

Shrewd Alliances

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The first field study on the Nicobar treeshrew on Great Nicobar Island revealed some unexpected results. In the locality of South Bay adjoining the Galathea National Park situated at the southern extremity of the island, these little known mammals are members of an unusual foraging association. Nicobar treeshrews forage extensively with Greater Racket-tailed Drongos and a sparrowhawk in an alliance driven both by foraging efficiency and predator avoidance.

A MOST UNUSUAL FLOCK

Mixed species flocks or mixed hunting parties are groups of species that typically forage together for gaining access to better food benefits. In some cases, members of mixed flocks also benefit from the alertness of other flock members in detecting and avoiding predators. These flocks typically comprise 'nuclear' species that are instrumental in flock formation and 'attendant' species that

trail the nuclear species in search of food. Although we are most familiar with these associations among birds (especially insectivorous ones), other taxa such as mammals and fish are also known to form such flocks.

In our study, what set this particular alliance apart was the composition of the group as well as its cohesiveness. Treeshrews foraged extensively with drongos and sparrowhawks. While avian mixed flocks are most common, mixed mammalian and bird associations are less frequently reported. While in most other instances, the group members share a particular functional trait, e.g. insectivores or bottom feeders, this group had a most unusual member, a raptor, which could be a potential predator of the small mammal that it was foraging with. Raptors (birds of prey) have been reported before in flocks of mammals that are larger and therefore not at risk from predation. Examples of these are mainly from the Neotropics and include the association between Double-toothed Kites *Harpagus bidentatus* and a number of primates including white-faced capuchin monkeys *Cebus capucinus*, squirrel monkeys *Saimiri sciurius* and pied-bare face tamarins *Saguinus bicolor bicolor*. In India, Hari Sridhar reported the participation by the Black Baza *Aviceda leuphotes* in mixed-species bird flocks in the Anamalai Hills. The presence of birds of prey in mixed avian and mammalian groups has not been extensively explored in the context of small mammals such as treeshrews where the predator-prey size ratio is larger, a factor that may increase relative predation risk, making this association unique.

A LITTLE MORE ABOUT THE GROUP MEMBERS

Treeshrews (Order *Scandentia*, Family *Tupaiaidae*) are a group of tropical small mammals found in the forests of South and Southeast Asia. As is true for many rainforest species occurring at low densities, field observations on treeshrews have been limited to a few studies mostly in Southeast Asia. However, before mammalian phylogenies were constructed, treeshrews were classified variously as primates and insectivores and many considered these small mammals to be some kind of a 'missing link' in primate and human evolution. During this period, treeshrew behaviour was being studied in some detail in captivity. The most intriguing behavioural adaptation of *Tupaia* was reported by Robert D. Martin in 1968 with respect to

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an 'absentee parental care system' where the mother visits the young only once in one or two days, for a couple of minutes. During this period, the young are known to ingest about a third of their body weight in milk (which has very high fat content), lie motionless in the nest to conserve energy, and groom themselves from time to time. Field studies by the Smithsonian's Louise Emmons confirmed this practice for wild *Tupaia* in Borneo, and it is widely believed that this strategy points to predator avoidance. The Nicobar treeshrew *Tupaia nicobarica* which is closely related to other Southeast Asian *Tupaia* is a small tupaiid (approximately 70 g.) with a restricted range and is found only on two islands (Little and Great Nicobar islands with an area of 150 sq. km. and 995 sq. km. respectively) in the Andaman Sea. In addition to being one of the smallest among all Tupaiids, the species is characterised by its extreme arboreality, and a high degree of insectivory making this species one among a handful of non-volant foliage gleaning insectivorous small mammals worldwide.

Drongos are medium-sized insectivorous birds belonging to the family *Dicruridae* and are distributed across the tropical and subtropical regions of Africa, Asia and Australia. Many drongo species have been reported to form associations with a wide range of species ranging from ants to mammals. Greater racket-tailed Drongos *Dicrurus paradiseus* (approximately 80 g.) are resident in many parts of South and Southeast Asia. These birds play various roles in foraging associations ranging from being mutualists that benefit co-occurring species, commensal feeders that attend on beaters taking advantage of flushed insects, to occasional kleptoparasites that distract insectivorous birds (with alarm calls) at the moment of prey detection and steal food. A wide range of research on this species suggests that they mimic songs, contact calls and alarm calls of other flock members. These flock members in turn benefit from their vigilance especially in attacks by *Accipiter* hawks. In our study, up to three drongos were observed with a single

foraging treeshrew and we also suspect that the birds were mimicking treeshrew contact calls. However, mimicry was not observed directly and may be employed only occasionally as treeshrews themselves make contact calls on a regular basis. Additionally, the birds also seem well aware of the routes taken by these small mammals. The drongos directly proceeded to frequently used patches and trees whereas the treeshrews used circuitous routes to use overhangs to reach the same site. On occasion it was also suspected that the drongos followed the researcher (MAO).

A number of sparrowhawks have been reported from Great Nicobar including the endemic Nicobar Sparrowhawk *Accipiter butleri*, the Besra *Accipiter virgatus*, the Chinese Sparrowhawk *Accipiter soloensis*, and the Japanese Sparrowhawk or Goshawk *Accipiter gularis*. The latter two species are migrants that arrive in winter. Almost all these sparrowhawks are known to feed on large

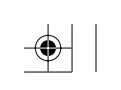
insects, small reptiles and amphibians, birds and occasionally small mammals. In species such as the Chinese Sparrowhawk, there is a greater preference for frogs and lizards, whereas those such as the Besra are more frequent in their attacks on small mammals and birds. At least some of the individuals that we observed were likely to be the Chinese Sparrowhawk. However, there is confusion regarding plumage characteristics and records of occurrence of some of these species on Great Nicobar. In the mixed foraging group, there was never more than one sparrowhawk and its role was mostly to wait at a distance for geckos that were flushed out infrequently. However, we recorded aggressive interactions between the raptor and other species that were being observed (both treeshrews as well as drongos). Typically weighing between 300 and 350 g., the sparrowhawk could be classified as a potential predator at least of the treeshrew.

METHODS

We studied three main aspects to understand this association. First, we collected data on the frequency with which different species combinations occurred, which helped us understand group formation and cohesiveness. Second, we observed distances of species from each other in different combinations on which we based some of our inferences on predator avoidance. Finally, we quantified the foraging rates to estimate feeding success of different individuals within and outside the group. We employed two commonly employed observation techniques in behavioural ecology, namely focal animal sampling and instantaneous scans. Focal animal/group sampling meant recording all relevant activities of group members after locating and following a group until it disintegrated or was lost in the canopy. Instantaneous scans on the other hand were recordings (like a photograph of a particular moment) of activity, group composition and distances between individuals; these scans were carried out at specified intervals and at different times of the day.



*Mixed-species foraging associations may be formed to enhance feeding success or to evade predators. Generally such associations have been observed between species belonging to the same taxon, for example, a mixed hunting flock comprising several species of birds or a mixed feeding group of mammals such as langurs and chital. The fact that three behaviorally different species – the Nicobar treeshrew *Tupaia nicobarica* (below) a timid, arboreal insectivorous mammal, a sparrowhawk (facing page shows a Besra, *Accipiter virgatus*), an aerial predator capable of hunting down the treeshrew, and the Greater Racket-tailed Drongo *Dicrurus paradiseus* (following page) an aerial insectivore – have been observed to forage in close-proximity of each other, raises several interesting questions regarding the evolution of associations between predators and prey and also on the intermediary role played by distinctly unrelated species.*



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RESULTS

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Both species of birds usually followed the treeshrews and fed on prey that were flushed out by its foraging. Treeshrews and sparrowhawks maintained a greater distance between each other than treeshrews and drongos. Also, distances between treeshrews and sparrowhawks were significantly greater when drongos were absent.

Ninety-seven per cent of the treeshrews' diet comprised insects, and the remaining three per cent was usually fruit. However, the shrews' foraging rate declined when drongos were present. In the rare case of more than two drongos in a flock, the birds stole food frequently and elicited aggression from treeshrews. Drongos fed once in one to four minutes in six different treeshrew–drongo–sparrowhawk combinations, while sparrowhawks fed once in 4 - 24 minutes in interspecific groups. During brief observations of solitary drongos and sparrowhawks, the former were only observed to feed twice and the latter not at all.

INFERENCES

The results of the study suggested that foraging efficiency was the driving force behind the formation of the flock. Although the foraging rates of the treeshrews declined when drongos were present, these birds may play a valuable role in protecting the shrew from sparrowhawks and other predators. Past studies report that drongos are known to be adept at perceiving and to be especially vigilant during *Accipiter* attacks and therefore foliage gleaning species such as treeshrews which are extremely conspicuous and not very vigilant benefit from the presence of drongos.

During the course of the study, treeshrews were seen maintaining greater distances from sparrowhawks in the absence of drongos, indicating that they did consider the raptor as a potential predator. The treeshrews were seen to react to other predators as well. On one occasion, their alarm calls led us to a reticulated python, a juvenile, about two metres in length. Thus, the high degree of association between drongos and treeshrews may be due to both foraging efficiency for the former and predator avoidance for the latter.

Sparrowhawk presence in mixed groups was strongly correlated to that of drongos. The pair-singleton dichotomy of the treeshrews plays a role in detection as breeding pairs, unlike solitary treeshrews, exchange frequent contact calls even when foraging close by. Drongos may depend either on

mimicry to access solitary individuals or track down the pairs on the basis of their contact calls. For the sparrowhawks, the drongos may serve as a signal for finding the treeshrews.

The occurrence data suggested that either the sparrowhawks could not trace single treeshrews without the help of drongos or that solitary individuals did not tolerate sparrowhawks in the absence of drongos. In limited observations on flock formation, sparrowhawks were always found to join treeshrew breeding pairs or groups with drongos, suggesting support for the former hypothesis. Out of 310 scans, only four records were of a sparrowhawk with a single treeshrew, and these were remnants of groups abandoned by drongos.

The sparrowhawk diverges from typical hunting techniques displayed by *Accipiters* which are known to supplement about 10 per cent of their diet with small vulnerable mammals. However, the lowered chance of predation success in the presence of drongos may have led to the choice of the predator in joining the group as a commensal. At a micro-level, the complexity of interspecific relationships in the context of mixed foraging is evident in that predators join potential prey as foraging commensals. At a macro-level, the dynamics of associations such as these has the potential to shed light on both ecological resource states and ethological adaptations of species.

Unfortunately, we have not been able to revisit the area to carry out further studies since the December 2004 tsunami. It would be very interesting to repeat this study in this and other locations where the treeshrew is found. A range of behavioural studies can be carried out on both treeshrews and drongos.

In conclusion, whereas most studies on mixed foraging flocks have examined benefits in terms of foraging efficiency, reduced predation risk or vigilance as fixed states for species or flocks, the results of this study suggest that strategies driving flock formation are more complex and context dependent with varying benefits for different species. 🐛

For the detailed text of this research paper go to <http://rsbl.royalsocietypublishing.org/content/early/2009/12/02/rsbl.2009.0945.full>



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