

Evolutionary ecology of leaf mining insects: a survey of abundance and distribution



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What is leaf mining?

Leaf mining is a type of feeding that only occurs in four orders of holometabolous insects: *Coleoptera*, *Diptera*, *Hymenoptera* and *Lepidoptera*. Eggs of leaf miners are laid either on, or just below the leaf surface. After hatching, larvae enter the leaf and remain between epidermal layers feeding on internal tissue for a few or all of their larval instars creating a characteristic discoloured "mine" on the leaf surface. These mines can vary considerably in shape and size.

Why did leaf-mining evolve?

Three hypotheses have been suggested by Connor and Taverner (1997):

1. Avoidance of enemies
2. Avoidance of plant defenses
3. Environmental regulation

The last hypothesis relates to the mine as an environmental regulator, protecting the miner from harsh environments. It has not been tested for miners but work on other endophagous insects (gall forming insects) has shown mixed results. In the United States, Fernandes and Price (1992) showed a dramatic rise in galling species with an increase in aridity, but in a similar study within Australia, Blanche (1995) found no such correlation.

Previous research

Research into leaf mining insects has been extensive overseas especially in the United States, Britain and many parts of Europe. In Australia, there have been some studies on the ecology and taxonomy of the insects, but they are generally poorly known. For example, in one family of leaf mining Lepidoptera alone (Nepticulidae), only 16 of the over 400 species collected have been named and described (Hoare *et al.* 1997).

I have carried out a preliminary study in several National Parks in NSW to determine where leaf miners are occurring, and on which species they can be found.

Questions

1. Within the native leaf miners, are there particular families of host plants which are preferentially fed upon by leaf miners? Is this related to leaf traits?
2. Is leaf mining more common in some vegetation types than others?
3. Is the distribution of leaf miners associated with a gradient in aridity?
4. Is there any co-occurrence between leaf mining and other forms of herbivory?



Where leaf mining occurs, digital photographs are taken of marked leaves. Where mines are active, samples are taken for lab rearing.

Study sites

I have field sites in various locations in several national parks and regional reserves in and around the Sydney area, and in nature reserves in the wider New South Wales (NSW) area.

- Royal National Park (Bola Creek, Walumarra Track and Flat Rock Creek)
- Ku-ring-gai Chase National Park (Bairne Track)
- Garigal National Park (Bungaroo Track)
- Berowra Valley Regional Reserve (Lyrebird Gully)
- Round Hill Nature Reserve

Methods

At all sites:

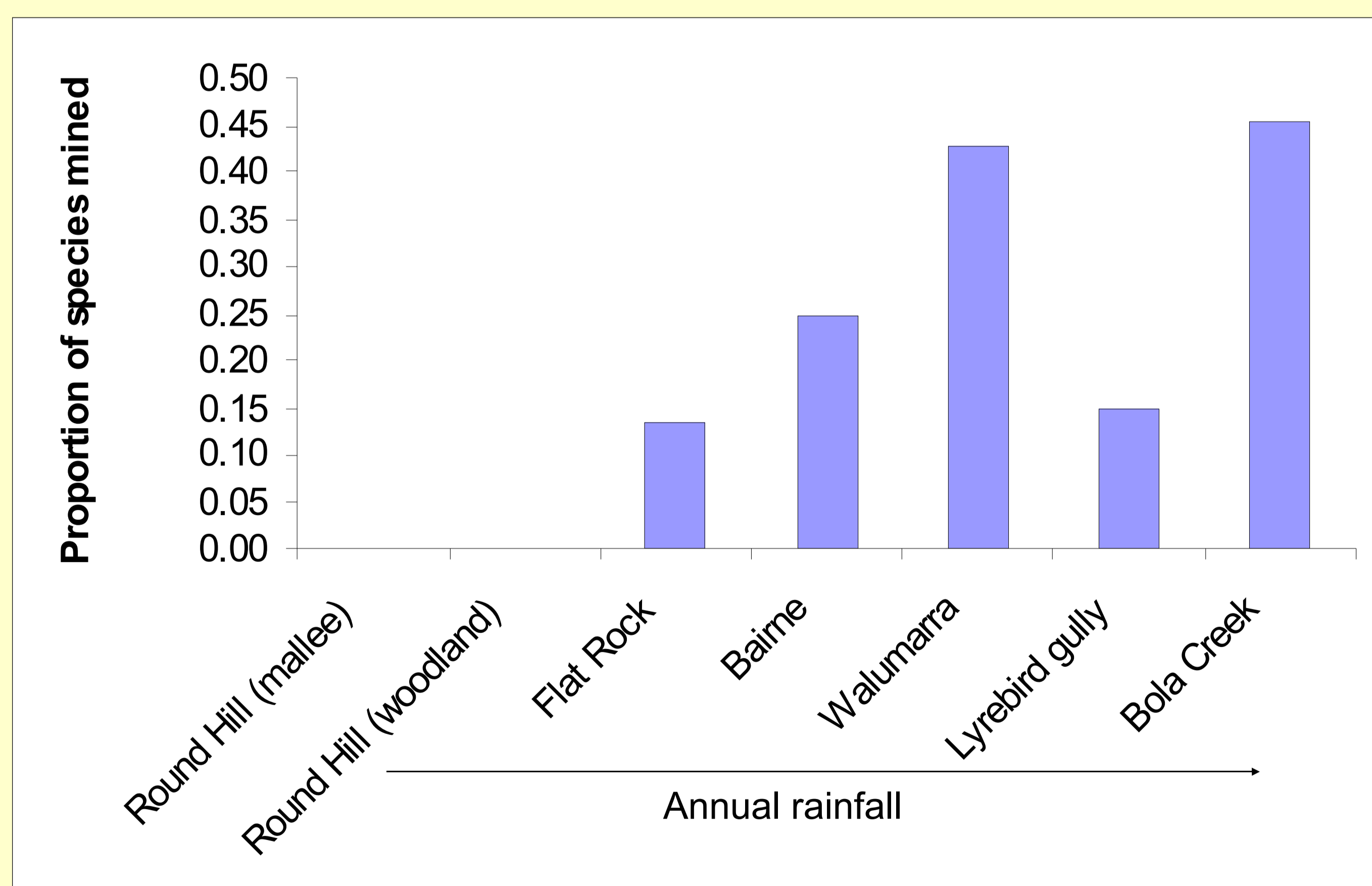
- 20m x 20m quadrat marked out randomly
- All vegetation within quadrat examined

Vegetation	Defining features	Location
Eucalypt Woodland	Community dominated by perennial woody plants >2m, where canopies do not touch.	Bungaroo, Garigal N.P., Bairne, Ku-ring-gai N.P., Flat Rock, Royal N.P., Round Hill
Heath	Low sclerophyllous vegetation on poor soils. Dominated by small shrubs.	Walumarra, Royal N.P.
Mallee	Closed canopy dominated by small multi-stemmed eucalypts.	Round Hill
Wet sclerophyll/ Rainforest	Closed canopy comprised of 1-4 species. Understorey with broad, thick leaves.	Lyrebird, Berowra R.R., Bola, Royal N.P.

On the first 3 individuals of every species found:

- Measure length, width and thickness of 5 adult leaves
- Note which herbivory occurs
- Note whether any mines are active (larvae feeding) or inactive (larvae dead or absent)

Preliminary results



The proportion of species that are mined at each site are represented here. Miners have not been found at all sites. The sites with the most mining are both in Royal National Park.

References:

- Blanche KR (1995) Factors influencing the diversity of gall-forming insects species on Australian plants. Unpublished PhD thesis, Macquarie University.
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Fernandes GW, Price PW (1992) *Oecologia*, **90**, 14-20.
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New family records

The literature indicates that in Australia, leaf miners used a wide range of host plants. I have found some that have previously been unrecorded.

Families from literature (n=29)	New families (n=7)
Apiaceae, Apocynaceae, Asteraceae, Betulaceae, Boraginaceae, Chenopodiaceae, Compositae, Convolvaceae, Cyperaceae, Euphorbiaceae, Fabaceae, Goodeniaceae, Lauraceae, Liliaceae, Malvaceae, Myrtaceae, Plantaginaceae, Platyneriaceae, Plumaginaceae, Portulacaceae, Proteaceae, Ranunculaceae, Rhamnaceae, Rutaceae, Saxifragaceae, Thymelaeaceae, Typhaceae, Verbanaceae, Xanthorrhoeaceae	Celastraceae (Bola Creek), Cunoniaceae (Bola Creek), Elaeocarpaceae (Lyrebird Gully), Haloragaceae (Flat Rock Creek), Pittosporaceae (Bola Creek), Rubiaceae (Bola Creek), Vitaceae (Bola Creek)

The majority of the new mining family records have come from the rainforest sites, with only one from a woodland area.

With the exception of Rubiaceae (*Morinda jasminoides*), all mines have thus far been inactive. Two adult Lepidopterans were reared from the mines of *M. jasminoides*, but they have not yet been identified beyond order.

Conclusions

- More data is required but, there is little evidence that leaf mines offer miners environmental regulation.
- Areas with high rainfall have so far had the majority of new mining records, as well as higher proportions of mined species. The scale of this study will be expanded to include areas with much higher rainfall.
- Most of the mines were inactive, probably due to time of year of surveying. Sampling will continue for more seasons.