A Note on the Cytology of *Botrychium lanuginosum* and the Occurrence of the Genus in Malesia

by

A. C. Jermy* and T. G. Walker**

Summary

Over the past twenty-five years intensive plant collecting has shown two species of *Botrychium* (*B. lanuginosum* Wall. ex Hook. & Grev. and *B. australis* R. Br.) to be present in eastern New Guinea, the former hitherto confined to Central—S.E. Asia and reaching to the Central Himalaya and the latter Australasian with a possible representative in S. America. A further species, *B. daucifolium* Wall. ex Hook. & Grev., is distributed from Sri Lanka (Ceylon) to the Philippines and Sulawesi (Celebes) with questionable outlying records in Fiji and Samoa, reaching S. China in the North, and replaced by a taxon of doubtful specific identity in Japan (*B. japonicum* (Prantl) Underw.). *B. lanuginosum* was found in large quantities in the kunai grasslands at 1600 m in the Finisterre Mountains of E. New Guinea and material fixed in the field has proved to be octoploid *n* = 180) and also hexaploid, suggesting the tetraploid cytotype recorded by other workers in India and Sri Lanka may also be present in New Guinea.

INTRODUCTION

The appearance of *Botrychium* in S.E. Asia and Malesia is seasonal. Its ecological requirements are little known but its appearance may be linked with the increased rainfall seen just before the full monsoon develops. For this reason limited collections have been made as the aerial parts of the leaf quickly become yellow and die down after the spores are shed. Three species have so far been recorded in Malesia, *B. lanuginosum* Wall. ex Hook. & Grev., *B. daucifolium* Wall. ex Hook. & Grev. and *B. australis* R. Br. The first and last species are components of well drained soil in the open anthropogenic grasslands in Malesia (from 1600 — 2700 m in New Guinea) and on similar grassy banks or more rarely in woods on the Asiatic mainland. *B. daucifolium* is a species of more shady situation often in open woodland in the Himalaya and on the open floor of the rain forest in Borneo and Sulawesi. Betty Molesworth Allen (1959) discovered a colony at 1500 m on Gunong Perdah in an opening in the tall forest, growing in a scrub of *Didymocarpus* and young *Cyathea*. She records the soil as being a black sticky humus.

KEY TO MALESIAN SPECIES OF *Botrychium*

1 Fertile segment arising from the rachis of the sterile blade, ± equal in length to adjacent sterile pinnae ........................................ 1 *lanuginosum*

1 Fertile segment arising from the petiole below the sterile blade; the stalk of the fertile segment 1 — 2 times as long as the sterile blade

2 Fertile stalk ± equalling sterile blade; upper pinnae linear-lanceolate or triangular, pinnatifid or dentate only ........................................ 2 *daucifolium*

2 Fertile stalk at least twice as long as the sterile blade; upper pinnules ovate, deeply cut to costa ........................................ 3 *australe*

* Botany Department, British Museum (Natural History), London, England.
** Department of Plant Biology, University of Newcastle upon Tyne, England.

The name first appeared in Wallich's Catalogue of 1828 without a description and was described by Hooker, the figure by Greville (*l.c.*) drawn from material supplied by Wallich. Ballard (1940) discusses the typification and describes the specimen in Greville's herbarium at the Royal Botanic Garden Edinburgh from which the two lower pinnae were removed, thus giving rise to the abnormal plant seen in his plate 79.

The species ranges from the Central Himalaya across China to Taiwan, south to Sri Lanka on the Indian subcontinent and in Malesia to Luzon, Sumatra, Java and New Guinea. The species is distinct in having a broadly deltate tripartite sterile blade, the lobes usually 3–4 pinnatisect, and with the fertile scape arising from the rachis above the insertion of the two lower pinnae (see Figs 1 & 2). The bud, rachis and especially the costal axils are usually sparse to densely covered with long unbranched hairs although some fronds in the New Guinea population mentioned below were almost glabrous. Hayata (1914) has described the glabrous form as *B. leptostachyum*, later to be combined by Nakai (1925) as a variety of *B. lanuginosum*, but in view of the wide variation in the above population both are of doubtful status. The degree of dissection of the sterile blade varies, younger plants being usually less compound, but always more dissected than either *B. daucifolium* or *B. australe*. There is no apparent correlation between ploidy level and degree of cutting or size of sterile frond (see Figs 1 & 2).


Wallich (1828) listed the first gatherings of this (No. 49) as *B. subcarnosum* and later by the name Hooker took up for it. The specimen drawn is in the Edinburgh herbarium and other plants of the same gathering at the British Museum (Natural History) London.

The species ranges from a similar area in the central Himalaya east to Taiwan and south to Sri Lanka. In Malesia it is found throughout the archipelago to Sumbawa Is. (G. Batulanteh), Celebes (G. Bonthain) and Mindanao (Mnt Apo) and Negros (Cuernos de Negros). Allen (1959) found two populations in the Cameron Highlands area of Pahang. There are specimens in the Kew Herbarium from Upolu, Samoa and Nadiavatu, Fiji which compare well with material of *B. daucifolium* from Asia, but a closer study of more recent material needs to be made.

*B. daucifolium* is distinct in having thin, but not membranous, lamina tissue and a less dissected frond in which the upper pinnae are barely cut (see Fig 3) but lobed with the segments toothed. The fertile spike arises from the petiole about 10 cm or more below the insertion of the blade and the fertile segments are strict, not spreading as in the other two species. The species varies in its hairiness, some species in Borneo being quite densely pubescent on the rachis and costae, Allen (1959) mentions that the very young fronds on her Malayan plants were covered with copious pale hairs. Himalayan plants tend, in herbarium specimens at least, to be more glabrous, as do the adult plants of Allen, who gives a fine general photograph of the species (*l.c.* facing p. 251).

Material from Japan, E. China and some from Taiwan, being more membranous, more deeply toothed and with the fertile stalk somewhat longer, has been separated off as *B. daucifolium* var. *japonicum* Prantl, raised by Underwood.

*Facing page*

(1898) to a species. It is certainly related in its morphology to the typical mainland asian B. daucifolium. A small form was described by van Alderwerelt van Rosenberg (1911) from Preanger Regencies, Java under the name of var. parvum. Later in 1913 the same author described yet another variety, subbasalis, which was not only smaller than usual for B. daucifolium but had the fertile spike arising towards the base of the stipe as in B. ternatum and B. austral. Clausen (1938) considered this, from the published description only, to be a possible new species. We have not studied van Alderwerelt van Rosenberg's type and must reserve judgement but it is our experience that juvenile and depauperate Botrychiums can appear very abnormal.


Collected and described by Robert Brown from material from Tasmania and New South Wales. The specimen in the herbarium of the British Museum (Natural History) from Parametta, Port Jackson can be taken as typical but the specimen at Kew is more complete (it contains roots) and is best to be designated lectotype. The species ranges from South Australia to New Zealand and north into south Queensland where it was recorded as B. ternatum (Thunb.) Sw. by Bailey (1883). It differs from the latter in its dissection of the thicker lamina which has hyaline marginal cells.

The sterile leaf is 10–20 cm long, ternate, with the central leaflet larger and more compound. The upper pinnae of this leaflet are ovate and cut to the costa, the resulting segments glabrous, linear and dentate at the truncate apex; the tissue is fleshy and the lamina margin is made up of two to three rows of hyaline cells. The compoundly branched and spreading fertile segment arises in the lower half of the stipe to a height of 30 cm. (see Fig. 4).

The map in Fig. 5 shows the range of the species in Australia. Its presence in Papua New Guinea in the Southern and Western Highlands Districts is a logical extension of this range. It grows in high altitude anthropogenic grasslands (Miscanthus-Themedo associations) and around 2700 m in Dammhonia-Poa grassland and Cyathea scrub and in two localities together with B. lanuginosum. The taxonomy of this australasian complex is little understood and is being reviewed by New Zealand workers at present and their results are awaited with interest.*

THE CYTOLOGY OF B. LANUGINOSUM IN NEW GUINEA

Whilst collecting fern material for subsequent taxonomic and cytological studies in Madang District, east New Guinea in 1964 the authors showed children in Moro, a village at 1680 m at the head of the Gusap River in the Finisterre Mountains, an illustration of Botrychium. Within the hour the children returned with armfuls of B. lanuginosum collected from amongst the kunai (Imperata grass) on old garden sites. This is a good example of the dangers of this method of collecting easily recognisable but possibly rare species. Luckily this population could withstand such collecting and some 50 specimens were taken to show the range of variation. Seven specimens thus collected had meiotic material and were fixed in the field.

One specimen (Walker 8333) showed exactly 180 bivalents at meiosis (Plate I) and three others (Walker 8332, 8334, 8336) 270 chromosomes and hybrid meiosis. The base number for Botrychium is well established as 45 and thus these New Guinea specimens were octoploid and hexaploid respectively. This contrasts with other counts for the species from the Indian subcontinent where Verma & Loyal (1960) recorded n=90 in a Himalayan specimen and Ninan (1956)

* Dr J. Braggins, University of Aukland, N.Z., is of the opinion (pers. comm., 1976) that the New Guinea specimens constitute a new subspecies.
recorded $n = 90$ and $2n = 180$, also for N India; Manton and Sledge (1954) showed a similar situation in Sri Lanka ($n = 90$). Hence all previous counts are at the tetraploid level. The fact that we have hexaploid material showing hybrid behaviour suggests that the tetraploid may also be present in New Guinea.

Fig. 5. Distribution of the three species of Botrychium found in Malesia.
REFERENCES


——— (1913) New or interesting Malay ferns 5. ibid. ser 2 (11): 6 et tab. 3.


Wallich, N. (1828) A numerical list of dried specimens of plants in the East India Company museum collected under the superintendence of Dr Wallich, London.
Plate 1. Permanent aceto-carmine squash of metaphase I of a spore mother cell of Botrychium lanuginosum (Walker 8333) together with explanatory diagram below. Magnification $\times$ 1000.