Diet of the Common Palm Civet *Paradoxurus hermaphroditus* in a rural habitat in Kerala, India, and its possible role in seed dispersal

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Abstract

Common Palm Civet *Paradoxurus hermaphroditus* diet in a rural habitat in India was studied by faecal analysis. Observations were made from January 2008 to May 2010, although no faeces were found after January 2010. In total 94 faeces were collected. Of these, vegetable matter alone was found in 82% and animal matter alone in 4%; 14% held both plant and animal matter. Fruits were the predominant vegetable matter in the faeces. Papaya *Carica papaya* was the most common fruit of which remains were found and was eaten year round. No seasonal change in proportion or dietary shift between vegetable and animal matter was observed. Seeds from faeces were viable and a high percentage of defecated seeds germinated. Considering the movement pattern of Common Palm Civets studied elsewhere and the high seed germination rate, Common Palm Civet is plausibly an effective seed disperser of fleshy-fruited plants in the study area. Common Palm Civet often attacks poultry and is perceived as a threat by the poultry farmers.

Keywords: Balaramapuram, faecal analysis, frugivory, poultry raiding, seed germination

Introduction

Order Carnivora includes a wide range of animals characterised by a diversity of diets. Studying diet in carnivores helps understand their influence on distribution and abundance of other species including plants, and their population dynamics, habitat use and social organisation (Rabinowitz 1991, Chuang & Lee 1997). Despite extensive literature on diet of large carnivores, information on the diet of tropical Asian small carnivores is limited (e.g. Joshi *et al*. 1995, Grassman 1998, Zhou *et al*. 2008, Mudappa *et al*. 2010). Diets of small carnivores, especially civets, in India have been studied few times (Krishnakumar & Balakrishnan 2003, Mudappa *et al*. 2010).

The palm civets (subfamily Paradoxurinae, family Viverridae) occur across southern and some of eastern Asia in a wide variety of habitats (Pocock 1933, Lekagul & McNeely 1977). The Common Palm Civet *Paradoxurus hermaphroditus* lives in tropical forests, plantations, fruit orchards and human-settled areas (Prater 1971), often residing in eaves of houses or outbuildings, across the Indian subcontinent and southern China to Southeast Asia including the Philippines and east to New Guinea, in part by introduction (Patou *et al*. 2010). In Kerala, a coastal state of peninsular India, Common Palm Civets are usually found in well-wooded areas and in open places including areas adjacent to human habitations (Balakrishnan 1997).

Common Palm Civet is an omnivore that feeds on fruits and flesh (Joshi *et al*. 1995, Grassman 1998, Krishnakumar & Balakrishanan 2003). In forested areas, it is primarily frugivorous, feeding on berries and pulpy fruits including those of figs and palms and is an effective seed disperser (Rabinowitz 1991, Corlett 1998, Nakashima *et al*. 2010). It is often considered a pest because of its raiding of coffee plantations, other fruit crops and poultry, even though the coffee beans recovered from its faeces are used to make a high-value speciality coffee (Prater 1971). The present paper reports the diet of Common Palm Civet in a rural area of Kerala, India, and the animal's possible role in seed dispersal.

Methods

Food composition was studied by analysing faeces, a technique widely used to study small carnivore diet (Corbett 1989, Rabinowitz 1991, Grassman 1998). Faeces were collected from a rural house terrace in Balaramapuram (8°42'N, 77°04'E) of Thiruvananthapuram, Kerala, India. The terrace was near a house where civets were observed to roost. According to the owner, up to three animals were present, although it was not confirmed that more than one provided the faeces analysed here. Observations were made every week from January 2008 to May 2010, although no faeces were found after 24 January 2010, and it was not possible to confirm whether the civets still slept at the same place.

Faeces were identified as from Common Palm Civet based on their occurrence in more-or-less the same location as the roosting animal(s), shape (including elongated nature) and composition of undigested plant or animal matter. Collected faeces were examined by naked eye and with a hand lens—seeking seeds, pericarps, hairs, bones, feathers, insect exoskeleton, insect wings etc. Seeds of Papaya *Carica papaya*, Common Jack *Artocarpus heterophyllus*, Jungle Jack *A. hirsutus*, Custard-apple *Annona reticulata* and Fishtail Palm *Caryota urens* collected from the civet faeces were sown directly and without any treatment in backyard soil to test viability of defecated seeds; no anti-seed-predator enclosures were used. Seeds were checked daily for germination and predation.

Results are presented as percentage frequency of occurrence (number of faeces with the particular item/total number of faeces x 100) of a particular matter in the faeces. A chi-square test was done to investigate the dietary preference (fruits vs. animal matter).

Results

In total, 94 faeces were collected. Most faeces (81) contained either plant or animal matter, but 13 contained both (Table 1). Vegetable matter predominated: more than 95% of the faeces contained vegetable matter, alone or with animal matter. Only

Table 1. Vegetable and animal matter composition of the faeces of Common Palm Civet *Paradoxurus hermaphroditus*, collected from a rural site in Kerala, India, during 2008–2010.

Item description	Number of faeces	Percentage of occurrence
Vegetable matter alone	77	81.91
Animal matter alone	4	4.25
Vegetable and animal matter	13	13.83
Vegetable matter with or without animal matter	90	95.74
Animal matter and with or without vegetable matter	17	18.10

4.3% of faeces contained only animal matter. Fruit materials were the dominant remains (90.1% of the faeces) year round. Intake of animal prey was low. The faeces held fruits much more frequently than they did animal matter ($\chi^2 = 23.62$, $df = 1$, $P < 0.001$). Grass plugs, i.e. partly chewed grass leaves (mostly with animal matter) and cooked rice were also found in the faeces. A single food item was recovered from 76 (80.8%) faeces, 17 (18.1%) contained two food items and one contained three food items (1.1%). There was no evidence of a seasonal shift in relative importance of animal material in the diet. Faeces composed entirely of animal matter were found in July 2008 (13 and 18 July; rodent skull and hairs and millipede remains), February 2009 (frog skin and bones) and November 2009 (millipede remains). Faeces containing both animal and plant matter were obtained in February (twice), May, June and November 2008; January, March (twice), July, September (twice) and October 2009; and January 2010.

Eighteen species of fruits and/or seeds were collected, with *Carica papaya* the most frequent fruit recovered (Table 2). In most cases, the civet(s) ingested fruit pulp along with seeds and defecated undamaged seeds. Although remains of *Artocarpus heterophyllus* were observed 13 times in faeces, seeds were found on only four occasions, probably reflecting their large size. The five predominant fruits found were *C. papaya*, *A. heterophyllus*, *A. hirsutus*, *Caryota urens* and *Annona squamosa*. Vertebrate matter, including rodents, birds, reptiles and amphibians was found in seven faeces. Invertebrate remains (insects, millipedes, beetles and snail shell) were found in 11 faeces. Cooked rice was found in four faeces of which two contained chilli *Capsicum annuum* pericarp and seeds. Excepting *Annona squamosa* (62.2%), all plant species showed high rates of germination (Table 3).

During the study period, seven incidents (one a direct sighting) of animals assumed to be Common Palm Civets taking live chickens from unattended poultry sheds were recorded. All incidents occurred between 18h15 and 19h30. In the direct sighting (18h25), the fowl escaped when the civet was threatened. In all other incidents, the animal killed the fowl and only the carcass of the fowl was found, without head and neck portion. These were identified as Common Palm Civet kills because this mode of attacking poultry on its head is believed by local poultry farmers to be peculiar to the species. According to the farmers, domestic dogs *Canis familiaris* and stray cats *Felis catus* usually tear the bird at the site itself and carry the carcass away, while mongooses *Herpestes* apparently attack only chicks and not adult birds. The local farmers felt that they never see Small Indian Civet *Viverricula indica* in the area. Thus, attribution of these kills to Common Palm Civet requires confirmation.

Table 2. Fruits and seeds present in Common Palm Civet *Paradoxurus hermaphroditus* faeces collected from a rural site in Kerala, India, during 2008–2010.

Plant type	Frequency of occurrence	Percent occurrence	Total number of seeds recovered
Carica papaya Papaya (Caricaceae)	24	25.53	346
Artocarpus heterophyllus Common Jack (Moraceae)	13	13.82	19
A. hirsutus Jungle Jack (Moraceae)	10	10.63	107
Caryota urens Fishtail Palm (Arecaceae)	6	6.38	42
Musa spp. Plantain (Musaceae)	3	3.19	0
Mangifera indica Mango (Anacardiaceae)	2	2.12	0
Capsicum annuum Chilli (Solanaceae)	2	2.12	14
Annona squamosa Custard-apple (Annonaceae)	5	5.31	68
Annona reticulata Bullock's heart (Annonaceae)	2	2.12	11
Annona muricata (Annonaceae)	1	1.06	2
Passiflora edulis a passion fruit (Passifloraceae)	2	2.12	56
Flacourtia jangomas (Flacourtiaceae)	3	3.19	47
Ananas comosus Pineapple (Bromeliaceae)	2	2.12	0
Syzigium cuminii Jamun (Myrtaceae)	1	1.06	18
Psidium guajava Guava (Myrtaceae)	2	2.12	92
Ficus bengalensis Fig (Moraceae)	2	2.12	148
Cucurbitaceae fruit	2	2.12	35
Unidentified	1	1.06	17

Discussion

Common Palm Civet is among the more frugivorous viverrids (Corlett 1998). No systematic studies on its diet have been carried out in India (Singh 1982, Krishnakumar & Balakrishanan 2003) but fruits have been recorded as its major food

Table 3. Germination percentage of seeds collected from Common Palm Civet *Paradoxurus hermaphroditus* faeces collected from a rural site in Kerala, India, during 2008–2010.

Species	Number of seeds sowed	Number of seeds germinated	Percentage of germination
Carica papaya	78	69	88.46
Artocarpus heterophyllus	10	10	100.0
Artocarpus hirsutus	40	36	90.00
Annona squamosa	45	28	62.22
Caryota urens	30	22	73.33

English names and botanical families for each species are given in Table 2.

in countries such as Nepal (Joshi *et al*. 1995), Thailand (Rabinowitz 1991, Grassman 1998) and Myanmar (Su Su & Sale 2007). A recent investigation of Common Palm Civet feeding ecology in semi-urban habitats in Trivandrum revealed fruit as the predominant (about 82%) component (Krishnakumar & Balakrishnan 2003). Joshi *et al*. (1995) observed that fruits constituted about 84.5% of the total faeces, with only 15.5% animal matter in Nepal. The present observations corroborate the earlier studies. Balaramapuram being a rural area, every home yard has one or more fruit plants. Excepting *A. hirsutus*, *Ficus* and *Mangifera indica*, these fruit plants have no specific time of fruiting, so fruits were available all year.

Most faeces contained a single fruit species/food item, showing that the civet(s) ate a single source in bulk at a particular feeding time. The frequent occurrence of grass leaves in the faeces (10.6% of total faeces) is consistent with other studies, mostly concluding a possible role of grass leaves in scouring the intestine and in the digestion process (Grassman 1998, Krishnakumar & Balakrishnan 2003, Balakrishnan & Sreedevi 2007, Mudappa *et al*. 2010).

Common Palm Civet(s) ate at least 18 fruit species in the present study, mostly from non-native plants (Nayar *et al*. 2006). Krishnakumar & Balakrishnan (2003) identified only 10 fruit species from Common Palm Civet faeces in two semi-urban habitats in Trivandrum, Grassman (1998) 13 fruit species in faeces pooled from Common and Masked Palm Civet *Paguma larvata* in Kaeng Krachan National Park (Thailand) and Su Su & Sale (2007) about 31 types of fruits in Common Palm Civet faeces analysed from Hlawga, Myanmar, with little seasonal fluctuation in total intake. *Carica papaya* was the predominant fruit found in the present study, as by Krishnakumar & Balakrishnan (2003). *Carica papaya* is a common fruit tree found in almost every home yard in Kerala, which fruits year round; and civets have easy access to these fruits. Most faeces containing papaya remains also had viable seeds. Similarly, seeds of *Artocarpus heterophyllus*, *A. hirsutus*, *Annona squamosa* and *Caryota urens* showed high seed germination rate (see Table 3). Both *Artocarpus* species are abundant across rural and forested parts of Kerala. Besides providing fruits, they are important timber species. By defecating viable seeds, Common Palm Civets may help the effective dispersal of these economically important trees.

Faeces with vertebrate and invertebrate remains showed that the animal supplements its carbohydrate-rich fruit diet with protein-rich animal matter. Su Su & Sale (2007), in Myanmar, found only very few vertebrate and invertebrate remains in the diet of *P. hermaphroditus*. Cooked rice in the faeces showed the scavenging nature of the Common Palm Civet. Bekele *et al*. (2008) observed high rate of scavenging in human habitats by the African Civet *Civettictis civetta* in Ethiopia and Balakrishnan & Sreedevi (2007) observed that faeces of Small Indian Civet collected near human habitats often containing cooked rice and fish bone.

In the present study, no seasonal dietary shift between fruits and animals was observed, in contrast to studies in Nepal and Thailand (Rabinowitz 1991, Joshi *et al*. 1995). The year-round availability of one or more types of fruits in the study area might explain the absence of seasonal dietary shift in this part of Kerala.

All seven poultry-raiding incidents during the two-year period occurred between 18h15 and 19h30, the time that civets leave their day roost. The civet may have drunk the blood by removing the head, as there were no signs of blood on the incident site or neighbouring areas. A recent observation of Balakrishnan & Sreedevi (2007) on the stomach content of Small Indian Civets showed that only the head region of a babbler *Turdoides* (a bird) was chewed and feathers and body were left intact. Similarly, in all these attacks apparently by Common Palm Civet, the headless carcass of the bird was found. The animal perhaps leaves the body of poultry because of its weight. Common Palm Civets become active around 18h00 and activity decreases later in the night (Rabinowitz 1991, Joshi *et al*. 1995, Su Su & Sale 2007): thus, in the present study, the civet raided poultry in its peak activity time. Although the species responsible for this raiding behaviour are not confirmed, the local belief that Common Palm Civet is the culprit means that the poultry farmers consider the species a menace.

Frugivorous carnivores may disperse seeds (Herrera 1989, Nakashima *et al*. 2010). When an animal ingests fruits, the successful dispersal of the seeds depends on feeding behaviour of the frugivores, the seed viability after consumption and gut passage and the movement of animals. The seeds collected from the faeces were undamaged and did not lose their viability after the gut passage. Daily movement patterns of civets in the present study area were not studied, but elsewhere (Rabinowitz 1991, Joshi *et al*. 1995, Su Su & Sale 2007, Koike *et al*. 2008) Common Palm Civets move long distances so may transport seeds equivalently. Carnivores may produce seed shadows differing qualitatively and quantitatively from those produced by other dispersers such as birds and primates (Nakashima *et al*. 2010). Even though faeces collected in this study were from a terrace and thus have low chance of germination in situ, other sites that the animal(s) defecated at may well have been more suitable for germination. It is plausible to assume that Common Palm Civets in the study area may be acting as a disperser of fruit plants in the locality.

In this study the faeces were collected from only a single locality and may have all come from only one animal, forestalling firm generalisation to the regional diet. Moreover, although faecal analysis proved the consumption of some species, some dietary components may have been overlooked if they are well

digested or otherwise leave no readily identifiable remains. Nonetheless, the present study provides a clue about the diet of *P. hermaphroditus* in rural India and its role in seed dispersal of economically important plants.

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