

Daily ranging behaviour of three tropical forest frugivores

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Data are presented on the daily ranging behaviour of six frugivorous birds of three species in a Malaysian lowland rain forest. Radiotelemetry showed that Green Broadbills *Calypptomena viridis* and a Yellow-crowned Barbet *Megalaima henricii* spent prolonged periods at fruiting *Ficus*. A Black-and-white Bulbul *Pycnonotus melanoleucos* preferred other fruit sources. Green Broadbills ranged over 2.5-6.0 ha per day, and c. 13-24 ha per week. In contrast, a Black-and-white Bulbul ranged over 8-18 ha per day, and c. 50 ha in a week.

Whilst ringing studies and observations of apparent changes in the abundance of certain species have enabled ornithologists to make some tentative generalisations about the movements of forest birds in South-East Asia and Sundaland, remarkably little is known about the daily ranging of forest species. Only two studies have addressed the problem of ascertaining home-range sizes, and both have focused on large non-passerines as their subjects (Davison 1981, Leighton 1982). No previous studies have investigated the daily movements of smaller or medium-sized arboreal species in the region, even though a knowledge of this aspect of bird behaviour is fundamental to an understanding of the resource use, population dynamics and future conservation of forest bird species.

Ringing studies have suggested that the ranging of non-migratory forest birds in Sundaland is strongly influenced by diet. Insectivorous species, and many species with mixed diets, appear to be largely sedentary, utilising relatively small patches of forest (Fogden 1970, Medway and Wells 1976, Wong 1986), although it is possible that such species range over larger areas if they join mixed bird flocks. In contrast, nectarivorous, granivorous and frugivorous species are generally more wide-ranging, or even nomadic (Fogden 1972, Medway and Wells 1976, Leighton and Leighton 1983).

This paper documents the daily ranging behaviour of six individual frugivorous birds, of three species. Although the data presented relate to only a few days of bird activity, information of this kind has not hitherto been obtained for similar tropical forest frugivores in the Indomalayan Region.

STUDY AREA AND METHODS

The study area, Kuala Lompat (3°43'N 102°17'E), lies at the south-eastern periphery of the Krau Game Reserve, Peninsular Malaysia, at the confluence of the rivers Krau and Lompat. The area is relatively flat, mostly at elevations of 50-80 m, although further west the terrain becomes more hilly

as it rises towards Mount Benom. Whilst most of the vegetation within the Game Reserve is climax forest, the Kuala Lompat area exhibits signs of limited disturbance. The vegetation has been described as Lowland Evergreen Dipterocarp Forest, although it is relatively poor in dipterocarps and unusually rich in large leguminous trees. Further descriptions of the study area can be found in Raemaekers *et al.* (1980) and Lambert (1987). The avifauna of the site is described in Medway and Wells (1971).

Radiotelemetry was used to document the ranging behaviour of suitable captured frugivorous birds. Birds were tracked by approaching them as close as possible, rather than using triangulation, although the latter technique was used on a few occasions when birds entered unknown areas. Although transmitter signals often bounced off vegetation, giving false directional information, it was possible to assess the correct direction of the signal by taking readings from different positions. Once in close proximity to the bird, distances could be assessed by movements of the signal needle and the noise emitted from the radio-receiver. At bias settings of four or lower, movements of the needle could only be detected at distances of less than 15 m, whilst the receiver noise became distinctly disyllabic (with a 'whiplash'-like second note) only when within c. 25 m, or when directly below the bird when in the upper strata of the forest.

It was found that approaching close to a bird's perceived position usually resulted in it moving. Birds were therefore not approached too closely, in order to reduce observer-induced bias to ranging data, and consequently were infrequently seen. Nevertheless, when a bird remained in a small area for a long time it was often possible to identify the fruiting tree that it was using, and subsequently observe it. Details of equipment used are given in the Appendix.

The data were collected during a three-year study of fig-eating by birds (which began in March 1984), and the study site was well known to the author before radiotelemetry began.

RESULTS

Between June 1985 and August 1986 at Kuala Lompat, a total of nine frugivorous birds of four species were trapped and tagged with radio-transmitters. Daily ranging data were obtained for the following three species: one Yellow-crowned Barbet *Megalaima henricii* (weight 55 g), one Black-and-white Bulbul *Pycnonotus melanoleucos* (31 g), and four Green Broadbills *Calypomena viridis* (mean weight 62 g). No daily ranging data were obtained for two other Green Broadbills, or a Brown Barbet *Calorhamphus fuliginosus*, which lost their transmitters soon after tagging.

Results from successful following of birds are summarised below by species, and accompanied by ranging maps (Figures 1 and 2). Observation time is defined in transmitter-minutes; this is the actual length of time during which data were collected and does not include intervening periods.

Ranging areas given refer to the area enclosed by a line joining the peripheral points of the area used by the birds. Detailed daily ranging maps can be found in Lambert (1987).

Yellow-crowned Barbet

A Yellow-crowned Barbet was caught at a fruiting *Ficus pellucido-punctata* strangler on 2 June 1985, at c. 15h00. The bird was released the following morning, at 08h15, below the same fruiting tree. Data were obtained for 1,380 transmitter-minutes during four days, but, for unknown reasons, signals from the transmitter terminated on the fourth morning.

During the diurnal period of data collection the barbet spent at least 71% (and possibly as much as 85%) of its time feeding at or in close proximity to a single fruit source, a *Ficus binnendykii* tree. The roost-site of the tagged bird, c. 700 m from the fruiting tree, was used on both nights during which data were collected. Apart from moving between roost-site and the fruiting *Ficus*, little other ranging was observed, so that the total area of forest used during the four days was only in the order of 7.6 ha. The roost-site was situated somewhere in the crown of a 40 m emergent tree.

Brown Barbet

On 9 February 1986 a Brown Barbet was caught and subsequently released at a fruiting *Ficus pellucido-punctata* tree. However, the transmitter was recovered the following day under a fruiting *Ficus binnendykii* tree some 400 m from the point of release. The bird was active in or near the fruiting tree for an hour prior to finding the transmitter, and suspected of feeding on the ripe figs.

Subsequently, on 14 February, the same Brown Barbet was identified (it had been colour-marked for later identification when initially caught) feeding in a second *F. binnendykii* tree with a group of five other Brown Barbets. This tree was c. 400 m from the point of capture and c. 750 m from the first *F. binnendykii*.

Black-and-white Bulbul

A female Black-and-white Bulbul was caught when it came to drink at a forest pond in the late afternoon of 22 August 1986. The bird was released at dusk, and flew to a nearby hanging vine stem about 4 m above the ground. It roosted on this vine during the first night. Subsequently, data were collected on the ranging of this bird for seven days, but on 29 August the signal from the transmitter was lost, almost certainly as a result of battery exhaustion in view of the small size of battery used (B. Cresswell pers. comm.).

During a total diurnal period of 2,220 transmitter-minutes radiotracking, the female Black-and-white Bulbul spent most of its time with at least one conspecific, and on occasions possibly as many as five. Both primary and secondary forest were used. Some 840 minutes, representing 38% of total observation time, were spent in secondary forest during the first two days.

Although it is difficult to estimate the exact area of forest utilised, lines drawn around the known daily ranges for all seven days enclose an area of approximately 50 ha. The maximum distance between areas visited was 1,800 m. Daily ranges varied between 8 ha and 18 ha.

As far as could be ascertained, different roost-sites were used each night. Similarly, daily ranging did not indicate any close affinity with any particular patch of forest, although three conspecific (unidentified) fruiting vines, situated within 50 m of each other, were important sources of fruit on four of the first five days. During these four days, 878 minutes, representing 39.5% of total observation time (of the whole seven-day period), were spent in close

Figure 1. Kuala Lumpur study area, showing location of ranging maps given in Figure 2. The six ranging areas defined are for birds as follows; ♂B, ♀A, ♀B, ♀C, – Green Broadbills; YB – Yellow-crowned Barbet; BW – Black-and-white Bulbul.

All areas are primary forest unless stated otherwise; hatched areas are man-made clearings, stippled areas are secondary forest (with some plantation areas to the east of R. Krau), swamp shading within primary forest indicates areas which are periodically flooded.

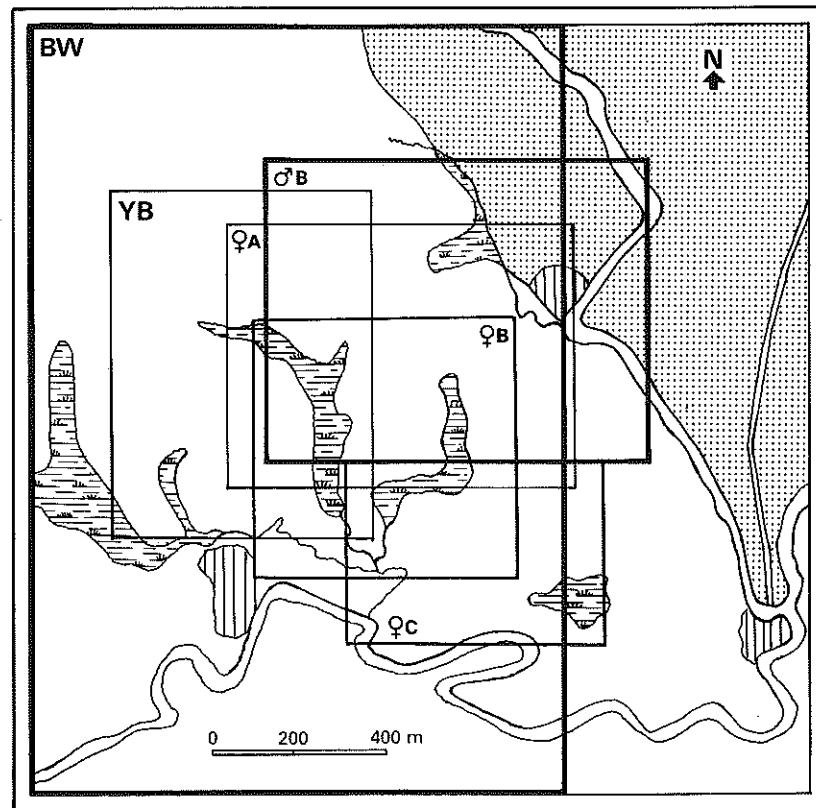
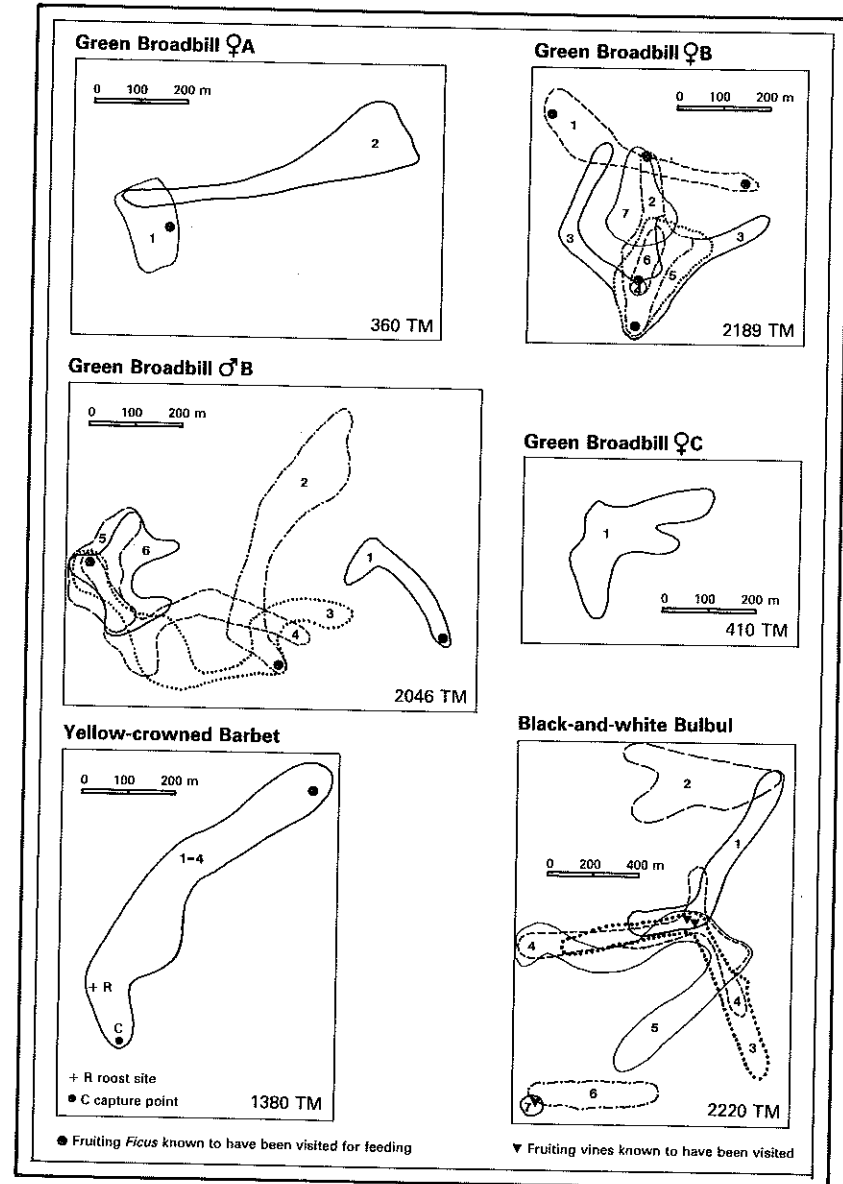


Figure 2. Summary of daily ranges of six individual forest frugivores. Numbers indicate successive days. See Figure 1 for location of the rectangle within the study site. Since birds were not necessarily followed for whole days, areas defined are minimum daily ranges. The total number of transmitter-minutes (TM), during which each bird was followed, is indicated.



proximity to these vines. Fruiting individuals of the same species of vine were also found in the vicinity where the bird spent the last two days, and it seems likely that the bird again fed on these fruits. When initially caught the bird defaecated seeds identical to those of the vine. The ripe red fruit of this vine were roughly spherical drupes, about 5 mm in diameter.

Green Broadbill

Sixteen bird-days' ranging data were obtained from following three female and one male Green Broadbills. Female A, Female B and Male A were captured at the same fruiting *Ficus obscura* tree on 23 March 1986, so that there is temporal overlap for some of the data. However, no ranging data were obtained for Male A, other than the final recovery position of the transmitter. Male B was caught at a fruiting *Ficus parietalis* tree on 20 April 1986 and followed for six days. A female (Female C), caught at the same tree a day earlier, lost its transmitter soon after release. A fourth female (Female D) was captured at a forest pond on 30 July 1986, but only followed for one day, after which the detached transmitter was found.

Female A During the first morning of data collection, 24 March 1986, Female A remained within 150 m of the point of capture, with the most distant points only 200 m apart. Just before dusk the bird was either in or very close to a fruiting *Ficus stupenda* tree at which it may have been feeding. The roost-site used on both day 1 and day 2 was within a swampy area of forest, where the bird appeared to be in the subcanopy of a small tree c. 10 m above the ground. At least one other Green Broadbill was at the roost-site just before dusk. During mid- and late afternoon of day 2 the bird was located 400–500 m east of the area known to have been used on day 1, within an area of secondary forest bordering primary forest. The bird remained in the secondary forest for at least 90 minutes.

Whilst the area of forest used on the first day may have been as little as 1.8 ha, data were collected during only three hours. On the afternoon of the second day, the bird had moved about 600 m from the roost and must therefore have ranged over 3.5 ha of the forest. In total, a minimum of 5 ha of forest were used during six hours of observation during two days.

Female B The ranging of Female B was monitored for 2,189 transmitter-minutes during a seven-day period. During this time an area of 13 ha of forest was used, with daily ranges of up to 5 ha.

At least five different *Ficus* trees were visited during the seven-day period; two (*F. sundaica* and *F. bracteata*) on the first day, a different *F. sundaica* on the second day, a *F. obscura* on the four subsequent days, and another *F. obscura* on the last day. In total 960 minutes were spent in or close to fruiting *Ficus* trees during five days (days 2–6), representing c. 50% of total observation time for those days. One of the fruiting *F. obscura* trees was evidently an important source of fruit since 62.4% of total time, during the

four days that it was used, were spent at or very near to this tree.

Female B roosted within the same swampy area on three successive nights. It was not established that the roost-site was shared, but Male A's transmitter was found within 10 m of the site.

Female C During 410 transmitter-minutes on the day after release, Female C used 6 ha of primary forest, some 250 m from the release point.

Male B Male B was followed for 2,046 transmitter-minutes during a six-day period. Daily ranges varied from a minimum of 2.5 ha to 4.5 ha (these are minimum values since the bird was not followed continuously), with a total ranging area of c. 24 ha during the whole period of data collection.

Two *Ficus* trees were visited during the period; a fruiting *F. benjamina* on day 2 and day 3, and a fruiting *F. pellucido-punctata* on days 3–6. The total time spent in or in close proximity to fruiting *Ficus* was 587 minutes, representing 30.7% of total observation time for the five days when these trees were visited.

DISCUSSION

Comparative ranging behaviour

Green Broadbills ranged over areas in the order of 2.5 ha to 6 ha per day. In contrast daily ranging areas of the Black-and-white Bulbul varied from 8 ha to 18 ha per day. Similarly, longer-term ranging was substantially different for these two species: Green Broadbills covered areas of 13 ha in seven days (Female B) and 24 ha in six days (Male B), compared to c. 50 ha in 6.5 days for the Black-and-white Bulbul.

Unfortunately, there are no comparative data on ranging behaviour of individual arboreal frugivores from South-East Asia, with the exception of hornbills. Leighton (1982) determined the home ranges of four hornbill species (Bucerotidae) in East Kalimantan, Borneo, by following habituated and individually recognisable groups and individuals. These large arboreal frugivores, weighing between 900 and 3,100 g (Kemp 1979), had home ranges of 120–770 ha. Davison (1981) radiotagged two male Great Argus Pheasants *Argusianus argus*, which ranged over no more than 6.2 ha per month, and usual monthly ranging was possibly only half this area. However, comparisons between this large terrestrial omnivorous non-passerine and small arboreal frugivorous species are not very enlightening.

Limited observations of marked birds, and ringing studies, provide the only information on ranging behaviour of passerine species in Sundaic forests. Observations of bulbuls in Sarawak have suggested that Black-headed Bulbuls *Pycnonotus atriceps* gather at roosts from at least three miles, and several individuals were retrapped at points enclosing areas of 12.9–20.7 km² (Fogden 1970). In contrast *Crimiger* bulbuls and Puff-backed

Bulbuls *Pycnonotus eutilotus* were repeatedly trapped in areas of about 4 ha or less during a two-year period. In Gunung Mulu National Park, Sarawak, ringing studies have shown that the largely nectarivorous Little Spiderhunter *Arachnothera longirostra* is highly mobile (Wells *et al.* 1978). Two trapped individuals were retrapped 490 m up the mountain eight and nine days later.

These observations and ringing studies have suggested that at least some frugivorous and nectarivorous species in Malaysian forests are nomadic, or at least patrol very large areas of forest. The Black-and-white Bulbul is one of the species which is suspected to be nomadic, as indicated by their sporadic appearances in patches of well-watched forest (Medway and Wells 1976). Black-and-white Bulbuls were observed in only five of 21 months' fieldwork at Kuala Lompat (Lambert 1987). The ranging of the Black-and-white Bulbul tagged in this study provides some evidence to support the notion that this species is nomadic. Not only did the individual that was tagged range over a much larger area of forest than the other species tagged, but it roosted at different sites every night. The ability to utilise different roost-sites on a daily basis is presumably a fundamental prerequisite for a nomadic species.

The importance of Ficus as a fruit resource

The limited data suggest that for all three species ranging is to a large extent determined by the availability of fruiting trees. All the birds followed for more than two days were found to spend prolonged periods at or within 30 m of fruiting trees, and to visit the same trees for several days. Whilst the Black-and-white Bulbul concentrated its feeding at five unidentified fruiting vines of a single species at two sites, the Yellow-crowned Barbet and Green Broadbills spent substantial periods of time at fruiting *Ficus*. Apart from brief consecutive visits to an unidentified fruiting tree made by Male B during 80 minutes on day 1, Green Broadbills and the Yellow-crowned Barbet were not seen to visit fruit sources other than *Ficus* during the period of data collection. Black-and-white Bulbuls are also known to feed occasionally on figs, but apparently prefer other fruits. Only one *Ficus* species was seen to be used by the Black-and-white Bulbul during this study (Lambert 1987).

The importance of *Ficus* to frugivorous bird assemblages in South-East Asia and Sundaland is well documented (McClure 1966, Wells 1975, 1982, Brockelman 1982, Leighton and Leighton 1983, Lambert 1987, in press), but no previous studies have documented fidelity to individual fruiting *Ficus* by individual birds.

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APPENDIX

RADIOTELEMETRY EQUIPMENT AND METHODOLOGY USED IN THIS STUDY

Data were collected using an AVM LA12 Receiver, with a Yagi antenna, and 'AVM' and 'Biotrack' transmitters. Zinc-air A13 cells were attached to all transmitters used except in the case of Black-and-white Bulbul which used a RM212 Mercury cell. Transmitters were attached to birds using one of two methods: tail mounting, or back mounting. For tail mounting the transmitter was glued to a special clip fastened over the central four tail-feathers (Bray and Corner 1972). This clip consisted of two thin pieces of plastic, c. 12 × 3 mm, held together by two fine

screws. After the clip had been screwed tightly to the tail, the screws were cut near the tightening nut and Superglue used to prevent the nut loosening. Superglue was also used to prevent the clip from slipping off the tail. Back mounts were composed of the transmitter with battery, attached to a small piece of cloth gauze. This package was glued to the bases of back-feathers. Superglue was utilised in both mounting techniques, whilst epoxy-resin (Rapid Araldite) was used to cover, and therefore waterproof, the whole tag.

Dusting by a Green Cochoa *Cochoa viridis*

JOSEP DEL HOYO and ENRIC CARRERA

At around 10h00 on 7 August 1986, about a kilometre beyond the checkpoint at km38 on the road to Mae Chaem in Doi Inthanon National Park, Thailand, we observed a male Green Cochoa *Cochoa viridis* dusting. It used a metre-wide strip of bare earth between the tarmac and the vegetation, at a point where montane forest practically abutted the road. During the two minutes or so that we had the bird in view, we were able to approach it to within 10m; its actions were similar to those of a sparrow *Passer* when dusting. When it finally flew up, it joined another Green Cochoa whose sex we could not determine, and together they moved fairly low through the trees near the road until lost to sight.

This took place on the third day of our visit to Doi Inthanon, throughout which it was consistently very cloudy with intermittent, usually very light rain. The dusting took place in a dry spell, but it started drizzling fifteen minutes later; indeed, only some 300m further along the road to Mae Chaem, we encountered very dense fog.

We can find no reference to dusting by this species, and P. D. Round, whom we told of our observation, knew of no similar record in Thailand, where probably the majority of sightings of Green Cochoa are currently made.

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A Short-billed Minivet *Pericrocotus brevirostris* nest in Nepal

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On the morning of 27 April 1986, I briefly watched a pair of Short-billed Minivets *Pericrocotus brevirostris* building a nest in an area of forest just above Hanga Than (c. 27°05'N 87°54'E), at about 2,140m, in the upper Mai valley in eastern Nepal.

The nest structure was built on a flat fork, about half-way along a large moss- and lichen-covered branch at a height of about 10m in a large tree,