

Food habits and activity patterns of the Asiatic golden cat (*Catopuma temminckii*) and dhole (*Cuon alpinus*) in a primary rainforest of Peninsular Malaysia

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Tropical rainforests of Southeast Asia are home to a rich diversity of lesser known carnivores, including the Asiatic golden cat (*Catopuma temminckii*) and dhole (*Cuon alpinus*). These medium-sized carnivores are found primarily in South and Southeast Asia and, while their distribution status is yet to be fully determined for some countries, over much of their range they appear to be sympatric (Sunquist and Sunquist 2002; Durbin et al. 2004). For both species, their populations in Peninsular Malaysia represent the southernmost extent of the continental distribution. The Asiatic golden cat and the dhole are listed, respectively, as Vulnerable and Endangered by the IUCN Red List of Threatened Species (Sunquist and Sunquist 2002; Durbin et al. 2004), as well as Appendix I and II species by the Convention on International Trade in Endangered Species on Wild Fauna and Flora (CITES 2007), respectively.

Adult Asiatic golden cats weigh about 8–16 kg (Sunquist and Sunquist 2002). In Malaysia, the average weight was 8.1 kg for females ($n = 3$) and 9.0 kg for males ($n = 3$) (Lim 2002). They are solitary hunters and primarily terrestrial, but they are able to climb trees if needed. Their diet mainly consists of small vertebrates such as birds, lizards, snakes, rodents and other mammals up to the size of small deer (Lekagul and McNeely 1977; Lim 2002), but there is a record of one cat killing a buffalo (*Bubalus bubalis*) calf (Pocock 1939).

Dholes are slightly larger than Asiatic golden cats; females weigh 10–13 kg and males 15–20 kg (Durbin et al. 2004). They are strictly terrestrial, communal hunters, primarily preying on vertebrate prey, with a preference of medium to large ungulates. In India, dholes prey on medium-sized (31–175 kg) ungulates, including young gaur (*Bos gaurus*) (Karanth and Sunquist 1995; Andheria et al. 2007). The size class of prey taken by dholes in Thailand was also similar (Grassman et al. 2005).

Nothing is known about the ecology of dholes in Malaysia to the extent that until recently (Durbin et al. 2004) even the species' presence was questionable (Stewart 1993). This paper presents the first information on diet and activity patterns of two threatened but lesser known medium-sized sympatric carnivores from a primary rainforest in Peninsular Malaysia.

Materials and methods

Taman Negara National Park (4°10'–4°56'N, 102°00'–103°00'E) is located in north central Peninsular Malaysia (Fig. 1), and at 4,343 km² is the largest national park in Malaysia and one of the largest parks in Southeast Asia. Elevations range from 70 m to 2,191 m ASL. Annual rainfall averages 2,500 mm. Average relative humidity is 86% with little monthly variation (Malaysian Meteorological Service, *in litt.*). The forest type is broadly classified as a tropical evergreen moist forest (Whitmore 1984).

The food habits of Asiatic golden cat and dhole were studied based on an analysis of scats collected at three sampling sites of 200 km² each in lowland rainforest areas of Taman Negara between 1999 and 2001 (Table 1). Samples were collected opportunistically during monthly maintenance trips to check on infrared cameras that were set to photograph terrestrial mammals and secondary-sign surveys of ground-dwelling animals at randomly selected points between the cameras.

For each scat, maximum diameter was measured, GPS location recorded and any secondary sign left by the predator such as scrapes or tracks was noted. Scats were air dried, weighed, and stored for later identification of the predator and contents. The difference in the maximum diameter of scats was compared using the *t*-test ($P < 0.05$). Up to 10 g of scat samples were sent to the

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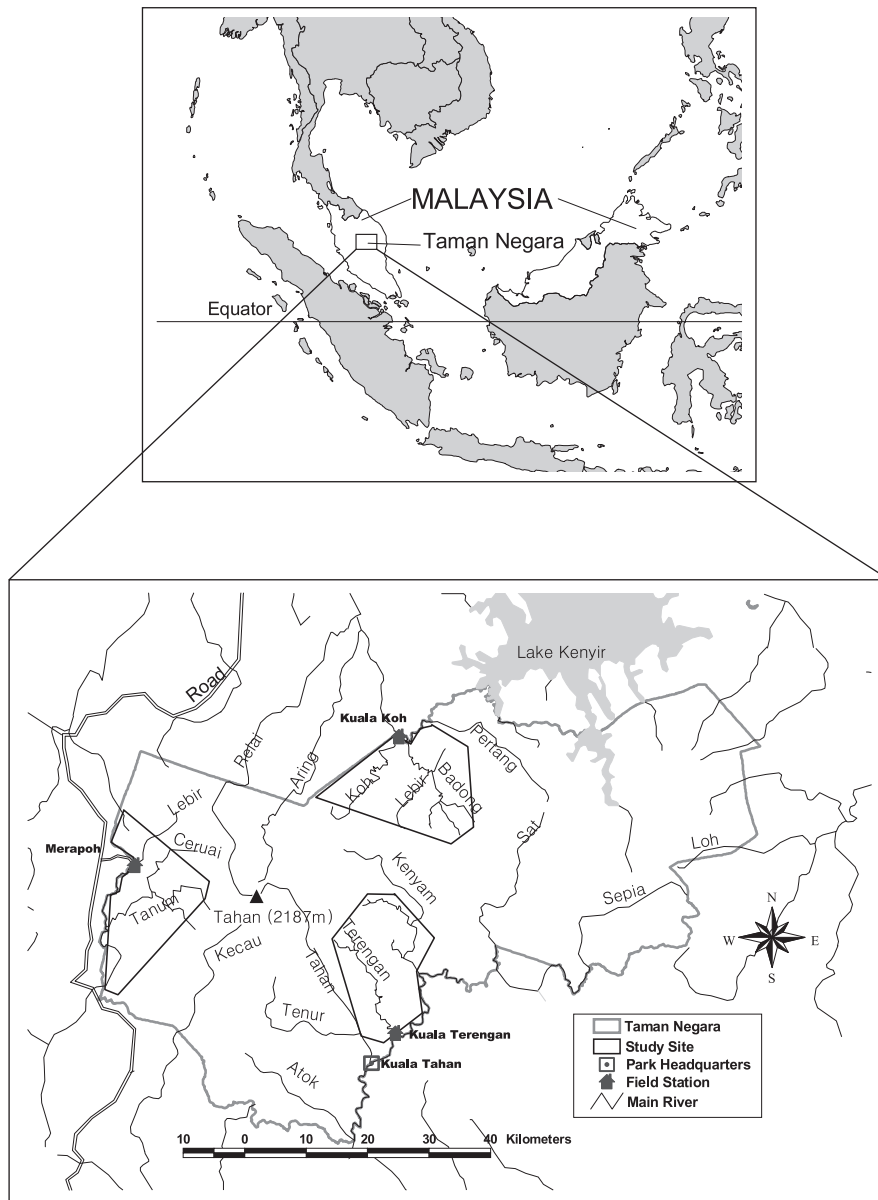


Fig. 1. Location of three study sites, Merapoh, Kuala Terengan, and Kuala Koh in Taman Negara National Park in Peninsular Malaysia where presence of golden cats and dholes were confirmed with scats and camera-trapping photographs.

Wildlife Conservation Society Science Resource Center (Bronx, New York, USA) for predator species identification based on mitochondrial DNA analysis (Iyengar et al. 2005). The methods involves isolating total genomic DNA from shed gut skin cells in the scat and then using the polymerase chain reaction to amplify homologous segments of mitochondrial DNA with species specific primers that contain species specific sites. Other parts of the scats were washed and dried in meshed nylon bags to retrieve hairs and other bodily remains of prey species. Length, color, width, medullar structure, and cuticle pattern of guard hairs in scats were examined under a

compound light microscope and identified by comparison with reference hair samples of various body parts of multiple specimens per species collected from local zoos and in the museum of the Department of Wildlife and National Parks Peninsular Malaysia. Other body parts such as dentitions, pinna and hooves also aided the prey species identification. Depending on which part of the body the hair came from, two species of mouse deer (*Tragulus napu* and *T. javanicus*) were sometimes indistinguishable. Therefore, these species were pooled in the result.

Infrared motion sensor cameras were set at 135 loca-

Table 1. General characteristics of the study areas including number of photographs and scats collected from each sites in Taman Negara National Park, Malaysia (1999–2001)

	Study site		
	Merapoh	Kuala Terenggan	Kuala Koh
Area sampled (km ²)	200	200	200
Vegetation	Lowland-hill dipterocarp	Lowland-hill dipterocarp	Lowland-hill dipterocarp
Elevation (m ASL)	90–714	70–706	70–898
Sampling period (month/year)	4/99–5/00	3/00–1/01	10/00–8/01
Total camera-trap nights ^a	4336	4847	4871
No. golden cat photos	21	4	12
No. dhole photos	6	2	8
No. golden cat scats	0	10	5
No. dhole scats	39	0	1

^aOne camera-trap night is a 24-hour period during which a camera trap is functional.

tions on active game trails in the three study sites encompassing 600 km² total in Taman Negara (Table 1). The study used the TrailMaster[®] active infrared system (Goodson Associates, Inc., Kansas, USA) and CamTrakker[®] passive infrared system (CamTrak South, Inc., Georgia, USA). Of 4,167 photos of mammals accumulated during 14,054 camera-trap nights, 37 and 16 photos were of golden cats and dholes, respectively. Detailed results of the camera-rapping study are presented elsewhere (Kawanishi and Sunquist 2004). For this study the time imprinted on each photograph was used to compare diurnal (0700–1900 hr) versus nocturnal (1900–0700 hr) activity patterns as percentage for each of the two species. Photographs of the same species taken within one hour at the same trap location were excluded from the analysis.

Results and discussion

Of the 80 carnivore scat samples analyzed based on mtDNA, 15 and 40 samples originated from Asiatic golden cats and dholes, respectively (Table 1). Fourteen samples belonged to other carnivores such as tigers (*Panthera tigris*), leopards (*P. pardus*), leopard cats (*Prionailurus bengalensis*) and a Malayan sun bear (*Helarctos malayanus*). The DNA sequence could not be obtained in 11 scats. The mean maximum diameter, $\bar{X} \pm SD$ (maximum–minimum), of the golden cats scats was 21.1 ± 3.3 (18–28) mm, slightly smaller than that of dholes at 26.3 ± 4.6 (17–37) mm ($t = 3.91$, $df = 50$, $P < 0.0005$). That some size overlap in scat diameters occurred in all carnivores except for tigers (Fig. 2) precludes predator identification of scats based on size alone.

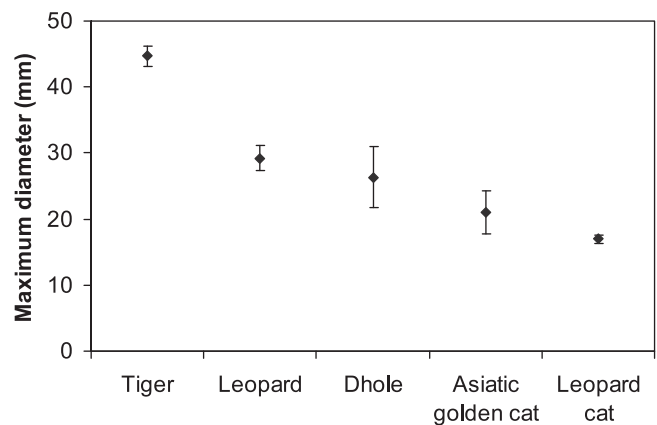


Fig. 2. The size difference in mean maximum diameter of scats of tigers, leopards, dholes, Asiatic golden cats, and leopard cats collected during 1991–2001 in Taman Negara, Peninsular Malaysia. The number of samples used for the size comparison was 3, 4, 38, 14 and 6, respectively. The error bar represents the standard deviation.

Both species consumed a variety of small vertebrates (Table 2). The largest prey taken by golden cats was a dusky leaf monkey (*Trachypithecus obscurus*); for dholes it was wild pig (*Sus scrofa*). Two cat scats contained a mouse and lizard and one contained a mouse, lizard and bird. One dhole scat contained only sand and nothing else was recovered. None of the dhole samples contained multiple prey or non-mammalian vertebrate species. Unexpectedly, 78% of the dhole scats contained mouse deer. Dholes were photographed at all three study sites, but all but one scats ($n = 39$) came from the Merapoh site (Table 1). The significance of mouse deer in the dhole diet therefore may not be a representative of the dhole diet in the entire park. Nevertheless, weighing only 2–4.5 kg, the mouse deer is too small as prey compared with the typical dhole diet elsewhere

Table 2. Prey species identified in Asiatic golden cat ($n = 15$) and dhole scats ($n = 40$) collected in Taman Negara National Park, Peninsular Malaysia (1999–2001). Three Asiatic golden cat scats contained multiple species and 1 dhole scat contained primarily sand

Prey species	Weight (kg)	Asiatic golden cat	Dhole
Mammals			
<i>Trachypithecus obscurus</i>	6.4–6.8 ^b	1	1
<i>Macaca nemestrina</i>	6.5 ^a	0	3
<i>Sciurid</i> spp.	<0.25 ^b	0	2
<i>Rattus</i> spp.	<0.5 ^b	1	0
<i>Chiropodomys gliroides</i>	0.023–0.035 ^b	1	0
<i>Murid</i> spp.	<0.2 ^b	5	0
<i>Atherurus macrourus</i>	2.5 ^b	1	0
<i>Sus scrofa</i>	32 ^c	0	2
<i>Tragulus</i> spp.	2–4.5 ^a	3	31
Snakes		2	0
Lizards		5	0
Birds		1	0

Data source: ^aPayne et al. (1985), ^bMedway (1978), ^cKaranth and Sunquist (1992).

(Karanth and Sunquist 1995; Durbin et al. 2004; Grassman et al. 2005; Andheria et al. 2007).

As communal hunters, dholes can form packs of over 30 animals, but pack sizes of 5–10 individuals appear to be the norm (Durbin et al. 2004). Although an accurate group size is difficult to ascertain by the camera-trapping method, the maximum number of animals photographed in a single frame was four animals and the other 15 dhole photos consisted of either single or paired animals. Based on a wide-angle photograph depicting three stationary animals investigating the camera trap and one resting on the ground, the actual pack size was probably no more than four. It is postulated that smaller pack sizes are more energetically advantageous in the rainforest where large prey species are scarce, thick vegetation favors stalk and ambush hunting techniques over cursorial hunting, and competition with tiger and leopards for small to medium-sized prey is high (Kawanishi and Sunquist 2004). Among the three top predators, dholes appeared least abundant with 16 photos whereas tigers and leopards scored 61 and 150 photos, respectively (Kawanishi and Sunquist 2004). Dholes' habitats are secured in Taman Negara, but the predators may be threatened by the scarcity of adequate-sized prey species. Indeed, the ribs of some dholes were clearly visible in some photographs.

While the sample of photographs used in the analysis of activity patterns was small, all dhole photographs ($n =$

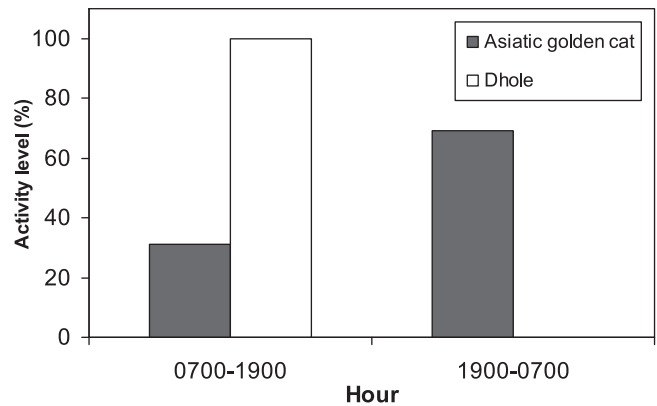


Fig. 3. Diurnal (0700–1900 hr) versus nocturnal (1900–0700 hr) activity pattern of Asiatic golden cats and dholes based on photographs taken during 1999–2001 in Taman Negara, Peninsular Malaysia. The number of photographs used for this analysis was 32 for Asiatic golden cats and 9 for dholes.

9) were taken during daytime (Fig. 3). Their principle prey, mouse deer, and two most abundant medium sized ungulates in the study sites, barking deer and wild boar all showed the same diurnal activity patterns (Kawanishi and Sunquist 2004). Asiatic golden cats were largely nocturnal with 69% of the photos ($n = 32$) taken between 1900 h and 0700 h (Fig. 3). Unlike strictly diurnal dholes, golden cats were active during both day and night except for 1400–1900 hr. This arithmetic tendency is reflected in the variety of vertebrate taxa, including both diurnal and nocturnal species, consumed by the cat (Table 2).

While Taman Negara is the best protected conservation area in Peninsular Malaysia, basic ecological studies of many threatened species are lacking. Besides logistical challenges associated with working in large road-less areas, scats and kill sites are difficult to find in a rainforest. Though sample sizes were limited, this study presents the first dietary information of golden cats and dholes from a Malaysian rainforest. Both species are fully protected under the local wildlife legislation. Yet the conservation status of neither species is known in Malaysia. Information from various sources needs to be gathered to first determine the distribution in the country. Understanding of basic ecology and threats based on more focused research is needed to devise a conservation strategy for these species.

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