

the literature^{2,10,20}. Further, in a few of these species, the estimates are comparable to those reported for star anise² (2.4–7%). However, one of the most significant advantages of the newly identified Indian sources is that the estimates are from leaves and not fruits as is the case with star anise. Quite obviously, extraction from leaves will be preferred over that from fruits; moreover, the sheer volume of the biomass offered by the leaves would render it economically feasible. In other words, the finding of the new sources of shikimic acid can potentially be used to meet the emerging needs of both the domestic and the international market.

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Anti-predator behaviour of Large brown flying squirrel (*Petaurista philippensis*): is this an effective census method to survey the species?

Density or relative abundance of wild animals over space and time is a prerequisite for evolving effective management strategies. Such population estimates of nocturnal mammals have been hard to obtain and are often prohibitively expensive. Acoustic lures are extensively employed in ornithology to elicit response from the focal bird and later this has been adopted as a census method for the elusive and secretive animals^{1,2}. Call playbacks of conspecifics are used mostly for passerines as well as for non-passerines like nocturnal and diurnal raptors^{3–6} and in secretive water birds⁷. Interspecific and potential predator calls

have also been employed to increase the detection rate of diurnal raptors of the woodland forest³. Similarly, call playback experiments were used to develop various theories of animal behaviour (neighbour and stranger discrimination).

We employed the call playback of conspecific owl calls to enhance the detection rate of owls in the preselected census points. In the reconnaissance survey, the Large brown flying squirrel (*Petaurista philippensis*) was observed to respond to the owl's calls and such response or alarm calls of flying squirrels were recorded. In earlier studies, spotlight search over the pre-established trail

was the common method employed to encounter flying squirrels in the Western Ghats^{8–10}. Some reports on gliding mammals revealed that they respond to the predator's approach¹¹. Rohner¹² recorded the anti-predator response of Eurasian Red squirrels (*Sciurus vulgaris*) to predator calls of the Tawny owl. Since call playback method has not been employed to census nocturnal mammals, we report our observations using this technique. Out of the two species of flying squirrels found in the southern Western Ghats (Large brown flying squirrel and Small Travancore flying squirrel), we selected the Large brown flying squirrel due to its

Table 1. Response of Large brown flying squirrel to owl calls

Species	No. of responses	Known occurrence
Barred jungle owlet (<i>Glaucidium radiatum</i>)	21	5
Collared's scops owl (<i>Otus bakkamoena</i>)	8	6
Brown hawk owl (<i>Ninox scutulata</i>)	4	4
Forest eagle owl (<i>Bubo nipalensis</i>)	3	0
Mottled wood owl (<i>Strix ocellata</i>)	4	4
Brown fish owl (<i>Ketupa zeylonensis</i>)	1	1
Total	41	20

wide distribution in various topographic scales⁹.

Three methods were employed for the census, viz. (1) Quiet listening: after reaching the census point, we kept quiet for 10 min and then looked for the calls and movement of squirrels. Interim spotlight searches were made during this period to record the presence of squirrels in the census point; (2) Call playback: call sequences of the predator's calls were played using stereo players and speakers to elicit response from the squirrels, and (3) Spotlight searches: after finishing the call playback, 10 min was spent in the immediate vicinity to search for the non-responsive or approaching individuals without calls. The observations were recorded from the protected areas in Kerala and Tamil Nadu.

Out of the 162 census points, Large brown flying squirrels were encountered in 62 (38%) census points across Tamil Nadu and Kerala. And they responded to the predator's call only in 41 (66%) census points (Table 1). Among these 41 census points, the flying squirrels were sighted through call playback method in 21 (51%) of the sites. Thus in 21 (34%) of the 62 sites from where Large brown flying squirrels were encountered, we did not receive any response from the squirrels, but recorded them using spotlight search. The behaviour of Large brown flying squirrels is reported to be affected by the weather, which influences their activity pattern due to thermal and physiological variations¹³.

Out of the 12 owl calls played, the highest response was obtained for the Barred jungle owlet *Glaucidium radiatum* calls (51%), especially for 'kao-kuk' with hooting call. Similar response was also obtained for 'kwaooo' call of Collared's scops owl *Otus bakkamoena*, than

that of the common call 'uuk'. Both the species of owls were reported to occur in most of the protected areas with a wide range of altitudinal gradients in the southern Western Ghats and there may be the possibility of predation on juvenile squirrels. However, we have not observed any direct interaction between this owl species and the Large brown flying squirrel. Few responses were also obtained for calls of certain larger owls such as Forest eagle owl, Brown fish owl and Mottled wood owl (Table 1). This may be due to the scattered distribution of these large owls in the southern Western Ghats. Most of the responses of the Large brown flying squirrel for these owl calls were obtained from census points, where the presence of the large owls was recorded during the present survey. Responses were not obtained for calls of juvenile large owls (Forest eagle owl and Mottled wood owl). No response was obtained to calls of Spotted owl and Barn owl, since these do not occur in the forest areas.

Among the habitats studied, wet evergreen forest, semi evergreen, riparian and shola forests had low visibility due to the high canopy density and thick lianas, which lead to low detection rate of the Large brown flying squirrel⁸. The call playback method certainly enhances the detection rate of the Large brown flying squirrel in low visibility areas.

From this survey we conclude that the use of predator's calls, especially of larger owls which predate on flying squirrels, may increase the detection rate of flying squirrels in transect or point surveys. Call playback can be used along with the already available methods like spotlight searches. Barred jungle owlet or Forest eagle owl calls are recommended for censusing the Large brown flying squirrel populations. It is recommended not to

use the calls of owls repeatedly in a census point as this may affect the foraging behaviour of the sciurid¹⁴.

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