

## Distributional Patterns of Epiphytic Ferns are Explained by the Presence of Cryptic Species

Tom M. Fayle<sup>1</sup>

Entomology Department, Natural History Museum, Cromwell Road, London SW7 5BD, UK

Insect Ecology Group, University Museum of Zoology, Downing Street, Cambridge CB2 3EJ, UK

Alex J. Dumbrell

Department of Biological Sciences, University of Essex, Wivenhoe Park, Colchester CO4 3SQ, UK

Department of Biology, PO Box 373, University of York, York YO10 5YW, UK

Edgar C. Turner, and William A. Foster

Insect Ecology Group, University Museum of Zoology, Downing Street, Cambridge CB2 3EJ, UK

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### ABSTRACT

In a recent article in this journal Zhang and colleagues investigated the factors affecting the distribution of a species of epiphytic fern *Asplenium nidus* L. in rain forest in Peninsular Malaysia. Here we suggest that their findings may be interpreted in the light of there being two cryptic species present, each with different ecologies, as is the case in Malaysian Borneo. We also discuss the implications of the existence of cryptic species when attempting to conserve forest diversity in the face of climate change and habitat conversion.

Abstract in Malay is available at <http://www.blackwell-synergy.com/loi/btp>.

*Key words:* *Asplenium nidus*; *Asplenium phyllitidis*; bird's nest fern; climate change; habitat conversion; microclimate; vertical stratification.

LITTER-TRAPPING *ASPENIUM* FERNS, COMMONLY KNOWN AS BIRD'S NEST FERNS, ARE abundant in rain forests from east Africa to northern Australia, and provide an important habitat in the canopy for arthropods and other animals (Ellwood & Foster 2004). Zhang *et al.* (2010) show that *Asplenium nidus* are present at high abundances in the forest understory, with lower abundances but larger individuals in the canopy and in emergent trees. They pose two possible explanations for these (and other) patterns: (1) trade-offs between light and water requirements lead to high recruitment but slow growth in the understory, and the reverse pattern in the high canopy; (2) the differences observed are due to the presence of two or more cryptic species of fern, each with different habitat requirements. They also stress the importance of using molecular methods to shed light on which of these hypotheses are correct.

In a paper in press at *Biotropica* at the time that the study of Zhang *et al.* (2010) was submitted, we demonstrated that the latter of these two (non-mutually exclusive) hypotheses is likely to be true for bird's nest ferns in Southeast Asia (Fayle *et al.* 2009). We collected field samples of *Asplenium* from lowland rain forest in Malaysian Borneo and sequenced the plastid trnL intron. This revealed that two sympatric fern species were present in the forest: *A. nidus* and *Asplenium phyllitidis* D. Don. The two species are morphologically very similar, and almost impossible to tell apart if

reproductive structures are not present; however, their ecologies differ markedly. *Asplenium nidus* is able to survive at all heights up to the top of the canopy (60 m) and is associated with emergent trees and more open areas while *A. phyllitidis* is never found higher than 30 m. The two species also differed in their growth responses, with larger *A. phyllitidis* being present higher in the canopy. This was not the case for *A. nidus*, the size of which was limited only by the diameter of its substrate plant.

Given that cryptic species are likely to be widespread within the *A. nidus* complex in Southeast Asia (Yatabe *et al.* 2001, Yatabe & Murakami 2003) our study suggests that many of the patterns observed by Zhang *et al.* (2010) can be explained by the presence of two species at their study site. A smaller, less desiccation tolerant species dominates in the understory, with the larger, true *A. nidus* being able to survive in the high canopy. We suggest that this smaller species is either *A. phyllitidis*, as is the case in our study (Fayle *et al.* 2009), or another species with a similar ecology. This explains both the vertical gradient of abundance observed by Zhang *et al.* (2010), with large numbers of the *A. phyllitidis*-like species being present in the understory but none in the high canopy, and the gradient in fern size, with larger *A. phyllitidis*-like ferns (but not larger *A. nidus*) in higher strata. There is some indirect evidence that the high light levels found in the upper canopy can lead to fast rates of growth of bird's nest ferns: ferns in oil palm plantations where light levels are comparable to those found in the upper canopy can reach sizes of 3.6 m diam (frond tip to frond tip) after only 14 yr

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<sup>1</sup>Corresponding author; e-mail: [tmf26@cam.ac.uk](mailto:tmf26@cam.ac.uk)

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(E. Turner, unpubl. data). It should also be pointed out that since most tree growth occurs at apical meristems it is unlikely that 'higher *A. nidus* were larger, simply because older individuals had been lifted into the canopy by the growth of their host.'

This finding highlights the importance of correctly defining species boundaries when conducting research in ecology and conservation. In Southeast Asia *A. nidus* has been recorded in habitats ranging from pristine forest to oil palm plantation. In plantations these ferns support diverse communities of arthropods (Turner & Foster 2009, Fayle *et al.* 2010), and so may be important in maintaining ecosystem functioning. It is likely that these ferns really are all *A. nidus* (Piggott 1996), as the microclimatic conditions in plantations are very similar to those found at the top of the rain forest canopy. This has not, however, been confirmed because the DNA of ferns from plantations has not yet been sequenced. Not only does this affect the conservation value of plantations for ferns (2/2 species vs. 1/2 species conserved when habitat is converted), but has major implications for the conservation of their resident arthropods if some are only able to survive in a particular species of fern. This is particularly important, because oil palm cultivation is burgeoning in Southeast Asia, but data on the effects of conversion are still relatively sparse (Turner *et al.* 2008). In addition, lumping of cryptic species may lead to over-optimistic estimates of the ability of species to withstand changes in climate. In the present case, without the recognition of cryptic species, the single fern species would appear to be able to withstand dramatic increases in temperature because it is able to survive at the top of the canopy. By splitting the species, however, we can see that increases in temperature might lead to the extinction of the less desiccation-tolerant, understory-specific species—for example as a consequence of climate change-induced droughts.

As Zhang *et al.* (2010) state, it is vital that we continue to integrate molecular techniques into ecological studies in order to properly define subject species where morphological identification

is problematic. Doing so may reveal many further instances of multiple cryptic species where only one was assumed to exist. Because each of these will have smaller population sizes and more restricted niches they are highly likely to be more vulnerable to threats such as habitat conversion and climate change.

## LITERATURE CITED

- ELLWOOD, M. D. F., AND W. A. FOSTER. 2004. Doubling the estimate of invertebrate biomass in a rainforest canopy? *Nature* 429: 549–551.
- FAYLE, T. M., A. Y. CHUNG, A. J. DUMBRELL, P. EGGLETON, AND W. A. FOSTER. 2009. The effect of rain forest canopy architecture on the distribution of epiphytic ferns (*Asplenium* spp.) in Sabah, Malaysia. *Biotropica* 41: 676–681.
- FAYLE, T. M., E. C. TURNER, J. L. SNADDON, V.K. CHEY, A.Y.C. CHUNG, P. EGGLETON, AND W. A. FOSTER. 2010. Oil palm expansion into rain forest greatly reduces ant biodiversity in canopy, epiphytes and leaf-litter. *Basic Appl. Ecol.* 11: 337–345.
- PIGGOTT, A. G. 1996. *Ferns of Malaysia in colour*. Tropical Press, Kuala Lumpur, Malaysia.
- TURNER, E. C., AND W. A. FOSTER. 2009. The impact of forest conversion to oil palm on arthropod abundance and biomass in Sabah, Malaysia. *J. Trop. Ecol.* 25: 23–30.
- TURNER, E. C., J. L. SNADDON, T. M. FAYLE, AND W. A. FOSTER. 2008. Oil palm research in context: Identifying the need for biodiversity assessment. *PLoS ONE* 3: e1572.
- YATABE, Y., S. MASUYAMA, D. DARNAEDI, AND N. MURAKAMI. 2001. Molecular systematics of the *Asplenium nidus* complex from Mt. Halimun National Park, Indonesia: Evidence for reproductive isolation among three sympatric *rbcL* sequence types. *Am. J. Bot.* 88: 1517–1522.
- YATABE, Y., AND N. MURAKAMI. 2003. Recognition of cryptic species in the *Asplenium nidus* complex using molecular data—a progress report. *Telopea* 10: 487–496.
- ZHANG, L., S. NURVIANTO, AND R. HARRISON. 2010. Factors affecting the distribution and abundance of *Asplenium nidus* L. in a tropical lowland rain forest in Peninsular Malaysia. *Biotropica* 42: 464–469.