The Biology and Systematics of *Bowenia* Hook ex. Hook f. (Stangeriaceae: Bowenioideae)

Thesis submitted by

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Statement of Systematic intent

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Abstract

The contents of this thesis describe a study of the Biology and Systematics of *Bowenia* Hook. ex Hook. f. (Cycadales, Stangeriaceae, Bowenioideae). The genus contains two recognised extant species, *B. spectabilis* (Hook. ex Hook.) and *B. serrulata* (W. Bull) Chamberlain. They are restricted to small areas of tall moist and closed forests of central and northeast Queensland, Australia, respectively. The genus was named after Sir George Ferguson Bowen (1821-1899), the species epithet *spectabilis* refers to the spectacular leaves with pinnules (1st order leaflets) with entire margins in the first case and *serrulata* to the serrate margins of the pinnules in the second. The species are unique in the extant cycads in having bipinnate foliage.

Surprisingly little is known about the biology of the members of this genus and this study redresses that situation. In addition, the systematics of *Bowenia* currently present difficulties for taxonomists and management authorities, as there is confusion about the number and distribution of species of *Bowenia* and the status of disjunct and morphologically different populations in northeast Queensland. As there is considerable interest in harvesting *Bowenia* leaves for the Australian and international 'cut flower' markets, clarification of the systematics of the genus is necessary for its effective management, and this study addresses this need.

The strategy adopted for the study was to undertake intensive fieldwork in central Queensland, become familiar with the taxon growing there, and then use that knowledge to facilitate studies in north Queensland. Studies in the field were complimented by work in the laboratory and in the greenhouse.

Bowenia contains a suite of toxins, is slow growing, reproductive events occur once a year and immediately prior to the onset of the 'wet' season, and access to study populations at the appropriate times was often difficult. These factors meant that the fieldwork required collecting sufficient data for analysis extended for a decade. The sequence of events in the study was to collect data on the morphology, reproductive biology, insect associations and genetic profiles of the taxa and integrate them in a database that could latter be used to provide characters for a phylogenetic analysis and a subsequent review of the systematics of the genus.

Studies of the morphology of plants in six populations representing the two recognised species and both morphological forms found in north Queensland, found that they could not readily be differentiated on the basis of leaf, pinnae and pinnule number or morphometrics or the size and branching habit of the subterranean stem. As these characteristics had initially been used to distinguish the two species, a search was made for other characters on which to base a phylogenetic analysis.

The pollination of the taxa was found to be obligate entomophilic and mediated by Molytine weevils involved in species-specific 'brood site reward' pollination syndrome. *Miltotranes prosternalis* (Lea) was demonstrated to be the pollination vector of all northern populations and *M. subopacus* (Lea) to be the pollination vector of plants in Central Queensland. In addition, it was discovered that the leaf beetle *Lilioceris nigripes* (Fabricius), whose range includes that of *Bowenia*, distinguished between the populations in central and northeast Queensland but not the northern populations.

Studies of the karyomorphology of representatives of the two currently named species and the disjunct and morphologically variable northern populations indicated the presence of two taxonomic entities. The first was the population in central Queensland corresponding to the currently recognised *B. serrulata* and the second comprised all the populations, irrespective of their pinnule and root morphology, in northeast Queensland.

A phylogenetic analysis using twelve characters across the six populations of *Bowenia* confirmed the presence of just two species, conforming to those previously named. A comparison of the result of the phylogenetic analysis with the distribution of the two taxa show that *Bowenia serrulata* (W. Bull) Chamberlain is restricted to central Queensland and *B. spectabilis* Hook. ex Hook. is restricted to northeast Queensland, and the two are and have been divided for millions of years by the intervening megathermal Burdekin Gap. In addition, the results show that *B. spectabilis* is morphologically variable and that plants with pinnules with serrate margins in northeast Queensland are examples of phenotypic variation within this species.

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_____ (1993b) The relationship between *Cycas ophiolitica* K.D. Hill Cycadaceae), the butterfly *Theclinesthes onycha* (Lycaenidae), the beetle *Lilioceris nigripes* (Coleoptera: Chrysomelidae) and the ant *Iridomyrmex purpureus*. 1991 Symposium Series. UCQPGSA, Rockhampton.

_____ (1996) Variations in the foliage of *Bowenia serrulata*. *Encephalartos* 45: 21-23.

_____ (2001) Focus on *Bowenia serrulata* (W. Bull) Chamberlain. *Encephalartos* 65: 19-23.

_____ (2002a) Focus on *Bowenia spectabilis* Hook. ex Hook. f. *Encephalartos* 70: 10-14.

_____ (2002b) Insect Pollination in the Cycad Genus *Bowenia* Hook. ex. Hook. f. *Biotropica* 34(3): 438-441.

_____ (2003) A profile of the Queensland rainforest cycad *Bowenia spectabilis* (Stangeriaceae). *Wodyetia* 7(3): 3-8.

Kokubugata, G., Kondo, K., **Wilson, G.W.**, Randall, L.M., Schnas, A and Morris, D.K. (2000) Comparison of karyotype and rDNA-distribution in somatic chromosomes of *Bowenia* species (Stangeriaceae, Cycadales). *Australian Systematic Botany* 13(1): 15-20.

_____, Hill, K.D., **Wilson, G.W.**, Kondo, K. and Randall, L.M. (2001) A comparison of chromosome number and karyotype in somatic chromosomes of Stangeriaceae (Cycadales). *Edinburgh Journal of Botany* 58(3): 475-481.

Poster papers

Wilson, G.W. (2002) Insect Pollination in the rainforest cycad *Bowenia.* Ecology 2002, Annual Conference of The Ecological Society of Australia, Cairns, Australia.

Kokubugata, G., Kondo. K., Wilson, G.W. and Randall, L.M. (1999) Comparison of karyotype and rDNA-Distribution in Somatic Chromosomes of *Bowenia* species (Stangeriaceae, Cycadales). XVI International Botanical Congress, St Louis, Missouri.

Technical Reports

Wilson, G.W. (1995) Invertebrate pollination vectors, herbivores and defenders of the rainforest cycads *Bowenia spectabilis* and *B. 'Tinaroo'.* Report to the Wet Tropics Management Authority, Cairns, Australia.