

TWO NEW SPECIES OF THE *ADIANTUM CAUDATUM* COMPLEX

J. GHATAK

Systematic Botanist, Botanical Survey of India, Calcutta

ABSTRACT

The paper presents *Adiantum indicum*, *A. malesianum* and six other taxa variously confused under the *Adiantum caudatum* complex, together with the key, the table and the illustrations.

Adiantum indicum Ghatak sp. nov.* (Figs. 1, 2, 3 & 5).

A. vestitum Wall. Num. List no. 75, 1828, nomen nudum; non Spreng. 1804.

Rhizome erect, short, covered by scales, roots and bases of tufted stipes. **Roots** dense, strong, dark. **Scales** c. 8 mm. long, c. 1 mm. broad, light brown along the periphery, dark brown in the middle, setaceous, smooth, entire, cells long, narrow, partition walls straight. **Fronds** c. 35 cm. long, isomorphic, sub-erect, when young with caducous, white scales c. 5 mm. long, c. 1 mm. broad. **Stipes** c. 2 mm. in diam., c. 5 cm. long, c. one-seventh in length of the rachis, erect, conspicuous, dark brown in colour together with the rachis, sparsely hairy with c. 1.5 mm. long, ferrugineous, multicellular, slightly curved hairs. **Lamina** c. 30 cm. long, c. 3 cm. broad, linear-oblong, simply pinnate, usually slightly curved, not brittle, with c. 38 pairs of multifarious pinnae and a pinna-less rooting apex c. 9 cm. long. **Rachis** 1-1.5 mm. in diam., rusty brown, less hairy on lower surface, hairs ferrugineous, usually 3-5-celled and c. 1 mm. long. **Pinnae** c. 1.5 cm. long and c. 7 mm. wide, subsessile, fairly close lobed to about one third the pinna-width, with moderately narrow sinuses; lobes usually 4 to 5 with somewhat truncated apices; lower margin of pinnae incipiently cuneate-rostriform at base, more or less transverse to the rachis, curved distally towards the apex; texture moderately thick, stiff and striate; upper surface almost glabrous except for a few hairs at the base; lower surface more hairy than the upper, hairs mostly short (c. 200 μ), straight, white unicellular, interspersed by few 2-3-celled multicellular ferrugineous slightly curved ones (c. 325 μ); fertile reflexed tips monosorus, coriaceous, slightly wide with usually 2-3-celled hairs (c. 300 μ); veins end in teeth. **Sporangia** smooth, stalk more or less equal to the oval head, with an annulus of about 18 dark brown thickened cells. **Spores** 42.0 \times 39.0 μ (mean of 100 measurements), 64 per sporangium, regular, trilete, triangular, base convex, apex slightly angular, light brown, with prominent dark brown round spots on exine.

Gametophytic chromosomes 60. **Sporophytic chromosomes** 120. **Reproduction** sexual, produces

sterile hybrids with more related species within *A. caudatum* complex (Ghatak, 1959).

Holotype: J. Ghatak J301 (Central National Herbarium, Shibpore, Howrah, India.)

Locality: WEST BENGAL: Belgharia, a suburb of Calcutta (22°34'N, 88°22'E, 9 m.), March 11, 1957 J. Ghatak 301. WALL. CAT.: KASHMERE: Ladakh (34°N, 77°E); NEPAL: (28°N, 84°E); BIHAR: Rajmahal (25°3'N, 86°50'E, c. 600 m.) and Monghyr (25°23'N, 86°28'E, c. 600 m.) Aug. 1820, Wallich 75 (160, 161, 162 & 175 K). ORISSA: Balasore hills, Balasore Dist. (20°44' & 21°51'N, 86°16' & 87°31'E, c. 300 m.) 1838, Blanford 105A (CNH, only the upper half of the sheet demarcated). MADRAS: Kannikatti (c. 900 m.) and Mundandurai (c. 600 m.), Tirunelveli Dist. (8°9' & 9°43' N, 77°12' and 78°23'E), Oct. 6 & Oct. 9, 1959, Swamy 960 & 980 respectively (Dept. Herbarium, Presidency College).

Ecology: The specimens were collected from moist, dilapidated brick walls about 1.75 m. high, along a path under the shade of *Mangifera indica* L. Professor B. G. L. Swamy's collections were from moist, shady crevices of rocks. They show vigorous growth from July to October.

Distribution: Restricted to India, appears to be absent from other parts of Asia as well as totally from Africa, America and Australia.

That the present taxon (sexual tetraploid) from India is distinct was known when it produced perfectly sterile hybrids (Figs. 2 & 3) showing highly irregular meiosis (Ghatak, 1959) with the more morphologically adjacent taxa like *A. zollingeri* Mett. ex Kuhn (sexual diploid) from Ceylon (Figs. 1 & 2) and *A. incisum* Forsk. *sensu* Pichi-Sermolli (sexual tetraploid) from Africa (Figs. 1 & 3). It has, however, been considered conspecific by Pic. Ser. (1957) with *A. incisum*, who also kindly identified the specimens under the same name. After cytotaxonomic studies involving breeding tests and comparing all the herbarium specimens on the complex present at Kew, British Museum, Central National Herbarium and Presidency College, Madras, the present investigator feels convinced that although the species is more intermediate in gross morphology between the above two well established species, nevertheless, it could be easily recognised in field as well as herbaria and hence deserves a separate specific status.

*The latin diagnosis is placed at foot note of p. 74

It resembles *A. zollingeri* in its preference for a comparatively moist shaded habitat, erect short rhizome with closely tufted semi-erect, conspicuously stipitate fronds (c. 35 cm.) not becoming pendant when grown in baskets under the same hot-house, in the absence of long hairs from both the surfaces of pinnae, in having less wide and not too

deep sinuses and narrow fertile reflexed tips. *A. incisum* does not show any of these characters. *A. zollingeri* differs from *A. indicum* because the former has perfectly glabrous lower surface of the rachis and glabrous pinnae, the fertile tips of which bear sometimes short, straight hairs.

All the superficial resemblances between *A. inci-*

| | <i>A. incisum</i> | <i>A. indicum</i> |
|----------------------------|---|--|
| 1. Habitat : | Prefers dry situation. | Prefers moist and shaded habitat. |
| 2. Habit : | Prostrate with distant and longer fronds (c. 45 cm.) showing inconspicuous and shorter stipes (c. 3 cm.), becoming very easily pendant when grown in baskets under the same hot-house. | Erect with closely tufted and shorter fronds (c. 35 cm.) showing conspicuous and longer stipes (c. 5 cm.), not becoming usually pendant when grown in baskets by the side of <i>A. incisum</i> . |
| 3. Ratio of Stipe/Rachis : | c. 1/15 | c. 1/7 |
| 4. Rachis : | Very hirsute throughout on both the surfaces with long (2-3 mm.), 6-7-celled hairs ; lower surface never less hairy than the upper. | Less hirsute, the lower surface less hairy than the upper, hairs shorter (1 mm.) and usually 3-5-celled. |
| 5. Pinnae : | <p>a. Not too numerous and not too close, deeply lobed with distinct cuneate-rostriform bases and wide sinuses.</p> <p>b. Texture not thick, not stiff and slightly striate.</p> <p>c. Upper surface glabrous or with few, scattered long hairs ; lower covered densely with long (c. 1.5 mm.), straight, ferruginous and pluricellular (3-5-celled) hairs.</p> <p>d. Veins not ending in teeth of sterile pinnules.</p> <p>e. Fertile reflexed outgrowths wide, glabrescent or even profusely hairy outside.</p> | <p>Comparatively numerous and close, less deeply lobed with incipient cuneate-rostriform bases and somewhat narrow sinuses.</p> <p>Comparatively thick, stiff and striate.</p> <p>Upper surface almost glabrous except for a few hairs at base, sinuses and margins ; lower less densely hairy with mostly short (c. 200μ), straight, white and unicellular hairs as well as few ferruginous, slightly curved and pluricellular (2-3-celled) ones (c. 325 μ).</p> <p>Veins ending in teeth of sterile pinnules.</p> <p>Fertile reflexed outgrowths less wide and invariably the most hairy part in the pinnae.</p> |
| 6. Spores : | Mean of 100 measurements is 30.0 \times 29.0 μ . | Mean of 100 measurements is 42.0 \times 39.0 μ . |

sum and *A. indicum* break down (see also, Pic. Ser., 1957) when both are compared as shown below.

The morphological characters common to all the members of *A. caudatum* complex are the multifarious, simply pinnate fronds with subsessile pinnae. The important exomorphic features of *A. indicum* by which it can be differentiated from *A. zollingeri*, *A. incisum* and all other species previously confused under *A. caudatum* are the lower surface of the rachis being always less hairy than the upper and the absence of long (c. 1.5 mm.) hairs, instead presence of short (c. $\frac{1}{2}$ mm.), straight unicellular hairs on the lower surfaces of the numerous closely arranged, less deeply incised pinnae.

A. indicum differs further from *A. caudatum* s.s. by the absence of hamate unicellular hairs on the surfaces of pinnae, the less hirsute fronds, the less striate texture and by the comparatively wide, less narrow fertile tips. Moreover, *A. indicum* is cytologically a sexual tetraploid whereas *A. caudatum* is an apogamous triploid. Their F_1 pentaploid

hybrids are apogamous and produce 80% sterile spores.

A. hirsutum Bory (Voy. 1: 198, 1804), which appears to be endemic in the Mascarene Islands (Pic. Ser. in *Webbia* 12: 676, 1957), also differs markedly from *A. indicum* because the former taxon has its rachis and pinnae densely covered on both the surfaces with short, simple, straight, rigid, sharp-pointed, white hairs mixed with long, pluricellular, ferruginous ones ; by the more numerous, more close, less thick but more striate pinnae with more semilunar outer and lower margin and by the small, narrow as well as more long than broad fertile reflexed tips.

A. ciliatum Bl. (Enum. Pl. Jav. 215, 1827 ; Pic. Ser., 1957) differs from *A. indicum* by the stipe and rachis being hirsute throughout, fronds with a few pinnae gradually decreasing in length towards the apex (the pinnae of the lower juga are the longest and the widest), by the sparsely ciliate pinnae with very widely scattered hairs on both the surfaces, by the

very narrow and long laciniae of the pinnae, denticulate with very acute cartilagineo-indurated denticles (white in well developed pinnae), by the fertile marginal outgrowths of the pinna being small, cordiform, thick and glabrescent.

Adiantum malesianum Ghatak sp. nov.* (Figs. 1, 4, 6 & 7).

A. caudatum (non Linn.) Holttum, Ferns of Malaya 599, 1954 (excl. var. *subglabrum*).

Rhizome comparatively conspicuous, short, erect, covered by scales, roots and by the bases of tufted fronds. *Roots* dense, dark brown, strong. *Scales* c. 4.5 mm. long, c. 1 mm. broad, setaceous, dark brown with pale edges, minutely and closely serrulate; cells long, narrow, partition walls straight. *Fronds* c. 46 cm. long, isomorphic, suberect, not very close; longer fronds pendant but shorter ones erect when grown in baskets, with caducous white scales c. 3 mm. long and c. 1 mm. broad in the juvenile stage. *Stipes* c. 2 mm. in diam., c. 12-18 cm. long, equal to one-fourth of the rachis, dark brown, both the surfaces with sparsely arranged stiff, ferruginous multicellular, spreading hairs (c. 1 mm.). *Lamina* c. 34 cm. long, c. 3.5 cm. broad, gradually broader towards the base and narrowed to the apex, somewhat linear-ovate in shape, simply pinnate, usually straight or slightly curved with c. 28 pairs of pinnae; when rooting at the apex, the rachis becomes long drawn, gradually slender and remains pinnaless for c. 7 cm. *Rachis* 1.5 mm. at base and c. 0.5 mm. at apex in diam., hirsute with ferruginous, 4-6-celled hairs (c. 0.75 mm.) which are longer, more spreading and less closely arranged on the shining lower surface. *Pinnae* largest towards the base, usually 1.5-2 cm. long and 6 mm. to 1 cm. wide, very shortly stalked (c. 0.5 mm. long), articulate, sometimes deciduous, almost parallelogram-shaped, except the several gradually reduced and closely spaced apical pinnae, when the rachis not rooting at the tip the odd terminal pinna becomes somewhat diamond-shaped and slightly larger than the adjacent ones; the lowest pair of basal pinnae are opposite or subopposite, conspicuously fan-shaped, much deflexed, not reduced, with greater number of ultimate lobes (c. 14) which vary in other pinnae from 4-10; upper and outer edges lobed half to one-third the pinna-width, the sinuses between the lobes rather narrow, apices usually truncate and often shortly toothed specially in sterile pinnae; the inner edge straight forming a small angle to the rachis or somewhat ascending, the lower edge for the major part more or less deflexed and later curved distally towards the apex, not cuneate-rostriform at base; the upper edge nearly parallel to the lower edge, curved somewhat to join the short outer edge; texture thin but stiff and prominently striate on the upper surface; veins radiating from the short, thickened pinna-stalk; both the surfaces somewhat densely hairy, the upper surface less hairy than the lower and usually

with stiff, long, sharp-pointed multicellular hairs (c. 0.5 mm.); the lower more hairy with two different types of hairs, short (c. 140 μ), unicellular, straight, simple, never hamate, white, rigid, sharp-pointed hairs mixed with long (c. 0.5 mm.), ferruginous, spreading, usually 3-5-celled hairs; reflexed fertile tips sub-coriaceous, slightly wide, densely hairy, hairs 1-3-celled. *Sporangia* smooth, stalk more or less equal to the oval head, with usually 18 dark brown thickened cells in the annulus. *Spores* 39.0 \times 36.0 μ (mean of 100 measurements), 64 per sporangium, regular, trilete, triangular, base convex, apex slightly angular, light brown in colour with small dark brown round spots on exine.

Gametophytic chromosomes 60. *Sporophytic chromosomes* 120. *Reproduction* sexual, produces pentaploid apogamous hybrids with the apogamous triploid *A. caudatum* s.s.; F_1 shows 88% sterile spores.

Holotype: J. Ghatak J350 (Central National Herbarium, CAL.).

Locality: BURMA: Forest de Gokteik Birmanie, Nov. 21, 1912, De Vilmorin (K); Gokteik Gorge, North Shan State, July & Nov., 1909, J. H. Lace 4971 (CNH) CHINA: old walls of Confucius temple, Shanghai, Aug. 1860, A. C. Maingay 469 (K); thickets near Macau Port, Canton, Aug. 1860, A. C. Maingay 472 (CNH); San Chouen, Kouy-Techeon (25°N, 113°16'E), 1913, Rosenstock 3727 (K); Yunnan, A. Henry 51461 (K); Lungchow (34°45'N, 106°55'E), H. B. Morse 22 (K). INDOCHINA: Tonkin (20°-22°N, 102°-104°E), Eang-Son: Sang-Son, Dec. 1913, Aug.-Chevalier 29745 (K). THAILAND: on the rock-edge by the stream, Pah Chang, 1923, Eryl Smith 2177 (K). MALAY PENINSULA: Kedah (6°N, 101°E), no collector's name, no. 14764 (CNH); Kaki Bukit, Perlis (6°30'N, 100°15'E, c. 300 m.), R. E. Holttum 35240 (K); Batu Caves, Selangor (3°25'N, 101°25'E), Dec. 1920, H. N. Ridley (K); Oct. 4, 1958, J. Ghatak 350 (CNH); Aug. 1880, H. Kunstler 351, 504 & 979 (CNH). MALAY ISLANDS: Limestone rock, Niah (3°54'N, 113°46'E), Baram Dist., Sarwak, Borneo, 1894, Hose 318 (K). POLYNESIA: New Hebrides (16°S, 168°E), 1896, Morrison (K).

Ecology: To quote Professor R. E. Holttum (Ferns of Malaya, 599, 1954), "It is a common fern of limestone rocks in Malaya, especially in the north, and as far south as Batu Caves in Selangor. It may also occur on earth banks in moderately exposed places in some parts of the north of Malaya, as it does in Java; but unlike other plants adapted to a drier and more seasonal climate it is found mainly on limestone, where it has well drained conditions for its roots." The notes on some of the herbarium specimens from areas other than Malaya as mentioned above confirm the statements by Holttum.

*The latin diagnosis is placed at foot note of p. 74

Distribution: Widely distributed through Burma, China, Malesia and Polynesia; appears to be absent from India, Africa, America and Australia.

A. malesianum (the sexual tetraploid from Malaya) is related to *A. caudatum* (the apogamous triploid from Ceylon) from which the former differs in its mode of reproduction and the number of chromosomes, scales with minute and very closely serrulate margin, conspicuously longer stipe, absence of hamate hairs, somewhat diamond-shaped ter-

minal pinna when the frond not rooting at apex, more fan-shaped and enlarged basal pinnae and less close as well as articulated nature of pinnae with distinctly broader fertile tips.

A. hirsutum (neotype compared at Kew) also differs from *A. malesianum* because the former has in addition (cf. Pic. Ser., 1957), the following distinctive features: a shorter stipe, smaller indusia and closely arranged, numerous, non-articulated

KEY

- | | |
|---|----------------------------|
| 1. Adult rachis and stipe practically without scales; pinnae rarely completely glabrous: | <i>A. caudatum</i> complex |
| 2. Pinnae not articulate; stipe not more than 6 cm. long: | |
| 3. Pinnae bearing abundant hamate white unicellular hairs; veins very prominent | <i>A. caudatum</i> |
| 3. Pinnae lacking hamate hairs, veins not very prominent: | |
| 4. Lower surface of pinnae very hairy | <i>A. incisum</i> |
| 4. Lower surface of pinnae at most slightly hairy: | |
| 5. Pinnae near apex of fronds much dissected; long hairs abundant on lower surface of rachis | 2n Singapore |
| 5. Pinnae near apex of fronds not so different from rest; lower surface of rachis glabrous or slightly hairy: | |
| 6. Lower surface of pinnae always glabrous; hairs, if present confined to surface of reflexed fertile lobes; spore $33.0 \times 30.0 \mu$ | <i>A. zollingeri</i> |
| 6. Lower surface of pinnae always bearing some hairs; surface of reflexed fertile lobes always hairy; spores $42.0 \times 39.0 \mu$ | <i>A. indicum</i> |
| 2. Pinnae articulate; stipe 12-18 cm. long | <i>A. malesianum</i> |
| 1. Adult rachis and stipe with abundant scales; pinnae always quite glabrous: | <i>A. confine</i> complex |
| 7. Plants large (c. 50 cm.) with non-articulate, deep green, flabellate, less leathery pinnae (c. 3×1.5 cm.) | <i>A. confine</i> |
| 7. Plants small (c. 18 cm.) with articulate, glaucous green, cuneiform, more coriaceous pinnae (c. 1×0.4 cm.) | <i>A. rhizophorum</i> |

pinnae with the basal pair reduced and not prominently fan-shaped.

ACKNOWLEDGEMENTS

The author wishes to record his grateful thanks to Dr. H. Santapau, Director, Botanical Survey of India; Professor R. E. Holttum at Kew and Professor I. Manton, Head of the Dept. of Botany at the University of Leeds for kindly making valuable changes in the manuscript.

LITERATURE CITED

- ALSTON, A. H. G. *The Ferns and Fern-allies of West Tropical Africa*, London. 1959.
- GHATAK, J. Cytotaxonomic studies on some species of *Cyclosorus* and *Adiantum*. Ph. D. thesis, University of Leeds, 1959.
- AND I. MANTON. A note on the cytogenetic relationship between *Adiantum confine* Fe'e from Africa and *Adiantum rhizophorum* Sw. from Mauritius. *J. Linn. Soc. (Bot.)* 58: 79-85, 1961.
- HOLTTUM, R. E. *Flora of Malaya, II. Ferns*. Singapore, 1954.
- LINNAEUS, C. *Mantissa*, 2: 308, 1771.
- MANTON, I. *Cytological information on the Ferns of West Tropical Africa*. Appendix, 78-81, 1959. See Alston, 1959, above.
- PICHI-SERMOLLI, R. E. G. *Adumbratio florae aethiopicae*. 5. Parkeriaceae, Adiantaceae, Vittariaceae. *Webbia* 12: 645-703, 1957.

The author regrets the misplacement of the *latin diagnoses* of the two new species which are as given below:

Adiantum indicum Ghatak sp. nov. (Figs. 1, 2, 3 & 5).

Species tetraploidea, *A. caudato* Linn., *A. zollingeri* Mett. et *A. inciso* Forsk. affinis; ab *A. caudato* L. differt pilis rectis unicellularibus; ab *A. zollingeri* Mett. differt rachide et pinnis infra hirsutis; ab *A. inciso* Forsk. differt pilis pinnarum fere omnibus unicellularibus, $1/5$ mm. longis; pila 1-1.5 mm. longa, multis cellulis constituta, interdum adsunt.

Adiantum malesianum Ghatak sp. nov. (Figs. 1, 4, 6 & 7).

Species tetraploidea, *A. caudato* Linn. affinis, a quo tamen differt stipite longiore (c. 12 cm. longo), pinnis articulatis, pilis hamatis nullis; pinnis infimis duabus flabelliformibus, non reductis, multifobatis (lobis ad 14); paleis rhizomatis minute serrulatis.

List of important morphological features of the species presented in Key

| CHARACTER | <i>A. zollingeri</i> (2n, Ceylon) | <i>A. indicum</i> (4n, W. Bengal) | <i>A. incisum</i> (4n, Ghana) | 2n, Singapore | <i>A. maleianum</i> (4n, Malaya) | <i>A. caudatum</i> (3n apog., Ceylon) | <i>A. confinis</i> (4n, Ghana) | <i>A. rhizophorum</i> (2n, Mauritius) |
|--|---|--|--|---|--|---|--|--|
| 1. Scales | | | | | | | | |
| a. On rhizome | Sparsely serrulate. | Entire. | Entire. | Entire. | Minutely and closely serrulate. | Entire. | Entire. | Entire. |
| b. On fronds | Confined to earlier stages, caducous. | Confined to earlier stages, caducous. | Confined to earlier stages, caducous. | Confined to earlier stages, caducous. | Confined to earlier stages, caducous. | Confined to earlier stages, caducous. | Abundant on stipe and rachis of adult frond, persistent. | Abundant on stipe and rachis of adult frond, persistent. |
| 2. Stipe | Moderate, c. 5 cm. | Moderate, c. 5 cm. | Very short, c. 3 cm. | Very short, c. 3 cm. | Very long, c. 12 cm. | Short, c. 4 cm. | Long, c. 8 cm. | Long, c. 8 cm. |
| 3. Rachis | Upper surface hairy, lower glabrous. | Very hairy on upper surface, lower lightly hairy. | Very hairy mostly with very long hairs on both surfaces. | Very hairy mostly with long hairs on both surfaces. | Very hairy on both surfaces. | Very hairy on both surfaces. | Sparsely hairy or almost glabrous. | More hairy on upper surface. |
| 4. Pinnae | | | | | | | | |
| a. Apical | Not very different. | Not very different. | Not very different. | Much dissected. | Diamond-shaped. | Not very different. | Not very different. | Not very different. |
| b. Basal | Not very different. | 1-2 pairs usually reduced. | Not very different. | Not very different. | Fan-shaped and enlarged. | Not very different. | Not very different. | Not very different. |
| c. Closeness | Not very close. | Close. | Not close. ¹ | Not close. | Not close. | Close. | Not close. | Not very close. |
| d. Striation | Not very prominent. | Moderately prominent. | Not very prominent. | Not very prominent. | Moderately prominent. | Very prominent. | Not prominent. | Not very prominent. |
| e. Sinuses | Not too close & not too deep. | Not too close & not too deep. | Wide & deep. | Wide and deep. | Close and deep. | Very close and deep. | Not deep. | Not deep. |
| f. Pubescence | Almost glabrous. | Lightly hairy on lower surface, upper almost glabrous. | Very hairy on lower surface, upper with few hairs. | Almost glabrous. | Hairy on both surfaces, lower more. | Very hairy on both surfaces, lower more. | Glabrous. | Glabrous. |
| g. Nature of hairs. | Hairs if present, very short, not hamate. | Medium to very short, not hamate. | Very long mostly, short few and not hamate. | Hairs if present, not very long & not hamate. | Hairs both long and short, not hamate. | Hairs both long and short, short hairs mostly hamate. | — | — |
| 5. Indusia or fertile tips. | | | | | | | | |
| a. Size | Rather small. | Moderate. | Wide, more broad than long. | Wide, more broad than long. | Moderate. | Small, longer than broad. | Wide, more broad than long. | Moderate. |
| b. Pubescence | Hairy. | Hairy. | Hairy. | Glabrous with a hairy fringe. | Hairy. | Hairy. | Glabrous. | Glabrous. |
| 6. Mode of 100 measurements of spores. | 33.0 × 30.0 μ. | 42.0 × 39.0 μ. | 30.0 × 30.0 μ. | 33.0 × 30.0 μ. | 39.0 × 36.0 μ. | 46.5 × 37.5 μ (from 8-celled sporangia). | 31.5 × 28.5 μ. | 30.0 × 27.0 μ. |

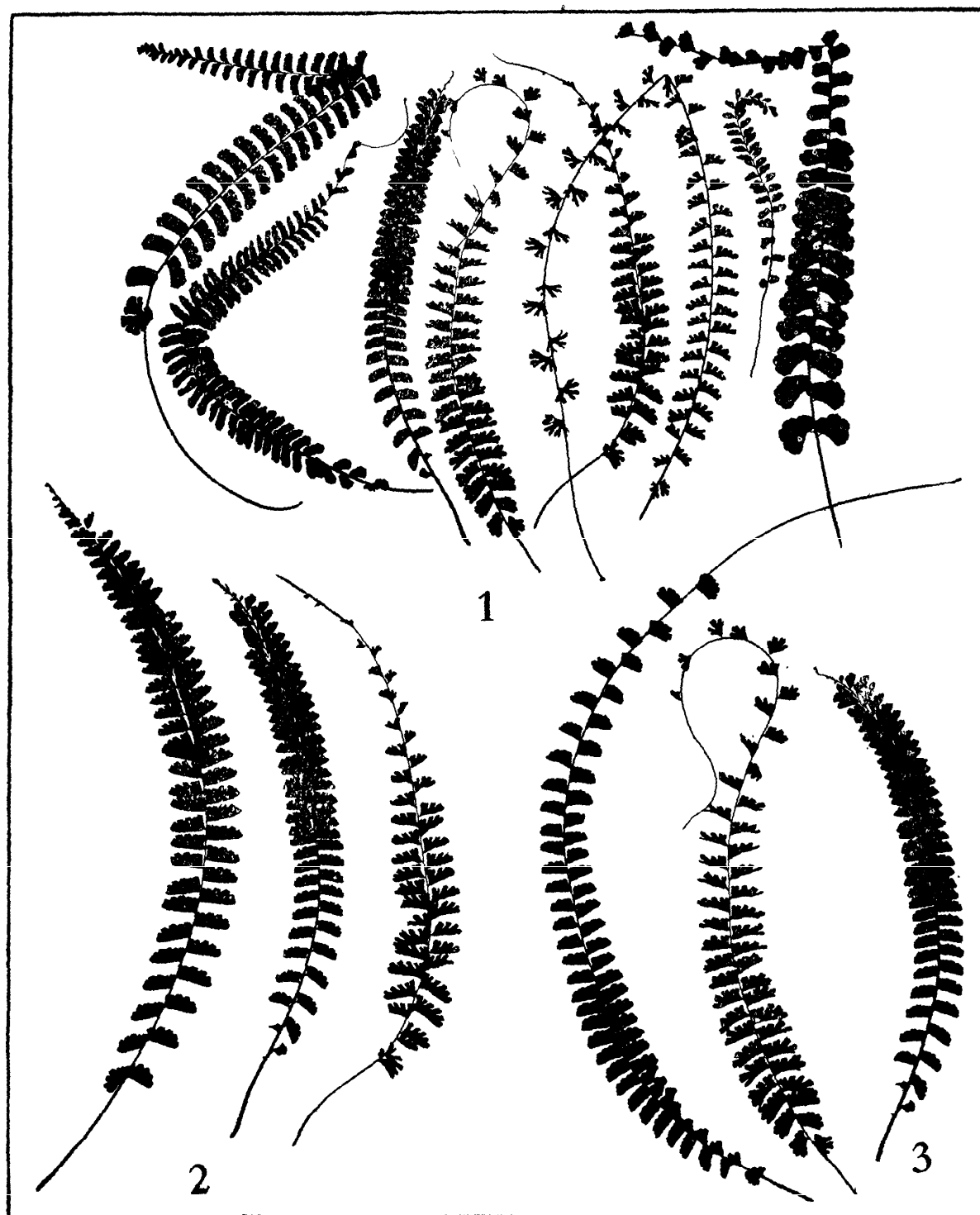


FIG. 1. Members of *Adiantum caudatum* complex. Silhouettes of mature fronds ($\times 1/3$) from plants of comparable age (16 months old), grown in the same hot-house of the Leeds University representing eight different species, two among which are new. From left to right : *Adiantum malesianum*, *A. caudatum*, *A. indicum*, *A. incisum*, *A. zollingeri*, $2n$ Singapore, *A. rhizophorum* and *A. confine*.

FIG. 2. From right to left : Silhouettes of mature fronds ($\times 1/3$) of *A. zollingeri*, *A. indicum* and their F_1 sterile triploid hybrid, showing relative dominance of the latter parent.

FIG. 3. From right to left : Silhouettes of mature fronds ($\times 1/3$) of *A. indicum*, *A. incisum* and their F_1 sterile tetraploid hybrid, showing relative dominance of distant pinnae.

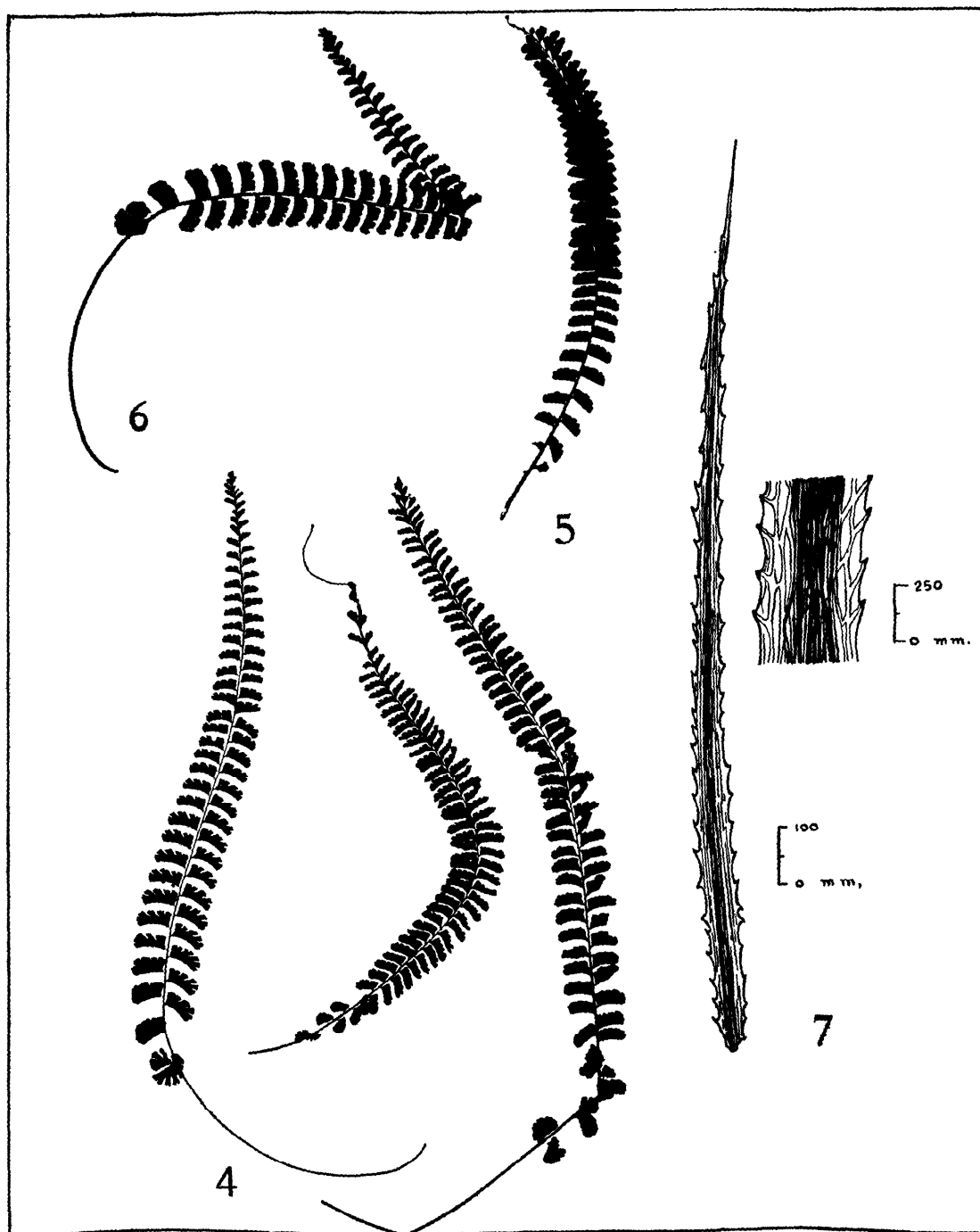


FIG. 4. From left to right : Silhouettes of mature fronds ($\times 1/3$) of *A. malesianum*, *A. caudatum* and their F_1 pentaploid apogamous hybrid, showing dominance of the former parent in long stipe, relatively distant pinnae and unreduced fan-shaped nature of the lowest pair of basal pinnae.

FIG. 5. Mature frond ($\times 1/3$) of *A. indicum*, showing moderately long stipe and comparatively close, numerous as well as less deeply cut pinnae with 1-2 basal pairs generally reduced and more distant.

FIG. 6. Mature frond ($\times 1/3$) of *A. malesianum*, showing longer stipe, diamond-shaped apical pinna and unreduced prominently fan-shaped basal pinnae.

FIG. 7. Mature rhizome scale of *A. malesianum*, showing minutely serrulate margin and a portion magnified.