Terrestrial Orchids: From Seed to Mycotrophic Plant. Hanne N. Rasmussen. Cambridge: Cambridge University Press. 1995. xii + 444pp. ISBN 0 521 45165 5. £45.00 (US$64.95) (hardback).

In *The Various Contrivances by which Orchids are Fertilised by Insects*, Darwin (1877, pp. 277–8) noted that if every seed produced by a single plant of the orchid *Dactylorhiza fuchsii* were to reach maturity, the world would be wholly populated by its progeny within three generations. The observation was not wholly original (similar comments can be traced back at least to Linnaeus), but it succinctly summarizes the peculiar reproductive biology of this recently evolved and diverse family of c.20,000 species.

Orchids are biologically paradoxical. They possess some of the most complex flowers, most sophisticated co-evolutionary relationships and most specialized autecologies in the plant kingdom, but also spread to the four winds some of its simplest seeds. An embryo of a mere 8–800 cells and negligible weight of 2–10μg is suspended within a dead, fusiform testa, well adapted to long-distance transport by both air and water. However, having travelled perhaps thousands of kilometres, almost every seed fails to become established. This is because success requires a remarkable coincidence, namely that the soil (or other substrate) in which the seed is eventually interred contains the appropriate fungal symbiont. Some orchid species cannot germinate without that mycorrhizal fungus, whereas the rest germinate but cease growth before developing their first leaf. The unusually intimate co-evolutionary relationships of orchids and endogenous fungi evidently require a delicate physiological balance that is rarely achieved.

The study of orchid symbiosis and ontogeny has a long (if sporadic) tradition, and Hanne Rasmussen – one of the most recent and eloquent torch-bearers – has produced a fine summary of current knowledge. Twelve interpretative chapters averaging 20 pages apiece discuss the morphology, ontogeny and environmental preferences of the orchids and their mycorrhizal associates, both independently and together. The following chapter of 120 pages describes in detail the ontogeny, mycorrhizal associates and behaviour in cultivation of 36 selected orchid genera, biased towards European and North American taxa and mycotrophically extreme saprophytes. The text concludes with recipes for 58 artificial growth media, a nomenclatural synonymy and a bibliography of c.600 references. Overall, the book is sensibly organized, well written, effectively (though hardly lavishly) illustrated, and attractively produced – only the fussy cover irritates. Obvious errors, such as the confusion of the terms albino and achlorophyllose on p. 169, are rare.

The one disappointment to me was that explicit discussion of the evolutionary implications of symbiosis is restricted to four action-packed pages. In particular, the author fails to realize that the intimate mutual relationship between orchid and mycorrhizal fungus is echoed in the close theoretical relationship between experimental biology and systematics. This shortcoming reflects a more general intellectual apartheid – there is insufficient conceptual overlap between the best reviews of orchid

biology (Arditti, 1991) and orchid systematics (Dressler, 1993). If recently initiated programmes to determine the evolutionary histories of orchids were combined with phylogenetic studies of their pollinators and of the taxonomically problematic mycorrhizae, some fascinating evolutionary inferences would result (cf. Funk & Brooks, 1990; Brooks & McLennan, 1991). The different ontogenies and co-evolutionary relationships documented by Rasmussen make sense only if compared in a phylogenetic context. The phylogenies in turn allow assessment of the number of evolutionary origins of many apparently iterative phenomena described by the author, such as the repeated transitions to wholly mycotrophic nutrition in adult descendants that previously only characterized juvenile stages of their ancestors – an evolutionary phenomenon termed neoteny (e.g. Gould, 1977) and apparently irreversible in this case. Phylogenies also allow predictions about the ontogeny, and identity of mycorrhizal associates, of poorly known orchids, if they are closely related to orchids that have been better studied.

The author's decision to focus on terrestrial orchids, rather than the better known (and currently more commercially important) epiphytes, is understandable. Unfortunately, it limits the opportunity to contrast the two main categories of life history. For example, Rasmussen notes the far greater importance of mycorrhizae in the early ontogeny of subterranean terrestrial orchids relative to their epiphytic brethren, which are superficial and thus can initiate photosynthesis far earlier. And as terrestrial orchids are dominantly temperate, their ontogenies are far more seasonal than those of tropical epiphytes, and controlled primarily by temperature and rainfall.

With these exceptions, Rasmussen has achieved an excellent interdisciplinary blend of information and interpretation. She argues convincingly that mycotrophy is fundamental to many aspects of orchid biology, facilitating the small seed size that in turn allows wind dispersal and the epiphytic life habit (pp. 236–7). The enormous number of ovules per ovary explains the need for many compatible pollen grains aggregated into pollinia; the pollinaria in turn allow close relationships with specific pollinators. Similarly, her synthesis has profound implications for orchid ecology and conservation, both *ex situ* and *in situ*. The importance of Rasmussen's own empirical contributions should also be noted, particularly in recognizing the limitations of the traditional artificial laboratory studies (the technically possible) and hence switching to an ingenious method of studying natural, *in situ* populations (the actual: Rasmussen & Whigham, 1993).

As I noted earlier in this review, a well-travelled orchid seed requires the remarkable coincidence of encountering a compatible mycorrhiza at its destination if it is to found a new population. This may seem ridiculously improbable – but then Rasmussen has by chance chosen to use as a model organism for her ontogenetic studies the one species out of 20,000 that I use as a model organism for evolutionary studies – *Dactylorhiza majalis*. Also, her pioneering work on natural populations of juvenile orchids was conducted at the Smithsonian Environmental Research Center, along the Maryland shore, at the same time that I was casually examining the adults

of the same species in the same woods. The power of coincidence should never be under-estimated!

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R. M. BATEMAN

Illustrations on the Flora of the Palni Hills, South India. K. M. Matthew. Madras: C.L.S. Press. 1996. xlvi+979pp with 950 black & white plates. ISBN 81 900539 1 4. £55.00 (hardback).

With the publication of *Illustrations on the Flora of the Palni Hills*, Father Matthew presents the second stage of his mission to spread botanical knowledge among the people of the Indian Peninsula. The first stage of this project, which was published as the *Flora of the Tamilnadu Carnatic*, covered the Tamilnadu plains and southern hill ranges, and the *Flora of the Palni Hills* can be seen as the montane counterpart to that work, extending the coverage to include the entire Indian Peninsula with the exception of the Western Ghats.

The motto of the project is 'Lab to land' and the intention is that the benefits of the work should be felt by the people of the region. Thus, whilst the basic research for the Floras has proceeded at the Rapinat Herbarium, the products of that work have been disseminated to students and villagers at the Anglade Institute of Natural History, where about 35,000 people have attended free three-day environmental awareness courses since 1984. The cost of most tropical Floras places them well beyond the reach of ordinary people, and Father Matthew has maintained a policy of pricing them at reduced rates to increase their circulation. At £55 the present volume may not appear especially cheap, but a huge amount of labour has gone into its production and if it were to be published in the UK from illustrations drawn here it could easily cost ten times the price.