

## Species Richness of Gallling Arthropods in Brisbane, Green Island, and Daintree National Park in Northeastern Australia

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**Species Richness of Gallling Arthropods in Brisbane,  
Green Island, and Daintree National Park  
in Northeastern Australia\***

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**Abstract.** We surveyed the species richness of gallling arthropods in northeastern Australia in October 2002 and found 38 sorts of arthropod gall. The gall midge species richness on *Eucalyptus* spp. may support the microenvironment hypothesis in which the gallling habit is considered to be adaptive to dry areas. In Green Island, the species richness of gallling arthropods was very poor, since the island is too small and far out at sea. The gallling species richness in Daintree National Park was apparently higher than the data recorded by Price *et al.* (1998) in the places locating on lower latitudes, but was lower than the previous data in Iguassu and Amazon, Brazil. The present data indicates that the species richness of gallling arthropods is relatively high both under humid conditions and under high plant species richness in tropical rainforests.

**Key words:** Cecidomyiidae, Eriophyoidea, Psylloidea, microenvironment hypothesis, humid conditions, plant species richness.

**Introduction**

The adaptive significance of gallling habit by arthropods has been discussed on many occasions. Price *et al.* (1987) proposed the microenvironment hypothesis and explained that the gallling habit has an adaptive significance to dry areas. In addition, Price *et al.* (1998) emphasized that the species richness of gallling arthropods is

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relatively high in temperate scleromorphic vegetation. In contrast, Docters van Leeuwen-Reijnvaan & Docters van Leeuwen (1926) explained the galling species richness in tropical rain forests on the basis of plant species richness. Their explanation has been supported by the field surveys at various places in tropical forests of Indonesia (Yukawa & Partomihardjo, 1997; Yukawa *et al.*, 2000, 2001a) and in Amazon and Iguassu, Brazil (Yukawa *et al.*, 2001b).

In this study, we examine these two explanations, based on the result of our field survey in subtropical and temperate areas in northeastern Australia.

## Materials and Methods

### *Census fields*

We surveyed at the following places: Mt. Coot-tha Botanical Gardens, Green Island, and Daintree National Park (Table 1). Mt. Coot-tha Botanical Gardens is 5 km distant from the Central Business District of Brisbane, which is located in the temperate zone with mild temperatures (30°C maximum) and a little rain (1200 mm per year) (Commonwealth of Australia, 2000). Green Island (1.6 km in circumference) is one of the small coral islands of the Great Barrier Reef and about 27 km northeast of Cairns. Daintree National Park is about 82 km north of Cairns. The climate of Daintree consists of dry and wet seasons. In the dry season (April to December), there is an average of 50 mm a month of rainfall and in the wet season (January to March), rainfall averages over 400 mm a month (Commonwealth of Australia, 2003). Rainfall varies throughout Daintree National Park with some parts receiving up to 4000 mm a year (Commonwealth of Australia, 2003).

### *Galls and host plants surveyed*

At Mt. Coot-tha Botanical Gardens, we searched intensively for arthropod galls produced on *Eucalyptus* spp. (Myrtaceae), most of which are native to Australia. On Green Island, arthropod galls were surveyed along a path. In Daintree National Park, we

**Table 1.** Localities of field survey and the time devoted to finding galls.

Date	Locality*	Location	Time devoted (minutes)	No. of persons engaged
Oct. 6 2002	CBG	S 17°30' E 153°00'	30	3
Oct. 7 2002	GI	S 16°18' E 145°50'	60	5
Oct. 8 2002	DNP	S 16°00' E 145°20'	60	5

\* CBG: Mt. Coot-tha Botanical Gardens, Brisbane; GI: Green Island; DNP: Daintree National Park.

searched randomly for arthropod galls on various plant species for 60 minutes and recorded the number of galls found every 15 minutes.

We identified galling arthropods based on the shape of galls by the method outlined in Yukawa *et al.* (2001b). We relied upon the assumptions that each gall morph is unique to a galling arthropod species and that galling arthropod species are specific to a single plant species (following Price *et al.*, 1998). Host plant family or species could not be identified.

In order to adjust the intensity of surveys in Daintree to that of other surveys by Yukawa *et al.* (2001b), the data was converted to time unit data, ‘TUD’, the number of sorts of gall found per hour by two persons (following Yukawa *et al.*, 2001b).

# Results

A total of 38 sorts of insect and mite galls were found during the course of our field surveys (Table 2). Among the 38 sorts, 31 were produced by Cecidomyiidae, four by Eriophyoidea, and three by Psylloidea.

**Table 2.** Sorts of arthropod gall found in each locality.

Galling arthropod	Locality*			
	CBG	GI	DNP**	Total
Cecidomyiidae	13	2	15+(1)	31
Eryophyoidea	0	0	3+(1)	4
Psylloidea	0	0	3	3
Total	13	2	21+(2)	38

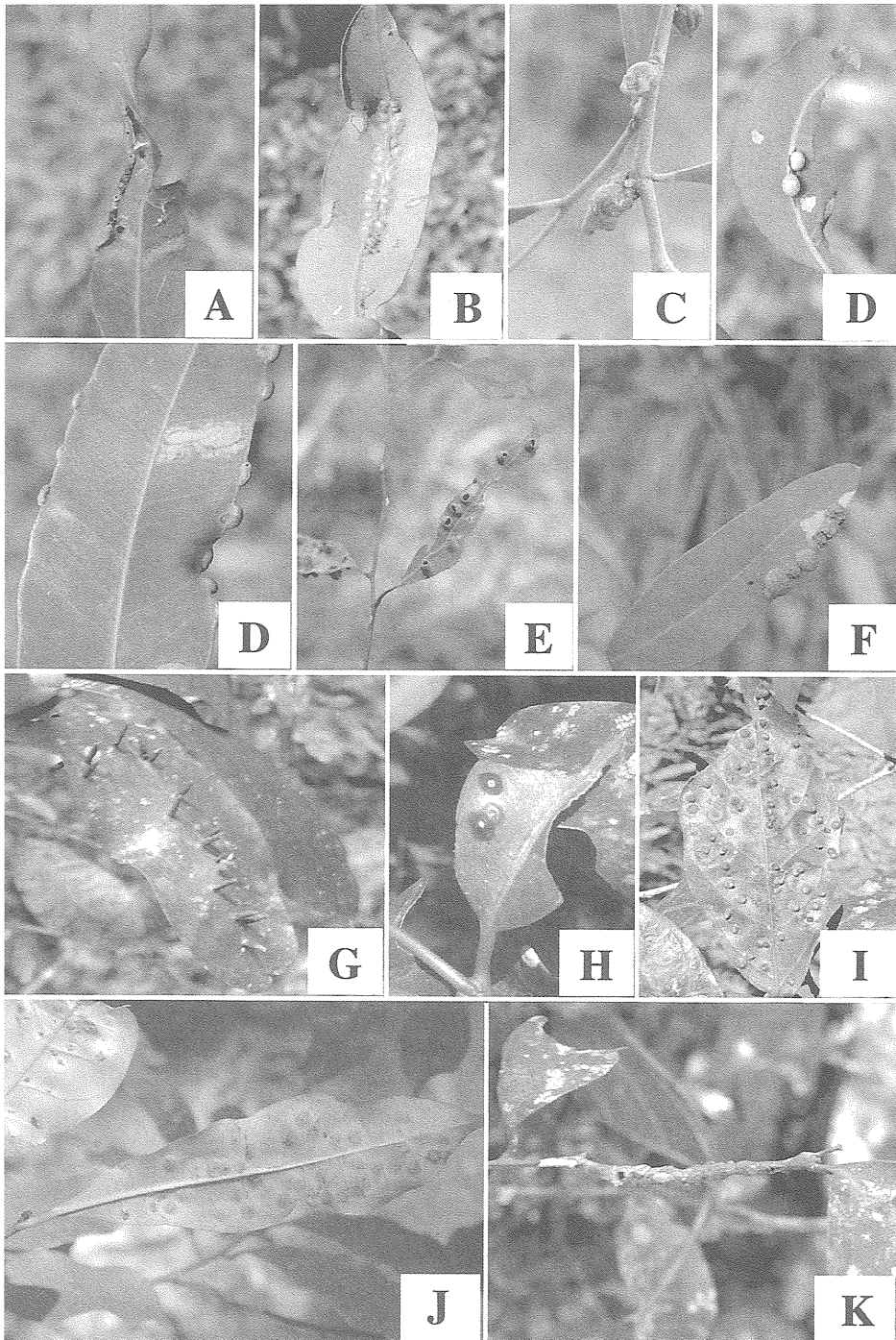
\* CBG: Mt. Coot-tha Botanical Gardens, Brisbane; GI: Green Island; DNP: Daintree National Park.

\*\* Numerals in parenthesis indicate the number of galls that were newly found after four times of 15-minute survey.

**Table 3.** Number of sorts of galls that were newly found during every 15-minute survey in Daintree National Park.

Galling arthropod	Four times of 15-minute survey*			
	1st	2nd	3rd	4th
Cecidomyiidae	6	4+(1)	1+(2)	4+(2)
Eriophyoidea	1	1	0	1
Psylloidea	0	1	2	0
Total	7	6+(1)	3+(2)	5+(2)

\* Numerals in parenthesis indicate the number of the same sorts of galls that were found during the previous 15-minute surveys.



**Fig. 1:** Galls found in this study. **A-F:** midge galls on leaves and a leaf bud of *Eucalyptus* spp. (Myrtaceae) in Mt. Coot-tha Botanical Gardens; **G-K:** arthropod galls on leaves and a twig of various plant species in Daintree National Park.

At Mt. Coot-tha Botanical Gardens, all 13 sorts of gall found on *Eucalyptus* spp. were produced by gall midges (Fig. 1: A-F). In Green Island, only two sorts of galls were found. They were all cecidomyiid galls. In Daintree National Park, we found 15 sorts of cecidomyiid, three of eryophyoid, and three of psylloid galls (Fig. 1: G-K). The TUD in Daintree National Park was 8.4. The number of sorts of galls that were newly found during the last 15 minutes did not decrease tremendously even after three times of 15-minute survey (Table 3). In addition, we found a cecidomyiid and an eryophyoid gall after the 60-minute survey. In total, 23 sorts of arthropod galls were found in Daintree National Park.

### Discussion

At Mt. Coot-tha Botanical Gardens, we found many midge galls on *Eucalyptus* species. Because *Eucalyptus* species have adapted to dry areas, the species richness of gall midges on *Eucalyptus* may support the microenvironment hypothesis (Price *et al.*, 1987). As to gall midge species associated with *Eucalyptus*, only less than 10 have been described so far (Barnes, 1951; Kolesik, 1995, 1998; Kolesik *et al.*, 2002). Further survey is needed to clarify factors that influence the galling species richness on *Eucalyptus* spp.

On Green Island, we found only two sorts of midge gall (Table 2). Since this island is too small and far out at sea, colonization, establishment, and maintenance of population seem to be considerably difficult for plants and animals, including galling arthropods as has been pointed out by MacArthur & Wilson (1967).

At Daintree National Park, we found 21 sorts of gall during the 60-minute survey. We could find more numerous galls if we devoted more time to searching for galls, because the sorts of gall found every 15 minutes did not overlap too much (Table 3). Thus the galling species richness in Daintree National Park was apparently higher than the data recorded by Price *et al.* (1998) in the places locating on lower latitudes. High plant richness in tropical rainforests has been considered to be an important factor in generating galling arthropod species richness (Docters van Leeuwen-Reijnvaan & Docters van Leeuwen, 1926; Wright & Samways, 1998). Our data in Daintree National Park can be also explained by this factor.

However, TUD (8.4) in Daintree National Park was distinctly lower than 17.0 in Iguassu, Argentine side, 23.1 in Rio Paraguquara, Amazon, and 32.0 in Efejeniu Saures, Amazon, although it was almost similar to 9.6 in Iguassu, Brazilian side (Yukawa, 2001b). These data indicate that the galling species richness tend to be relatively high in more humid tropical rain forests in Brazil than in Daintree National Park with dry season. As discussed in Yukawa *et al.* (2001b), there are several

examples indicating that the species richness of galling arthropods is relatively high both under humid conditions and under high plant species richness in tropical rainforests. The lower TUD in Daintree National Park than in Brazil may be explained by the combination of these two factors.

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