FLYING FOX WORKSHOP PROCEEDINGS

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Pollination of eucalypts by flying-foxes in Northern Australia

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Abstract

Flying-foxes (F: Pteropodidae) are shown to pollinate two species of *Eucalyptus* (F: Myrtaceae) in their diet. The two plant species are widespread and common in lowland forests of the 'Top End' of the Northern Territory and are adapted to attract nocturnal pollinators. Reasons are given to support the argument that flying-foxes are key species for the maintenance of genetic diversity in northern tropical forests: flying-foxes pollinate their food plants, they transport pollen further than members of other forager groups, and many flower species are included in their diets.

Although this part of the story of pollination of by flying-foxes is set in Kakadu National Park, N.T., this information is applicable to the Lismore Region.

Introduction

Tropical plant communities depend on animal agents to transport their genes in pollen a greater distance than plant mechanisms allow (MacArthur, 1972) and with more accuracy than is achieved through wind and water dispersal (Cruden, 1976). The principal benefits of cross pollination to a plant community are (1) an increased potential for its long term survival through the production of genetically diverse progeny, and (2) the promotion of plant species diversity within the community (Pianka, 1974).

Plants control the dispersal of pollen in two ways:

(1) by advertising the standing crop to specific forager groups (Faegri & van der Pijl, 1966), and

(2) by varying the amount of 'reward' available to visitors.

In theory, bats visit flowers that are visible in dim light and are strongly scented at night because they fly a long distance from their roost to feed at night (Peggy Eby, this manual); these floral characteristics act as an attractant in the dark. Flowers of the genus *Eucalyptus* conform to the theoretical bat-flower and their reproductive strategies include cross-pollination and the reliance on animal agents for pollen transport (Pryor, 1976). Insects and birds are pollinators of eucalypt flowers (Armstrong, 1979); and in 1863 flying-foxes were first reported to eat their nectar and pollen (Gould, 1863). Although the flower-food list for flying-foxes has grown since 1863, this is the first attempt to prove that flying-foxes pollinate the Australia flora.

This paper answers two questions:

(1) Do flying-foxes pollinate eucalypt flowers?

(2) Do eucalypts advertise their receptive flowers to flying-foxes?

Methods and results

The study was conducted in Kakadu National park in the Northern Territory between May 1986 and November 1988. Pollination of flower-foods by the largest local pteropodids, the black flying-fox *Pteropus alecto* and the red flying-fox *P. scapulatus*, was investigated. Two plant species, *Eucalyptus porrecta* and *E. confertiflora*, from lowland forests in the 'Top End' were chosen.

Food categories scored in monthly samples of flying-fox faeces and gut contents show that bats eat more flowers each month, represented by 71% of the food items scored (n = 12000 items), than other foods except in March and April, the end of the wet season, when native fruits are plentiful and flowers are available in Kakadu National Park ('Kakadu').

Thousands of pollen grains stick to the fur of flying-foxes when they feed on flowers. Examination, with light microscopy, of 10000 grains removed from the fur of 100 flying-foxes shows that 78% are full, entire grains and the remaining 22% are evacuated. A full pollen grain is likely to be viable; an evacuated grain is not viable.

Results from the manipulation of flower exposure to pollen from different sources using 50% woven shadecloth to protect clusters of flowers from contamination with unspecified pollen are presented in the next three paragraphs and shown in figure 1.

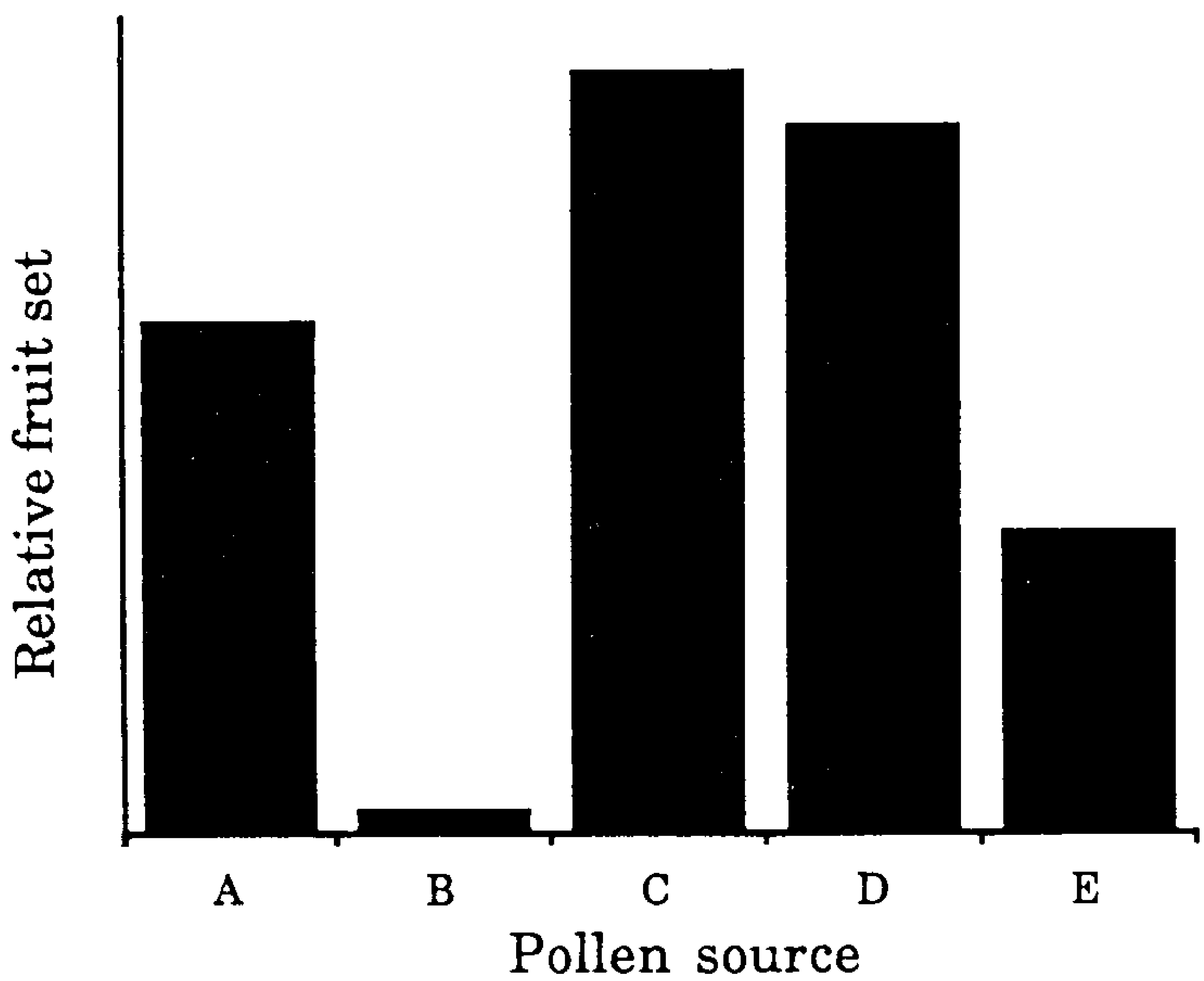

Fig. 1. The pattern of fruit set in tropical *Eucalyptus* flowers exposed to pollen from different sources: A all pollen, B self pollen, C nocturnal pollinators, D diurnal pollinators, E 'bat' pollen, that is pollen on the body of a flying-fox. Fruit set was recorded from 6 treatments (A - E) using 1210 flowers on 26 trees of 2 species.

Covered buds were rubbed with the head of a live flying-fox when the buds flowered (n = 568 flowers on 16 trees). Fruit set in less than one-quarter, between 11 and 21%, of the flower sample (Fig. 1 - source E). Inhibitors for fertilisation of an ovule either on the body of a flying-fox or in the eucalypt flower are therefore lacking. Mechanical damage to the stigmas of the rubbed flowers may account for the lower fruit set in 'bat pollinated' flowers (Fig. 1 - source E) when compared with clusters of open flowers in which 18.7 to 23.7% set fruit (Fig. 1 - source A).

Flowers exposed to pollinators, 'bat pollinated' and open flowers, resulted in significantly higher fruit set, at 11 - 23.7%, than clusters of covered flowers exposed only to pollen from their nearest neighbours, with fruit set below 1% (Fig 1. - source B). *E. Porrecta* and *E. confertiflora* are shown to primarily depend on outcrossed pollen for fertilisation and, therefore, on an agent for pollen transport.

Fruit set in 28 - 37.2% of flowers uncovered at night, 1830 - 0630 hours figure 1 - source C, is marginally greater when compared with 26- 35.5% of flowers uncovered during the day, at 0630 to 1830 hours figure 1 - source D, but the difference is not significant. Although these results demonstrate that *E. porrecta* and *E. confertiflora* are generalists in their pollinating relationships with animal visitors there may be a degree of specificity for one forager group.

At six hourly intervals from 0800 hours, records were made of the number of flowers opened and the amount of nectar produced. Significantly more of the floral foods, nectar and pollen, are produced at night than during the day (Fig. 2). The two eucalypts are therefore adapted to attracted nocturnal pollinators. Furthermore, flowers are mostly opened after sunset, more nectar is produced at midnight than at other times of the day, and flowers produce large amounts of nectar, between 400 and 4000 microlitre. For maximum food intake and a balanced diet a large animal must visit several flowers twice in the night transporting pollen from plant to plant.

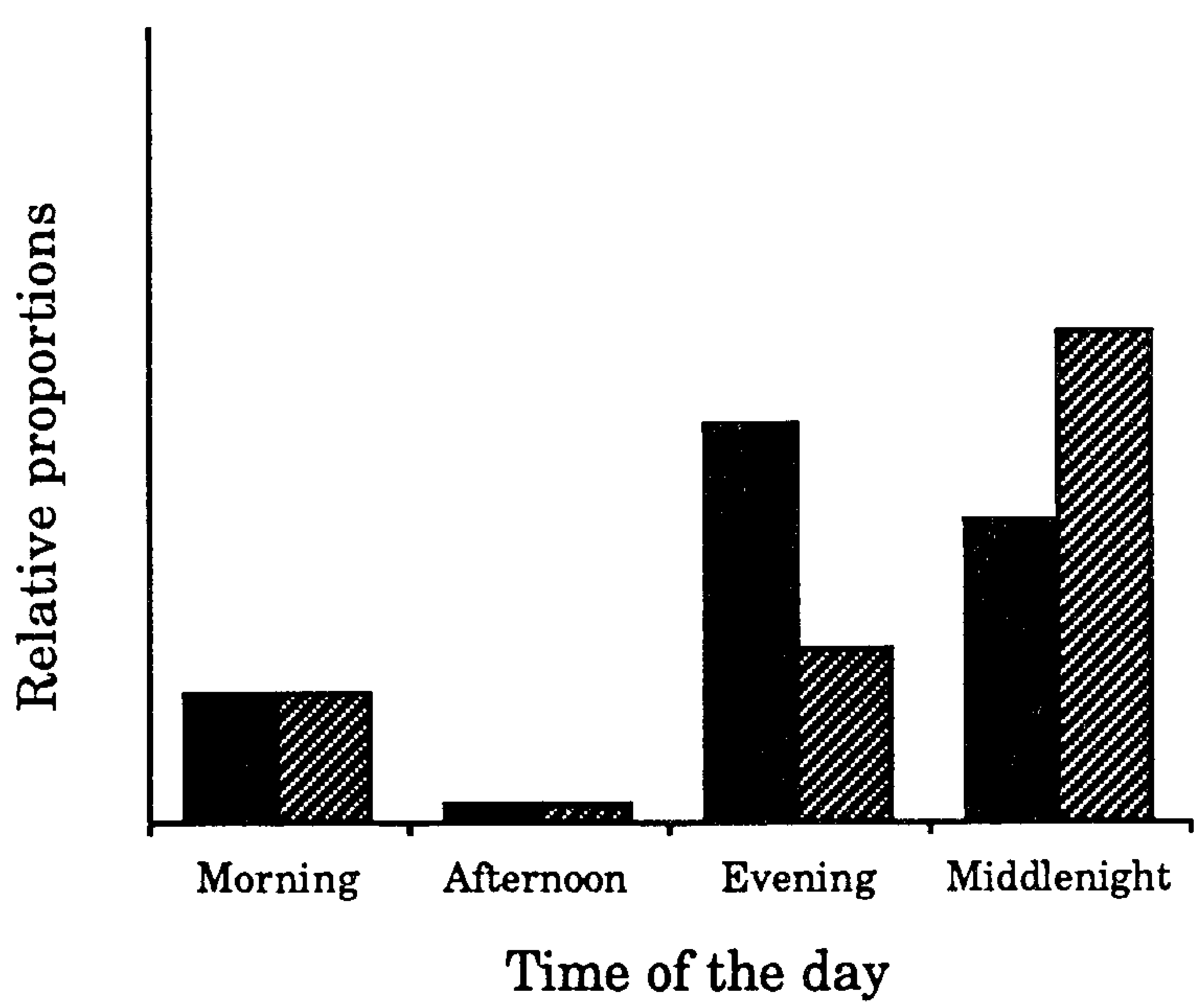

Fig. 2. The pattern of numbers of flowers opened (solid bar) and amount of nectar produced (hatched bar) by tropical *Eucalyptus* trees at different times of the day. Samples from 1348 flowers on 26 trees of 2 species were taken at 0800, 1400, 2000, and 0200 hours to correspond with morning, afternoon, evening, and middlenight.

Discussion

Manipulation of flower exposure to pollen from different sources demonstrates that the breeding system of two species of *Eucalyptus* in northern Australia primarily depend on outcrossed pollen for fertilisation and therefore on an agent for pollen transport. Although eucalypts are probably generalists in their pollinating relationships with animal visitors these results reinforce that dependence of tropical plants on agents for pollen transport.

This study has produced evidence that flying-foxes are agents for pollen transport in two species of *Eucalyptus* that are widespread and common in northern Australia. The evidence produced by this study is:

(1) the quantity and quality of pollen on the fur of flying-foxes;

(2) the lack of inhibitors either on the fur or in the flower to disrupt fertilisation of the ovule;

(3) the timing of presentation of floral foods, pollen and nectar; and

(4) the mode of presentation of floral foods.

Almost half of the species in the flower-diet of bats in Kakadu are *Eucalyptus* species and about two-thirds of all the species belong to the family Myrtaceae (McCoy, 1990). Flowers of species within the family Myrtaceae are similar form and fit the criteria for a bat-flower (McCoy, 1990). The ramifications from this study are that flying-foxes play a significant role in the maintenance of genetic diversity within a species, species diversity within the forests and the long-term survival of native forests because they feed on many flower species and they move more pollen further than other pollinators of the Australian flora.

We must therefore conserve the Australian flying-foxes in order to ensure the health and long-term survival of fragmented native forests for future generations of Australian people.

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