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Fruit Dispersal by the Lesser Dog-faced Fruit Bat, *Cynopterus brachyotis* (Muller) (Chiroptera: Pteropodidae)

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Abstract: The lesser dog-faced fruit bat, *Cynopterus brachyotis,* becomes active shortly after sunset and flies directly to fruiting trees. Individual bats make one to several flights around fruiting trees before removing fruits. Feeding roosts and day roosts are located 2–2000m from fruiting trees. Our observations of partially eaten fruit from different species of plants dropped beneath feeding and day roosts suggests that *C. brachyotis* eats several different types of fruits each night. During the principal fruiting season, *C. brachyotis* preferentially feeds in the forest rather than in nearby urban areas, indicating that this species has distinct food preferences when nearby, alternative food sources are available. These results also support the hypothesis that Old-World fruit bats, including *C. brachyotis,* are 'sequential specialists'. Tree species which bear fruit throughout the year, or have prolonged fruiting seasons, may be of major importance for the maintenance of stable populations of *C. brachyotis.* The tendency for *C. brachyotis* to consume fruits away from source trees, at both feeding and day roosts, has important consequences for seed dispersal.

INTRODUCTION

All members of the Pteropodidae are phytophagous, taking fruit, floral resources (nectar and pollen) and/or leaves (Marshall, 1983, 1985; Phua and Corlett, 1989; Kunz and Diaz, 1995, Tan *et al.,* 1998), with insects forming only a small proportion of their diet (Funakoshi *et al.,* 1993). Foraging areas used by free-ranging pteropodids, and the types of food they consume, are largely influenced by the seasonal flowering and fruiting phenologies of trees (Lim, 1966). Marshall (1983) postulated that phytophagous bats are neither true generalists nor specialists, but rather 'sequential specialists', favouring at any given time one or a few plant species amongst the group of potential food sources available.

The lesser dog-faced fruit bat (*Cynopterus brachyotis*) is a common plant-visiting bat in South-East Asia. Throughout its range, this species occupies a variety of habitats including primary rainforest, disturbed forest, mangrove swamps, cultivated areas, orchards, gardens and urban areas, and it is well adapted to anthropogenic conditions (Lim, 1966; Medway, 1983; Phua and Corlett, 1989; Francis, 1990, 1994; Zubaid, 1993, 1994; Tan *et al.,* 1997). Empirical evidence for bats as dispersal agents in the Old-World tropics is largely anecdotal (Phua and

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Corlett, 1989; Tidemann *et al.*, 1990; Rawlinson *et al.*, 1992; Whittaker and Jones, 1994; Whittaker and Turner, 1994). Here we report preliminary observations on the role of *C. brachyotis* as an important seed-disperser in a paleotropical forest. The data presented here were collected as part of a major study on the tent-making behaviour (Tan *et al.*, 1997) and food habits of this plant-visiting bat (Tan *et al.*, 1998).

METHODS

The study was conducted on the main campus of Universiti Kebangsaan Malaysia, Bangi, Selangor, West Malaysia (2°55'N, 101°45'E). A disturbed lowland dipterocarp forest, the Bangi Forest Reserve (approximately 100ha), is located within the campus boundaries and descriptions of the floristic composition of this forest are given in Latiff (1990).

Observations were made from January to December 1996. Information on the food habits of *C. brachyotis* was obtained by collecting fruit remnants dropped directly beneath feeding and day roosts. Day roosts were located in the modified fronds of ornamental palms planted in the vicinity of buildings on the university campus (Tan *et al.*, 1997). Collections of food samples and night-time observations of activity were made at least once each week. The availability of fruits was based on an assessment of presence or absence.

The locations of fruit trees in the forest were determined by recording the presence of uneaten or partially eaten fruits. The linear distance between fruiting trees and feeding or day roosts was estimated. All fruiting species were identified using reference collections in the UKM Herbarium and the Forest Research Institute of Malaysia (FRIM) at Kepong.

RESULTS

In the present study, *C. brachyotis* consumed all or parts of fruits from 38 plant species (Table 1). Fruits of two species, namely *Calophyllum inophyllum* and *Ficus fistulosa,* were available to bats throughout the year (Table 1). Other plant species that had a prolonged fruiting season, and on which bats also fed, included *Elaeocarpus stipularis, Eugenia grandis* and *Polyalthia longifolia.* Although fruits of the above-mentioned species were abundant on the UKM campus (ornamental trees), *C. brachyotis* preferred to feed on fruits available in the Bangi Forest Reserve during the peak fruiting season from July to September (Table 1). Most of the bats, in fact, depended on forest fruits during this peak fruiting period. Most of the fruiting trees in the Bangi Forest Reserve were about 20m in height, and included *Palaquium* spp., *Payena* spp., and *Pouteria malaccensis.* Ornamental palms in the campus provided an important alternative food source for *C. brachyotis* immediately before and after the primary fruiting season.

Cynopterus brachyotis first became active shortly after sunset, when individuals appeared in the vicinity of fruiting trees. Most bats made one to several flights around fruiting trees before removing a single fruit. Feeding roosts and day roosts were located 2–2000m from the fruiting trees. Bats were faithful to an

Table 1. Fruits consumed by *Cynopterus brachyotis*

Plant species	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Calophyllum inophyllum	campus	+	+	+	+	+	+	+	+	+	+	+	+
Ficus fistulosa	forest	+	+	+	+	+	+	+	+	+	+	+	+
Elaeocarpus stipularis	forest	+	+	+	+	+						+	+
Eugenia grandis	campus	+	+	+	+	+							+
Elaeocarpus sp.	forest	+	+	+									+
Eugenia sp. (2)	forest	+	+						+	+			
Eugenia aquea	campus			+	+	+	+			+	+	+	+
Polyalthia longifolia	campus			+	+	+	+	+	+	+			
Pellacalyx saccardianus	forest			+			+	+		+	+	+	+
Ficus roxburgii	campus			+	+		+			+			
Mimusops elengi	campus				+	+	+			+	+	+	+
Eugenia malaccensis	campus					+	+	+				+	+
Livistona rotundifolia	campus						+	+		+	+	+	
Nephelium malaccensis	campus						+	+	+				
Licuala grandis	campus						+	+			+	+	
Pternandra echinata	forest						+		+				
Ficus benjamina	campus						+	+		+			
Chrysalindocarpus lutescens	campus						+	+					
Livistona chinensis	campus						+	+					
Ptycosperma macarthurii	campus						+						
Roystonea regia	campus						+				+		
Eugenia jambos	campus							+	+	+			
Artocarpus maingayi	forest							+	+	+			
Palaquium obovatum	forest							+	+	+			
Payena maingayi	forest							+	+	+			
Pouteria malaccensis	forest							+	+	+			
Eugenia sp. (1)	forest							+	+				
Diospyros sp.	forest							+	+				
Palaquium gutta	forest							+	+				
Palaquium clarkeanum	forest							+	+				
Payena lucida	forest								+	+			
Madhuca selangorice	forest								+	+			
Ficus sp. (2)	forest								+	+			
Ficus sp. (3)	forest								+	+			
Eugenia sp. (3)	forest										+		
Unidentified seed (1)	forest												
Unidentified seed (2)	forest							+	+				
Unidentified seed (3)	forest							+					
Unidentified seed (4)	forest							+	+				

individual feeding roost as long as nearby fruiting trees remained productive. Sometimes, bats transported fruits to other nearby fruiting trees (different fruit species). After consuming one fruit, a bat would typically remove another fruit and transport it to a feeding or day roost. Our observations of partially eaten fruits beneath both feeding and day roosts on a given night suggest that *C. brachyotis* eats several different types of fruit each night. Soft fruits were either totally or partially eaten by the bats. It was common for some fruits to be dropped undamaged beneath feeding or day roosts. In the Bangi Forest Reserve, uneaten fruits with tooth marks, belonging to what we judged to be *C. brachyotis*, were commonly observed on the forest floor.

DISCUSSION

In the present study, *C. brachyotis* fed on the fruits of at least 38 plant species (Table 1). During the primary fruiting season, *C. brachyotis* preferentially fed on fruits in the forest rather than in nearby urban areas. This indicates that *C. brachyotis* shows distinct food (and habitat) preferences when alternative fruiting trees are available. These results support the hypothesis of Marshall (1983) that pteropodids, including *C. brachyotis*, are 'sequential specialists'. *Cynopterus brachyotis* apparently is able to assess the nightly availability of different types of fruits. Most of the fruits in the Bangi Forest Reserve which were eaten by bats were located in the forest canopy. This observation may explain why pteropodids are more often captured in the canopy of forests as compared to the understorey (Francis, 1990, 1994; Zubaid, 1994).

Consumption of fruits which are available throughout the year, or those with a prolonged fruiting season, may be an important factor in maintaining stable populations of *C. brachyotis*. The seasonal phenological differences among congeneric plant taxa (e.g., *Ficus* spp. and *Eugenia* spp.) has led to a steady production of fruit throughout the year. The present data indicates that *Ficus* spp. are important in the diet of *C. brachyotis*. Other studies have shown that pteropodids have a great predilection for *Ficus* spp. (Bhat, 1994; Funakoshi and Zubaid, 1997; Marshall, 1985; Phua and Corlett, 1989; Tan *et al.*, 1998). Similarly, many species of phyllostomids feed predominantly on fruits of *Ficus* spp. (Fleming and Heithaus, 1981; Handley *et al.*, 1991).

Phua and Corlett (1989) observed that fruits weighing up 20g (all fruits in the present study weighed less than 20g) were usually carried to feeding roosts up to 100m from a source tree. In a recent study conducted in a disturbed lowland rainforest at Ulu Gombak, Malaysia, Funakoshi and Zubaid (1997) found that *C. brachyotis* did not feed in the fruiting trees, but instead dispersed to feeding roosts. The average distance between *Ficus* trees and feeding roosts in the latter study was 50–78m (determined by radio-telemetry). The tendency for bats to consume fruits at feeding or day roosts has important consequences for seed dispersal.

By feeding on fruits that are carried away from a parent tree, *C. brachyotis* plays an important role in seed dispersal. Some pteropodids fly up to 50km each night to forage for food (Marshall, 1985; Whittaker and Jones, 1994). Because fruit-eating bats often defecate or drop seeds in flight, they can potentially disperse

seeds over a large area each night. Fleming and Heithaus (1981) reported a gut-retention time of 1h 20min in *Carollia perspicillata,* and Wolton *et al.* (1982) reported a retention time of 2h 20min for six species of pteropodids in Liberia. Apparently, many plant-visiting bats are able to ingest seeds without causing damage to them (Utzurrum and Heideman, 1991; Utzurrum, 1995), although a size-threshold for seeds dispersed by pteropodids is unknown. Charles-Dominique (1986) estimated that a frugivorous bat such as *Artibeus lituratus* is capable of dispersing 28,000 small seeds of *Cecropia obtusa* in a single night. Kunz (1996) suggested that one of the consequences of seed dispersal by bats is that the survival and growth of trees from such seeds may ultimately provide roost trees for other bats. In addition to dispersing seeds over a wide area, the concentration of seeds deposited beneath roosting sites may give rise to a clumped distribution of source trees. For example, Milton (1980) observed a clumped distribution of food resources within the home range of the mantled howler monkey (*Alouatta palliata*) and suggested that this may be due to the concentration of seeds deposited beneath sleeping sites followed by the subsequent maturity of the tree and production of fruit.

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