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Short Note

Notes on the Diet of the Malay Civet (*Viverra zangalunga*) and other Civets in Logged and Unlogged Lowland Dipterocarp Rain Forests in Sabah, Borneo

CHRISTINA P. COLON¹ and JOHN B. SUGAU

Civet diets were examined in a logged and unlogged Bornean rain forest. Malay civets (*Viverra zangalunga*) consumed invertebrates, fruit, rodents, insectivores, birds, snakes and lizards, and appear to show preference for centipedes and scorpions. Other civet species consumed fruit, such as figs, *Connarus* sp. and *Annona* sp., particularly in the unlogged forest, but also consumed invertebrates and vertebrates. Reduced fruit consumption observed in the logged forest may be due to lower availability and may be offset by increased consumption of invertebrates. The increased overlap in diet between Malay civets and other civets in disturbed areas may lead to increased competition.

Keywords: diet, frugivory, civet (*Viverridae*), logging, dipterocarp rain forest, Sabah, Borneo

Scat and stomach content were used to compare diets of civets in logged and unlogged forest in the Danum Valley Conservation Area and Ulu Segama Forest Reserve in Sabah, Borneo. Civets are among Asia's most frugivorous carnivores (Corlett 1998), while Malay civets (*Viverra zangalunga*) are partially omnivorous (Eisenberg 1989), consuming meat and insects (Payne *et al.* 1985), leaves, fruit and scraps (Macdonald and Wise 1979).

Scats were collected along roads and trails from December, 1995 through May, 1997. Scats were attributed to Malay civets based on size, location, morphology and grooming hairs (n = 58). Scat that could not be attributed to Malay civets were considered to be from civets common to the area, and were analyzed as a group (n = 122). Based on sightings and road kills, the most likely species producing these scats were the common palm civet (*Paradoxurus hermaphroditus*), banded palm civet (*Hemigalus derbyanus*) and small toothed palm civet (*Arctogalidia trivirgata*). Scat were initially dried then soaked in alcohol for

Manuscript received: 20 September 2011

Manuscript accepted: 24 January 2012

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analysis. Stomachs were retrieved from road kills in the logged forest (n = 6) and necropsied at Sepilok Orangutan Center. Stomach contents were preserved in 10% formalin, then identified under a dissecting microscope. Diet items were identified using a reference collection from the study area. A sub-sample was examined at 100x magnification for earthworm chaetae. Seeds were identified at the Forest Research Center in Sandakan.

Food availability was assessed with 10 pit traps 25 cm in diameter, at 10m intervals along a 100 m transect in both forests. Traps contained 2.5 cm untreated water, and were checked on alternate days for 30 days from October 8th to November 7th, 1996. Diets were compared between Malay civets and other civets, as well as between forest types, using a Chi². A Renkonen index of percentage similarity (Krebs 1989) was used to quantify overlap between sites. Diet diversity between sites was determined with a Simpson's index of diversity.

In both forest types, invertebrates dominated the diet for Malay civets; including beetles, crabs, scorpions, and millipedes (Table 1.). Vertebrates eaten

Table 1: Diet items (and percentage) from Malay civet (*Viverra zibetha*) scats in an unlogged (n=17) and a logged forest (n=41) in Sabah, from October 1995 to May, 1997.

	<i>Unlogged Forest</i>	<i>Logged Forest</i>
<i>Invertebrates</i>		
Araneae (Spider)	2 (12%)	2 (5%)
Blattodea (Cockroach)	3 (18%)	17 (42%)
Brachyura (Crab)	11 (65%)	22 (54%)
Chilopoda (Centipede)	0 (0%)	1 (2.5%)
Coleoptera (Beetle)	8 (47%)	28 (68%)
Formicidae (Ant)	0 (0%)	3 (7%)
Isoptera (Termite)	2 (12%)	5 (12%)
Myriapoda (Millipede)	7 (41%)	11 (27%)
Scorpiones (Scorpion)	5 (29%)	19 (46%)
<i>Vertebrates</i>		
Aves (Bird)	0 (0%)	1 (2.5%)
Insectivora (Insectivore)	0 (0%)	1 (2.5%)
Lacertilia (Lizard)	0 (0%)	2 (5%)
<i>Other</i>		
Rodentia (Rodent)	0 (0%)	2 (5%)
Fruit	13 (76%)	18 (44%)
Leaf	5 (29%)	7 (17%)
Unidentified bone	3 (18%)	7 (17%)
Unidentified larva	3 (18%)	11 (27%)

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included rodents, insectivores, birds, snakes and lizards. The stomach of one juvenile male Malay civet contained earthworms, grass, bees and grasshoppers, while a sub-adult female's stomach contained unidentified berries, earthworms, ants, beetles, grasshoppers, and leaf matter.

There was 73% similarity in diet between sites for Malay civets, with 76% of scats in the unlogged forest containing fruit versus 44% in the logged forest. Although invertebrates were consumed more in the logged forest, only snails were significantly more common ($p < 0.001$).

Fruit dominated the diet of other civets, particularly in the unlogged forest (91%) as compared to the logged forest (39%). Of the 20 species of fruit in scats, most were collected in the unlogged forest (logged 42 spp, unlogged 6 spp), and most common were figs, *Connarus* sp. and *Annona* sp. (Table 2.). Although the density and diversity of fruit trees was artificially high around the Field Center, six genera identified in scats from the unlogged forest were present in the unlogged forest (Newbery, *et al.* 1992) and all were reportedly common there. *Dimocarpus longan* and *Psidium* sp. are the only domesticated species consumed by civets (J. Sugau pers. obs.). In the logged forest, *Ficus* was reported (Howlett and Davidson 2003), but data on other taxa are lacking.

Table 2: Seeds identified from civet scats (not including Malay civets) in an unlogged (n = 42) and a logged forest (n= 6) in Sabah Borneo, October 1995 to May, 1997.

<i>Fruit Taxa</i>	<i>Unlogged Forest</i>	<i>Logged Forest</i>
<i>Adenia</i> sp. (Passifloraceae)	-	1 (1.6%)
<i>Alangium</i> sp. (Alangiaceae)	2 (5%)	-
<i>Annona</i> sp. (Annonaceae)	4 (9.5%)	-
Apocynaceae	3 (7%)	-
<i>Connarus</i> sp. (Connaraceae)	5 (12%)	-
<i>Dialium indium</i> (Leguminosae)	1 (2.4%)	-
<i>Dimocarpus longan</i> (Sapindaceae)	-	1 (1.6%)
<i>Ficus</i> sp. (Moraceae)	15 (36%)	1 (1.6%)
<i>Garcinia</i> sp. (Guttiferae)	1 (2.4%)	-
<i>Glochidion</i> sp. (Euphorbiaceae)	1 (2.4%)	-
Leguminosae	2 (5%)	1 (1.6%)
Menispermaceae	1 (2.4%)	-
<i>Microcos</i> sp. (Tiliaceae)	-	1 (1.6%)
<i>Palaquium</i> sp. (Sapotaceae)	2 (5%)	-
<i>Polyalthia</i> sp. (Annonaceae)	1 (2.4%)	-
<i>Pometia pinnata</i> (Sapindaceae)	1 (2.4%)	-
<i>Psidium</i> sp. (Myrtaceae)	2 (5%)	-
Vitaceae	1 (2.4%)	-

The next most common diet items for other civets were centipedes, beetles, crabs, millipedes and scorpions (Table 3) with 60% similarity between sites. Vertebrates eaten include rodent, lizard, snake, bird, fish, an insectivore, and a bat. The stomach of an old male common palm civet contained all items above, as well as vertebrate fat and muscle, and a flower that appeared to be Asteraceae, and that of a sub-adult male contained only seeds of the genus *Connarus*. The stomach of an adult male banded palm civet contained a brown spiny rat (*Maxomys rajah*), plant matter, a claw from a land crab, and arthropod legs (probably insect), and that of a sub-adult male contained earthworm chaetae, a beetle, centipede legs and spider remains. Taxa that occurred in civet diets with significantly higher ($p < 0.03$) frequency in the logged forest were ants beetles, centipedes, roaches, lizards, millipedes and scorpions.

There was a 69% similarity between diets of Malay civets and other civets in the logged forest, with Malay civets consuming significantly more invertebrates ($p < 0.015$). In the unlogged forest, there was less dietary overlap (59% similarity). Invertebrate and vertebrate prey availability between sites was similar. The 256

Table 3: Diet items from scat of civets other than Malay civets in unlogged (n=66) and logged forest (n=54) in Sabah Borneo, October 1995 to May, 1997.

<i>Diet Category</i>	<i>Unlogged Forest</i>	<i>Logged Forest</i>
<i>Invertebrates</i>		
Acarina (Tick/Mite)	0 (0%)	1 (2%)
Araneae (Spider)	2 (3%)	4 (7.4%)
Blattodea (Cockroach)	2 (3%)	17 (32%)
Brachyura (Crab)	12 (18%)	18 (33%)
Chilopoda (Centipede)	11 (17%)	28 (52%)
Coleoptera (Beetle)	6 (9%)	27 (50%)
Formicidae (Bee/Wasp)	1 (1.5%)	8 (15%)
Isoptera (Termite)	2 (3%)	0 (0%)
Orthoptera (Grasshopper/Cricket)	3 (4.5%)	4 (7.4%)
Scorpiones (Scorpion)	6 (9%)	18 (33%)
Stylommatophora (Snail)	3 (4.5%)	8 (15%)
<i>Vertebrates</i>		
Aves (Bird)	1 (1.5%)	5 (9.3%)
Chiroptera (Bat)	0 (0%)	1 (2%)
Insectivora (Insectivore)	1 (1.5%)	0 (0%)
Lacertilia (Lizard)	0 (0%)	5 (9.3%)
Ophidia (Snake)	1 (1.5%)	3 (5.5%)
Osteichthyes (Fish)	1 (1.5%)	3 (5.5%)
<i>Other</i>		
Fruit 60 (91%)	21 (39%)	
Leaf	9 (14%)	8 (15%)
Unidentified bone	1 (1.5%)	2 (3.7%)

animals captured in pit traps in the unlogged forest and 234 captured in the logged forest overlapped by 99.6%. Most numerous were ants, roaches, beetles, millipedes, spiders and centipedes (Table 4.). The most common vertebrates were shrews and rough skinks. Among Malay civets, there was 55% overlap between food availability and diet, with scorpions (*Heterometrus* sp.) and centipedes (*Scolopendra* sp.) rarely appearing in pit traps, while insectivores, grasshoppers, and spiders were more common in traps than diet.

The omnivorous diet of the Malay civet from this study support previous findings by Eisenberg (1989), Macdonald and Wise (1979) and Payne et al. (1985). Malay civets appear to show some degree of prey preference, particularly for centipedes and scorpions. These data also confirm that fruit is a critical food resource for civets, and is a primary diet item in unlogged forest. The reduced fruit consumption observed in the logged forest may be due to lower availability (Johns 1985), but appears to be offset by increased consumption of invertebrates, which either remain abundant (Burghouts *et al.* 1992) or re-colonize (Davis *et al* 2001) after logging. The increased overlap in diet between Malay civets and other civets in disturbed areas may lead to increased competition.

Table 4: Terrestrial animals captured in pit traps in logged (n=234) and unlogged (n=256) forests in Sabah, Borneo from 8 October to 7 November, 1996.

<i>Diet Category</i>	<i>Unlogged Forest</i>	<i>Logged Forest</i>
<i>Invertebrates</i>		
Annelida (Segmented worm)	4	3
Arania (Spider)	17	19
Blattodea (Cockroach)	20	23
<i>Camponotus</i> sp. (Carpenter ant)	38	31
Coleoptera (Beetle)	30	21
Diptera (True fly)	1	2
Formicidae (Bee/Wasp)	88	81
Hemiptera (True bug)	2	5
Hymenoptera (Ant/Bee/Wasp)	2	1
Isoptera (Termite)	3	1
Lepidoptera (Moth/Butterfly)	1	0
Orthoptera (Cricket)	21	17
<i>Platyrrhynchus</i> sp.(Diplopoda)	19	22
Scorpionidae (Scorpion)	4	2
<i>Scutigera</i> (<i>Chilopoda</i>) (<i>Long legged centipede</i>)	6	6
<i>Vertebrates</i>		
<i>Chaperina fusca</i> (<i>Saffron bellied frog</i>)	1	0
<i>Kalophrynus pleurostigma</i> (<i>Black spotted sticky frog</i>)	1	1
<i>Mabuya rudis</i> (<i>Rough skink</i>)	13	5
<i>Rattus</i> sp.(Rat)	1	1
<i>Suncus</i> sp. (Shrew)	12	12

ACKNOWLEDGEMENTS

Gratitude is extended to David Burney and Alan Rabinowitz for their mentorship. Thanks to Fordham University, The J.W. Fulbright Foundation, The Wildlife Conservation Society, and The Royal Society of London, for their generous financial support. Thanks to the staff of Danum Valley Field Center, Economic Planning Unit, Yayasan Sabah, and Rakyat Breyaya for permission to conduct research in Danum Valley. A posthumous thanks to Robert Wisdom and Annelisa Kilbourn for help with the necropsies.

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