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A PRELIMINARY RADIO-TRACKING STUDY OF THE RANGING BEHAVIOUR OF OLIVE-WINGED BULBUL (*PYCNONOTUS PLUMOSUS*) AND CREAM-VENTED BULBUL (*P. SIMPLEX*) IN A LOWLAND SECONDARY RAINFOREST IN SINGAPORE

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ABSTRACT. - Olive-winged bulbul (*Pycnonotus plumosus*) and cream-vented bulbul (*P. simplex*) were found to be sedentary non-territorial species with home range sizes of 0.29-7.23 ha during the breeding season. Range sizes were not significantly different between species. Indices of available food sources (or food plants) within the home ranges of both species were also not significantly different. More studies need to be done with larger samples over longer periods and with birds of different ages, sex and breeding status to better understand the factors influencing home range size in these two species. Ranging studies are important as they help determine conservation measures to be taken in the light of shrinking native habitats in South-East Asia.

KEY WORDS. - Olive-winged Bulbul, *Pycnonotus plumosus*, Cream-vented Bulbul, *P. simplex*, ranging behaviour, lowland secondary rainforest.

INTRODUCTION

The ranging behaviour of tropical rainforest birds has been little studied. Whilst ringing studies provide clues on whether birds are sedentary or nomadic (Lambert, 1989), they are by no means conclusive. One method to obtain accurate home range data on a species is to radio-track it. This enables certain individuals of the species to be followed continuously over a period of days.

Home ranging studies in South-East Asia have been limited to four species: the great argus pheasant *Argusianus argus* (Davison, 1981) and a few individuals of green broadbill *Calyptomena viridis*, yellow-crowned barbet *Megalaima henricii* and black-and-white bulbul *Pycnonotus melanoleucos* (Lambert, 1989). It is important to investigate this aspect of bird behaviour as it contributes to an understanding of resource use and minimum area requirements and helps in the conservation of forest species.

We conducted preliminary radio-tracking studies on olive-winged bulbul, *Pycnonotus plumosus*, and cream-vented bulbul, *P. simplex*, to ascertain their ranging behaviour and to estimate their range sizes. Indices of food availability based on food plant coverage within the range of the two species were also measured. Although sample sizes were small and birds were tracked for a short period of time only, the data are the first of their kind for these common forest species.

MATERIALS AND METHODS

Study subjects. - Both olive-winged bulbul and cream-vented bulbul are found in the Malay Peninsula and Greater Sundas. Olive-winged bulbuls are found at the forest edge, plantations and lightly wooded areas, and cream-vented bulbuls in the primary forest, secondary growth and deserted clearings (King et al., 1975; Hails & Jarvis, 1987). Both species are thought to have a mixed diet of fruits and insects (Kang & Hails, 1995). Our study was carried out during their breeding season which peaks between March and June (Hails & Jarvis, 1987).

Study area. - The study was conducted at Nee Soon (1°24'N 103°48'E), which is part of the 1622 ha city

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water catchment area situated in the centre of Singapore island (Briffett, 1990). The 15 ha study plot and its surroundings were mainly disclimax secondary forest, *adinandra belukar* (see Sim et al., 1992 for a full description). Forested areas were interrupted by large pure stands of *resam (Dicranopteris linearis)* where the soil was depleted of nutrients. The daily average temperature was 26.6°C and the mean relative humidity was about 85% (Singapore Meteorological Service).

Bird capture. - All birds were captured at the same site using mist nets (12 m x 2.5 m, mesh size 30 mm). Three olive-winged bulbuls and one cream-vented bulbul were captured on 11 May 1998 and another three olive-winged bulbuls and two cream-vented bulbuls were captured on 27 May 1998. Their age, sex and breeding status were noted. Age of the birds was determined by the amount of skull pneumatization. Unpneumatised areas were pinkish in colour and such birds were considered to be juveniles and less than two years of age. Adults had pneumatised skulls which were whitish in colour. Sex was determined by the presence and absence of the cloacal protuberance. Cloacal protuberance is evident in males during the breeding season (Ralph et al., 1993). Brood patches present in females were also identified. All the birds were in good condition with no sign of injury or disease.

Radio-tagging. - The tail mounting technique was used to attach radio-transmitters to the birds (see Appendix for details). All the birds weighed more than 21 g and the transmitters weighed 1 g each. This was less than five percent of the body mass of the bird as recommended by Kenward (1987). The transmitters were purchased from Holohil Systems Ltd. (Ontario, Canada), model BD-2A. The portable telemetry receiver used was from AVM Instrument Company Ltd. (California, USA), model LA12-DS.

Radio-tracking and range analysis. - The radio-tracking techniques used involved following individual birds on foot using a hand-held, foldable, three element Yagi antenna. Birds were tracked for at least 1.5 h between 0700-1100 hours or 1400-1800 hours per day for ten days after capture. As bird activity peaks in the morning (Hails & Jarvis, 1987), birds were tracked more often in the mornings than in the afternoons. All individuals were tracked for a total of six days in the morning and four days in the afternoon. Fixes were taken every five minutes. Due to the active movements of the birds, it was assumed that fixes were independent of each other. This resulted in 18 fixes per 1.5 h session or at least 180 fixes (15 radio-tracking hours) per bird after ten days. Birds could be detected up to a range of 250 m and were approached till they were not more than 50 m away to improve the accuracy of the fixes. Most times, birds were kept at a distance of 20 m to reduce observer induced bias to ranging data. The effects of tag distance on the signal strength were investigated before the study so that distances could be estimated by the strength of the beeping tone emitted by the receiver. A signal could be detected without the aid of the antenna if the distance was less than 10 m.

For every radio-tracking day, the positions for each bird were plotted on the field map of Nee Soon. Determination of range size was based on the minimum convex polygon (MCP) (Mohr, 1947). Isolated points that did not have any fixes within a 50 m radius were discarded to prevent an artificial inflation of range size. Only one point was discarded out of the entire data set. The resulting area was then determined by an area meter.

Available food plant sampling. - Five sites within each range were chosen randomly from the map. The number of fruiting plants was counted and the percentage of *D. linearis* cover estimated within a 5 m radius of the site. *D. linearis* was chosen as it is thought to be a potential source of insects for both species of birds (Peh, personal observations).

Data analyses. - Data analyses were carried out using the statistical analysis programme StatView SE + Graphics following standard techniques (Siegel & Castellan 1988). Statistical differences for all tests was set at $\alpha = 0.05$. Standard error (SE) follows all mean values in the text and tables.

Graphs of cumulative observed size of the range of bulbuls against the number of days were plotted to obtain 'area curves' which could be used to determine if home ranges reached saturation sizes. Mann-Whitney *U*-test was used to determine if the two species had different range sizes or differences in the density of the fruiting plants and the amount of *D. linearis* within their range.

RESULTS

Area curves. - Figs. 1a and 1b show the cumulative plots of average range size for olive-winged bulbul and cream-vented bulbul against the number of radio-tracking days. They are based on MCP estimates and produced smooth asymptotes. Graphs started to level off by day five for both species. It is assumed that all ranges reached saturation for the period of study. Day ten for cream-vented bulbul was not taken into account as the sudden increase was due to one bulbul (no. 789) making a brief excursion out of its usual range. However, it is also possible that the range of cream-vented bulbul no. 789 was underestimated in this study.

Range size. - The mean range size estimates for olive-winged bulbul and cream-vented bulbul were 2.17±0.86 ha and 3.53±5.33 ha, respectively (Table 1). The difference in the range size between the two species was not statistically significant (U = 13, df = 3, 6, P = 0.30). The ranges of all individuals overlapped approximately less than 50%, except olive-winged bulbul no. 709 and 699, and cream-vented bulbul no. 729 which had ranges that fully overlapped with other birds (Fig. 2).

Table 1. Range sizes of individual olive-winged bulbuls and cream-vented bulbuls calculated by the minimum convex polygon using all the fixes observed in ten days of radio tracking for each animal. Mature is an individual more than two years of age while a juvenile is less than two years old. * denotes the presence of brood patch.

Species	Animal no.	Sexual status	Minimum convex polygon (ha)
Olive-winged bulbul	709	Mature male	0.29
	647	Mature male	5.58
	699	Mature male	0.79
	689	Mature female*	3.77
	946	Mature female	0.61
	964	Juvenile female	1.95
			Mean ± SE: 2.17 ± 0.86
Cream-vented bulbul	729	Mature female	1.24
	749	Mature female*	2.12
	789	Juvenile male	7.23
			Mean ± SE: 3.53 ± 5.33

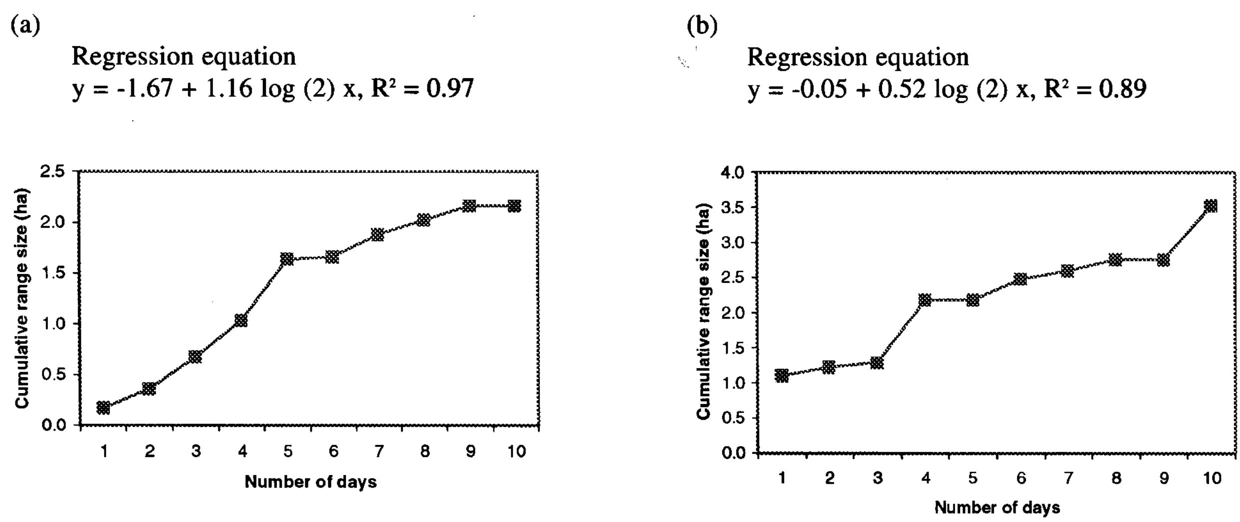
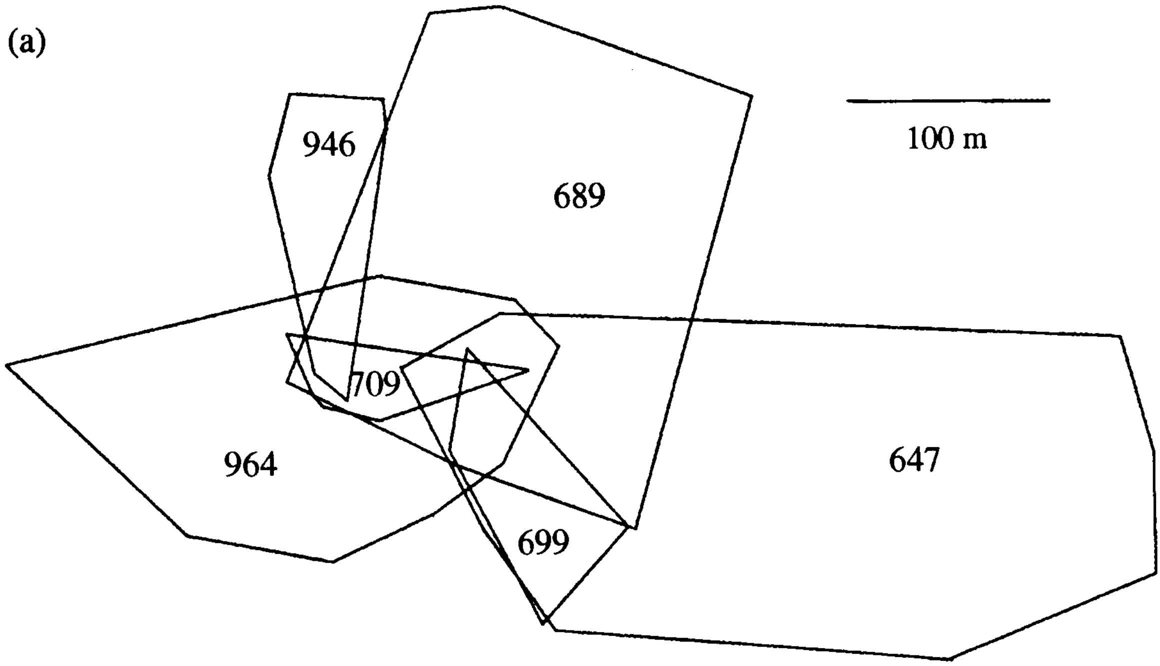


Fig 1. Cumulative mean range sizes of six olive-winged bulbuls (a) and three cream-vented bulbuls (b).



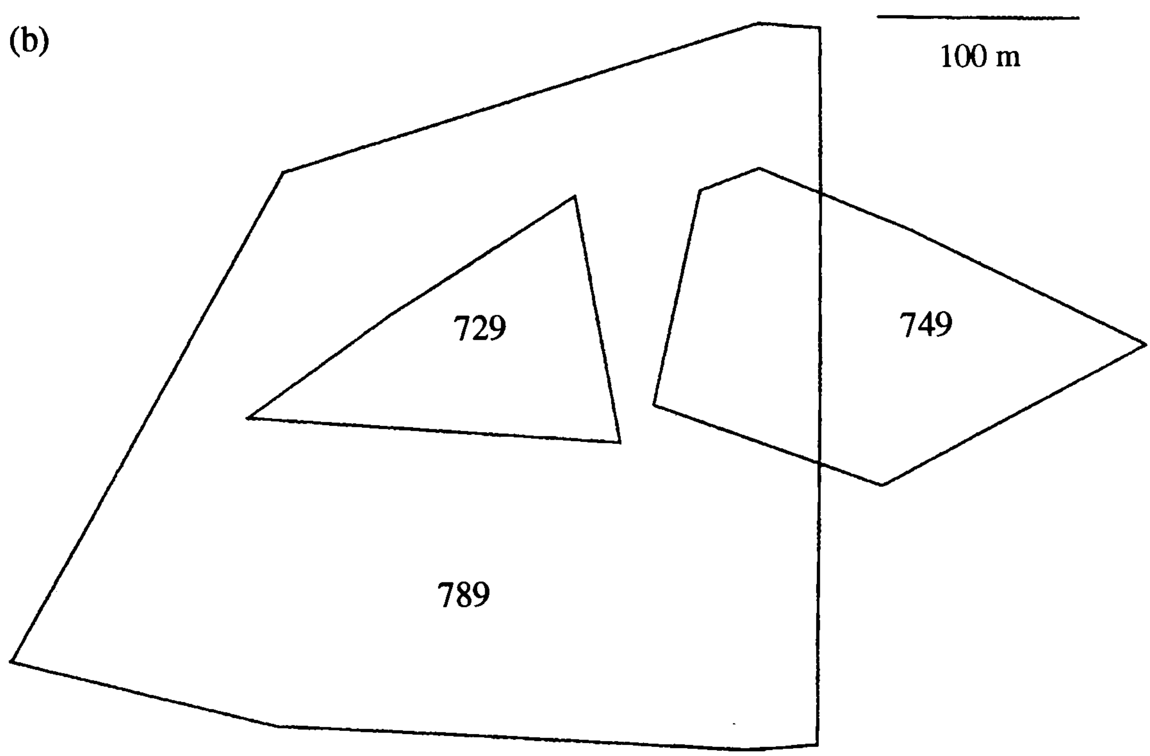


Fig 2. The polygons indicate the range sizes of six olive-winged bulbuls (a) and three cream-vented bulbuls (b) after ten days of radio-tracking.

Available food plant coverage. - The most common fruiting tree was *Adinandra dumosa*. The mean density of all fruiting trees within the range of olive-winged bulbuls ranged was 0.026 ± 0.005 plants per m^2, while that for cream-vented bulbul was 0.031 ± 0.014 plants per m^2. There was no significant difference in the density of the fruiting trees within the range of the two species ($U = 11$, df = 3, 6, $P = 0.60$).

The percentage cover of *D. linearis* within the range of olive-winged bulbul varied from 25 to 61% with a mean of 43.7 ± 7.1% and that of the cream-vented bulbul ranged from 45 to 96% with a mean of 67.3 ± 15.1%. No significant difference was found between the two species in the percentage of *D. linearis* cover within their ranges ($U = 14.5$, df = 3, 6, $P = 0.15$).

DISCUSSION

There were no apparent differences in range size between olive-winged bulbul and cream-vented bulbul. Indices of food availability within the range of both species were also insignificantly different. However, these could be due to small sample sizes and the large variance in the data set. The small range sizes of olive-winged bulbul and cream-vented bulbul show that the individuals were sedentary during the ten day study period. This is expected of birds with a mixed diet because they are not obligate to travel in search for a particular food sources(Wong, 1986). Other bulbuls suspected to be sedentary are puff-backed bulbul *Pycnonotus eutilotus* (Lambert, 1989) and yellow-bellied bulbul *Criniger phaeocephalus* (Navjot S. Sodhi, unpublished data). These birds were both trapped repeatedly in Sarawak in areas of less than 4 ha. In contrast, black-and-white bulbul is thought to be nomadic (Medway & Wells, 1976; Lambert, 1989), the one individual having a known range of 50 ha during seven days in the non-breeding season. They presumably follow the pattern of their preferred fruit production (Lambert, 1989).

Olive-winged bulbul and cream-vented bulbul exhibit a large degree of space sharing as seen from the overlap of their ranges. Hence, they do not seem to defend feeding territories. Some smaller ranges of individual birds were totally enclosed within larger ones (Fig. 2). This may imply that there was a high concentration of food in such range (e.g. no. 709) where all overlapped. Though it may suggest that there is no food territoriality, breeders may possibly have nest territories which are away from this "epicentre".

For both species, mature females with brood patches apparently had ranges larger than non-breeding females (see Table 1). Females are known to increase their food intake when in breeding condition and are also involved in feeding nestlings or fledglings. Both factors will increase the foraging distances and hence range sizes of the females. Indeed, breeding female no. 749 was observed to be flying back and forth between a few fixed points for several radio-tracking days. This may be indicative of foraging for nestlings or fledglings. Males, on the other hand, may have small ranges when guarding nest sites (e.g., Hanski et al., 1992) or larger ones while pursuing fertile females. This may account for the variation in range sizes of the males. Unfortunately, due to the dense vegetation cover, birds were seldom visually located for any length of time and no confirmation of the above suggestions could be obtained.

Clearly, further study is required with larger samples of juveniles and adults of both sexes to better account for intraspecific and interspecific variations. Fruit-eating birds may spend several days at one or two good food patches then move to another, which will increase their range size over time. However such study may be difficult to achieve as current small transmitters (less than 1 g) have a short tag life. Comparisons also need to be done between the breeding and non-breeding seasons. It is important to understand the area requirements of rainforest birds and the factors that influence these requirements as it will enable conservationists to set aside large enough areas of suitable rainforest for the continued survival of these species.

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APPENDIX

Tail mounting techniques. - Each bird was transferred back to the cloth bag with only the tail protruding out of the bag to facilitate handling. The rump feathers were cut off to prevent interference with the attachment of the radio-transmitter on the feathers at the base of the tail. Tail feathers were fanned out and a strand of seide silk was sewn through the shaft of the central tail feather using a suture needle. The radio-transmitter was smeared lightly with the super-glue and pressed firmly onto that shaft for ten seconds. Next, the two ends of the strand of seide silk were tied together and the knots were dabbed with a drop of super-glue to prevent their coming undone. The antenna ran horizontally along the length of the feather tail and was further secured by tying it to the rachis of the feather with the seide silk and then smeared lightly again with the super-glue. The procedure of attaching the transmitter onto the birds took an average of five minutes and the birds were then released at their site of capture.