THE CYTOTAXONOMY OF THE *ASPLENIUM STUHLMANNII* COMPLEX (ASPLENIACEAE, PTERIDOPHYTA) IN AFRICA

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ABSTRACT

A new octoploid species, *Asplenium mantoniae*, intermediate between two tetraploids species, *A. stuhlmannii* and *A. jaundeense*, is described from West Africa. The morphology and distribution of members of the complex are consistent with the view that the octoploid has probably arisen by hybridization of the two tetraploids and chromosome duplication.

INTRODUCTION

*Asplenium stuhlmannii* Hieron. was first described from tropical East Africa and is widely distributed from northern Tanzania to the southern Sudan. Similar, though not identical, material occurs in West Africa and was placed in *A. stuhlmannii* by Tardieu-Blot (1953) and Alston (1959) and reported by Manton (1959) to be octoploid with \( n = 144 \) chromosomes, based on meiotic analysis. Subsequent cytological examination of East African material has shown the genuine *A. stuhlmannii* to be tetraploid with \( n = 72 \) chromosomes (Appendix in Braithwaite 1964; Fig.1). Further studies of the two cytotypes suggest that they are sufficiently distinct morphologically and geographically to merit recognition as two separate species and the octoploid material from West Africa is described here as a new species, *A. mantoniae*. The new species also bears some resemblance to *A. jaundeense* Hieron., a tetraploid species (Fig.1) from West Africa, and its possible relationships to the two tetraploids is discussed.

_Figure 1._ Acetocarmine meiotic squash preparations. *A. Asplenium stuhlmannii n = 72*, Somalia (British Somaliland; *B. A. jaundeense n = 72*, arrow points to an out of focus bivalent,Yaunde, Cameroon. Scales = 10 µm
<table>
<thead>
<tr>
<th>Species</th>
<th>Locality and origin</th>
<th>Chromosome number</th>
<th>Spore size*</th>
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<td><em>A. stuhlmannii</em> Hieron</td>
<td>Somalia, collected by Mr Desmond Kelsall (O. S Dept, St Andrews) on a hill walking expedition in 1949, ex University Botanic Gardens, St Andrews. Kenya, living plant sent to Kew with a consignment of orchids</td>
<td>n = 72</td>
<td>40·9 ± 2·49</td>
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<td>30·3 ± 2·06</td>
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<td>A. mantoniae sp. nov.</td>
<td>Nigeria, plant raised in Leeds from spores taken from Hambler 513 (BM)</td>
<td>n = 144</td>
<td>47·1 ± 3·57</td>
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<td>Ghana, locality not known, collected by Adams (see Manton 1959), plant in this study raised from spores taken from herb. specimen of Manton’s plant</td>
<td>n = 144</td>
<td>31·7 ± 2·36</td>
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<tr>
<td>A. jaundeense Hieron.</td>
<td>Cameroon, Yaunde, collected for the author as a living plant and first established at Kirstenbosch in 1961 then sent to Kew and subsequently transferred to Leeds</td>
<td>n = 72</td>
<td>34·1 ± 2·85</td>
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<td>23·4 ± 1·69</td>
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* means ± SD (n = 100)

**Table 1.** Locality, source, chromosome numbers and spore sizes of living plants of the *Asplenium stuhlmannii* complex.
MATERIAL AND METHODS

Live plants for cytological investigation were accumulated from a variety of sources (see Table 1) and finally established in the Botanic Garden, University of Leeds. In addition, all the relevant herbarium material at BM and K was examined. Voucher specimens will be deposited in BM.

Chromosome counts were made on acetocarmine squash preparations of meiosis using the standard method for ferns (Manton 1950).

Spore samples for measurement were mounted in either gum chloral or Depex and measured using a calibrated eyepiece and ×40 objective.

THE SPECIES

Asplenium stuhlmannii Hieron.


Rhizome creeping with rather stiff loosely tufted fronds. Rhizome scales 3–5mm long, 0·5–0·75mm wide at the base, linear subulate with a rounded base and ending in a short hair point, clathrate with smooth cell walls; median cells dark thick-walled and compressed with narrow, sometimes obscured, lumens, becoming thinner walled and pellucid towards the margins. Fronds up to 24–45cm long, pinnate to deeply bipinnatifid; stipes black becoming green near apex, sparsely scaly. Lamina bright green, linear lanceolate, 15–37 × 2·5–9·5cm with 10–17 pairs of opposite or subopposite spreading pinnae. Pinnae 1 8–5·0 × 1·0–2·3cm, coriaceous, broadly trullate to trullate, base broadly cuneate; basal pinnae deeply divided, upper pinnae less so, into 3–5 lobes; largest lobes (pinnules) cuneate-obovate and further cut into 3 or 4 segments with truncate lacerate apices, smaller lobes rectangular with truncate lacerate-crenate apices. Veins and sori subflabelliform. Spores plano-convex, (32–) 36–44 (–50) × (20–) 24–30 (–35) µm perispore costate with loosely anastomosing low ridges or folds. Reproduction sexual, chromosome number n = 72 (2n = 144).

Ecology and distribution. Asplenium stuhlmannii is a fern of rocky outcrops often in grassland at altitudes from 850 – 2188m. It grows in sheltered rock crevices or in shade around the base of rocks or on top of rocks in the shade or less often in full sun. It is widely distributed in East Africa: Tanzania, Rwanda, Uganda, Kenya, E Zaire, Sudan and E Central African Republic (Figure 1).

Notes. The name A. stuhlmannii is here restricted to the East African material with creeping rhizomes bearing scales made up of smooth walled cells, pinnate to deeply bipinnatifid fronds with broadly trullate to trullate pinnae and spores with costate-alaete spores with rather low smooth folds or wings (Figure 3). All the material is tetraploid in so far as can be judged from comparisons of spore measurements from specimens in
the herbaria with those from the cytologically authenticated material.

*Asplenium stuhlmannii* var *laciniata* with larger pinnae, more deeply dissected into laciniate lobes probably represents a larger luxuriant shade form. The rhizome scales and spore ornamentation and size match those of typical *A. stuhlmannii*.


![Figure 2](image-url)

Asplenium mantoniae A. Braithw. sp. nov. 
Asplenium stuhlmannii et A. jaundeense similis sed differt chromosomate numero (n = 144) et sporis majoribus; a A. stuhlmannii pinnis trapezo-trullatis, basaleis acutis et lobis paucioribus; a A. jaundeense lobatis profunde trapezioid-trullatis pinnis.

Holotypus: Nigeria, Ondo Province, insel-berg nr Ado Aiye, 7° 54´ N, 3° 30´ E, with creeping rhizome growing under overhanging boulders, Hambler 513 (BM).


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Rhizome creeping with stiff tufted fronds; rhizome scales dark brown, up to 6mm long, 1mm wide, linear-subulate, clathrate, cell walls thick and opaque in the middle, becoming thinner and pellucid towards the margin, walls facing lumens often irregularly minutely denticulate (Figure 3). Fronds 15–44cm long, pinnate to deeply pinnatifid; stipe dark purplish brown 4·5–20cm long with small scales similar to those of the rhizome at the base; rachis dark purplish brown, for the most part becoming green towards the apex, sparsely scaly. Lamina 10–24cm long, 3·5–7·5cm wide, narrowly ovate with 8–13 pairs of subopposite spreading pinnae merging into a lobed apex. Pinnae 2·0–6·5 × 0·75–2·5cm, narrowly parallelogram-shaped to trapezoid-trullate, base narrowly cuneate then divided into 3–4 lobes merging into lacerate-serrate, sometimes attenuate, acute apex (Figure 2); largest basal acroscopic lobe obtriangular to rectangular and further cut into 3 lobes with irregularly crenate apices, remaining lobes rectangular with irregularly crenate apices, becoming progressively smaller towards apex of pinna. Veins and sori subflabellate. Spores plano-convex, (40–) 46 – 48 (–55) µm × (28–) 31–32 (–37) µm, costate-alate with much anastomosing high wavy (undulating) ridges or wings. Reproduction sexual, chromosome number n = 144 (2n = 288).

Ecology and distribution. This new species is generally associated with rocky outcrops, usually but not exclusively granite, e.g. the inselbergs of Nigeria, where it is found in the shade on rock faces, in damp rock crevices or growing under overhanging boulders from 100 – 400m. It has a predominantly West Africa distribution (Guinea, Sierra Leone, Ivory Coast, Ghana, Nigeria, Cameroon) with outliers in the Central African Republic (Figure 2).

Notes. The new species resembles _A. stuhlmannii_ in its general growth habit, frond architecture, colour and texture, but is distinguished by its slightly larger rhizome scales made up of cells with thicker and often dentate cell walls, generally larger but less divided and more trapezoid or parallelogram-shaped pinnae with narrower cuneate bases and by its larger costate-alate spores with broader more frequently anastomosing wavy (undulating) perispore folds or wings. In these respects it resembles the following species, _A. jaundeense_, despite being traditionally confused with _A. stuhlmannii_. (see Figures 2 & 3).

Etymology. Dedicated to the late Professor Irene Manton F. R. S. in recognition of her contribution to knowledge of the cytology of the fern flora of West Tropical Africa. specimens examined. GUINEA: Haut Niger (Fouta Djallon): Mt Bambaya, vers 100m, 1945, _P. Jaeger_ 2113 (K); Macenta, _Adams_ 5513 (P); Gueckedou, _Adams_ 5581 (P). SIERRA LEONE: Northern Prov., Bumba (?Bumban), 1200ft, 1932, _R. Glanville_ 436 (BM). IVORY COAST: Séguéla, rocher granitique a 15km E. sur la route de Beoul, sous un surplombe humide, 1948, _H. des Abbayes_ 619 (BM); entre Seguela et Maukono, fissure rocheuse, 1954, _R. Schell_ (K); Rocher d’Issia, in grove on granitic rock, 250m, 1962, _A. J. M. Leenwenberg_ 4140 (K); Pays des Ayoles, sommet du Mont Kouan près Aanamé (manelog granitique), 400m, 1909, _A. Chevalier_ 21269 (K,P); Mt Dou, _Man, Porteres s.n._ (P); Mt Semelebou, _A. Chevalier_ 22095 (P). GHANA: Bhongo-Ahafo Prov.: Ebaw Rock near Mim, growing in moist crevices on granite outcrop near thicket margin, 1973, _Hall & Abbis_ 44559 (K). NIGERIA: Oyo Prov.: hill 3 km N of Iseyin, 7° 58´ N, 3° 34´ E, 350m, rather shady crevice in granitic rocks, 1962, _J. B. Gillett_ 15399 (K); Okeho, group of low hills about 3 miles from Iseyin road, in savannah country, 1959, _R. W. J. Keay_ FHI 37748 (K); Ibadan, Oje Rock, sheltered rock crevices near summit, 1967, _D. P. M. Guile_ 3018 (K). Ondo Prov.: Erio near Aramoko-
Figure 3. Morphology of the Asplenium stuhlmannii complex showing silhouettes of fresh juvenile fronds (top, scale = 5cm), pinnae from lower part of mature dried fronds (middle, scale = 2 cm) and sections (middle to margin, scale = 0·1mm) of the rhizome scales (bottom). A, *A. stuhlmannii*, Somalia; B, *A. mantoniae*, Hambler 513; C, *A. jaundeense*, Yaunde, Cameroon.
Ekiti, base of *Hildegardia* on steep rock faces, 1968, *J. B. Hall* 67 (K); *ibid.*, shade of rock on inselberg, 1968, *J. B. Hall* 71 (K); Idanre, *Jones* s.n. (FHI 14846) (BM); among granite boulders on the lower more or less forested slopes of granite hills, 1946, *A. P. D. Jones* 14844 (BM); Idanre, behind Rest House, in rock fractures, texture coriaceous, dark green, 1968, *D. Gledhill* 957 (K); inselberg NE of Ado Rock, 7° 51´ N, 3° 30´ E, amongst rubble under overhanging ledge – small quantity only growing with *Pellia doniana*, 1958, *D. J. Hambler* 419 (BM); inselberg near Tapa, 7° 34´ N, 3° 30´ E, under overhanging boulders growing with *Pellia doniana* and *Sanseviera* sp., 1958, *D. J. Hambler* 526 (BM).

Plateau Province: near Farm Rua between Willsani Camp and Marhai, soil filled crevices in shady side of rock, 1968, *J. B. Hall* 659 (K); Sha, 3600ft, rock crevice in deep shade, scarp slope, dark green erect fern, *D. W. Lawlor & J. B. Hall* 570 (K).


*A. jaundeense* Hieron.


*Asplenium dimidiatum* var. *zenkeri* Hieron., in Engler *Veg. der Erde* 9: 28, fig. 24, 1908.

Rhizome creeping giving rise to fronds a few millimetres apart; rhizome scales dark brown, up to 6 × 1mm, subulate, clathrate with median cells dark-thick-walled and compressed, often with narrow occluded lumens, marginal cells thin-walled and pellucid, walls facing lumens distinctly minutely dentate. Fronds up to 66 cm long; stipes up to 26cm, matt black with scales at the base similar to those of the rhizome. Lamina up to 41 × 8cm, oblong to linear-oblong with 10 – 20 opposite-subopposite pairs of spreading pinnae merging progressively into a lobed apex; rachises similar to stipe but glabrous and becoming green towards the apex. Pinnae up to 6 × 3cm, trapezoid-rhomboid to cuneiform hastate, base narrowly cuneate, inaequilateral, acroscopic side up to 1:5cm long, basiscopic side up to 3cm long; largest pinnae subtrilobed to trilobed, lateral lobes truncate irregularly inciso-dentate, terminal lobe long, elongate-deltoid, sparsely alternately inciso-dentate, ending in an acute point; trilobing tending to disappear and pinnae becoming trapezoid-rhomboid towards apex and in juvenile fronds. Costae not evident, veins and sori sublabellate. Spores plano-convex, (28–) 33–36 (–40) µm × (19–) 22–24 (–27) µm, perispore costate-alate with anastomosing high wavy ridges or folds (wings). Reproduction sexual, chromosome
number \( n = 72 \) \( (2n = 144) \).

**Ecology and distribution.** The limited ecological information available suggests that this species is associated with rocky outcrops or boulders at altitudes ranging from 300 – 1000m. It is known only from West Africa: Gabon (locality not placed), Cameroon and eastern Nigeria (Figure 2).

**Notes.** Distinguished from *Asplenium mantoniae* by its trapezoid- rhomboid three lobed pinnae with often long attenuate apical lobe and smaller spores, \((28–) 33 – 36 \text{ (–40)} \) \( \mu \text{m} \times (19–) 22 – 24 \text{ (–27)} \) \( \mu \text{m} \).

The morphologically similar *A. megalura* Hieron. differs by its erect rhizome, rather brittle wiry fronds with fewer and often long-attenuate pinnae, a large 3-lobed apical pinna and spores with sparsely anastomosing shallow ridges or wings. It also differs ecologically being usually epiphytic in forest and is widely distributed in tropical and subtropical Africa.


**DISCUSSION**

The three species of the *Asplenium stuhlmannii* complex are united by the presence of a creeping rhizome clothed in clathrate scales with dark median band and translucent margins, and bearing rather stiff once- pinnate narrowly lanceolate or narrowly ovate fronds. The rhizome scales, pinnae and spores of the three species are shown in Figures 2 & 3.

The clathrate rhizome scales of all three species are made up of dark thick-walled cells with compressed lumens in the middle parts becoming thinner-walled and translucent towards the margins. Apart from differences in the size of the cells related to ploidy, there are subtle differences in the inner surface of the cell walls bordering the lumens. Those of *A. stuhlmanni* are smooth while those of *A. jaundeense* are minutely denticulate. Those of *A. mantoniae* are often, but not always, sparsely denticulate (Figure 2), and thus somewhat intermediate.

The pinnae and spore ornamentation of *A. mantoniae* are also intermediate between those of the two tetraploids. The pinnae possess a narrower acute base and are more trapezoid-rhomboid and less dissected than the broadly trullate pinnae of *A. stuhlmannii* and possess a broader cuneate base and are more trullate with deeper lobes than the trapezio-rhomboid almost entire pinnae of *A. jaundeense*. The spores of *A. mantoniae* are larger than those of the two tetraploids on account of their higher level of polyploidy. Their higher more anastomosing wavy perispore folds or wings contrast with the rather low sparingly anastomosing straight perispore wings of *A. stuhlmannii*. In this respect they resemble the spores of *A. jaundeense*.

The morphological analysis suggests a close relationship between the three members of the complex and is consistent with the view that *A. mantoniae* has most likely arisen by hybridisation between the two tetraploids and subsequent doubling of the chromosome number of the hybrid to produce the octoploid. The present
distributions of *A. jaundeense* and *A. stuhlmannii* are widely separated in West and East Africa respectively so that such a hypothesis would imply that in the past their distributions must have either been sympatric or in close contact. The distribution of *A. mantoniae* partly falls between those of the two tetraploids, but has also extended the distribution of the complex particularly in West Africa where it may now be found as far west as Sierra Leone and Guinea.

**REFERENCES**


