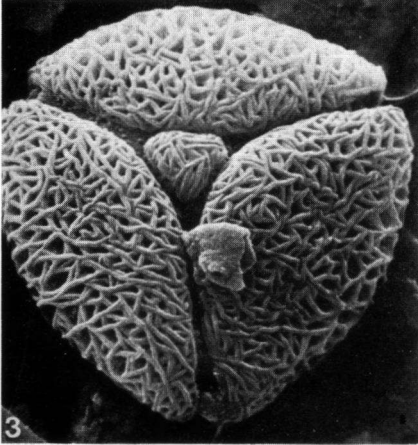
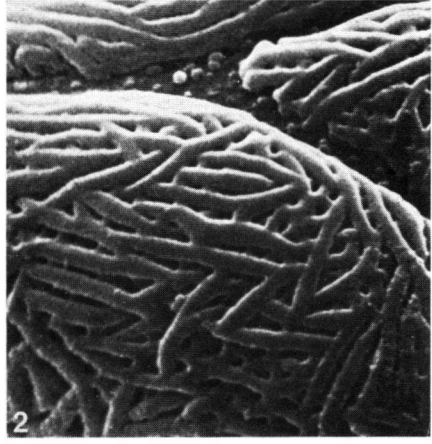
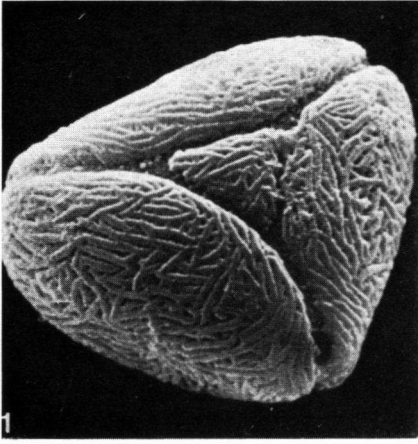


PLATE II